INTERNATIONAL DESIGN CONFERENCE - DESIGN 2024
https://doi.org/10.1017/pds.2024.163

Design as a practice for implementing complex digital health: preliminary results from an interview study in the Netherlands

Fredrik K. Karlsson [1,✉], Valeria Pannunzio [2], Dirk Snelders [1] and Maaike S. Kleinsmann [1]

[1] Delft University of Technology, The Netherlands, [2] University of Cambridge, United Kingdom

✉ k.f.karlsson@tudelft.nl

Abstract

Challenges in implementing digital health in clinical practice hinder its potential. The complexities posed by implementation could benefit from using design practices. To explore the current role of design practices in digital health implementation, designers in the Netherlands were interviewed. The preliminary results indicate that designers contribute to digital health implementation processes, especially in the early stages. Design practices are mainly used for engaging the users, testing concepts, aligning the ideas of stakeholders, and adapting interventions to fit within the contexts.

Keywords: implementation science, design practice, digital health, complexity, healthcare design

1. Introduction

Digital health is a broad field, including technologies such as artificial intelligence, telemedicine, wearables, and mobile applications. Digital health is currently used to improve access to care, increase the quality of care, reduce inefficiencies, and improve patient personalization (DHCE, 2020), and some institutions, including the WHO, are promoting further adoption worldwide (WHO, 2019; DHCE, 2020). While there is considerable potential in new digital health solutions, realizing their benefits has often been slower than anticipated due to difficulties in implementation (Wachter, 2016). Given constrained healthcare conditions, establishing and improving procedures for implementation is crucial for maximizing investment impact (Bauer et al., 2015). Greenhalgh et al. (2017) identify several key issues in digital health implementation, such as lack of adaptability in digital health solutions and insufficient prototyping, leading to inadequate proof of concept and usability. Suggestions to address digital health implementation issues include increased attention to implementation challenges during intervention development and continuous stakeholder engagement (van Gemert-Pijnen, 2022; Ross et al., 2018). An iterative approach is also suggested for complex digital health solutions to address emerging issues and replace ineffective strategies (Ross et al., 2018).

Based on current implementation issues, an opportunity exists for design practice to contribute to reducing some of the issues with digital health implementation. Current design research in the digital health domain's complex, interdisciplinary field focuses on efforts in collaborative co-design due to the need to manage multiple perspectives and disciplines (Duffy et al., 2022). Future directions for design for digital health have also been discussed by Cafazzo (2020), who argues that while the major issues with digital health occur at implementation, we need to shift the scope of design *"to consider the delivery of a service, rather than solely the digital health product within a service"*. The current design for health research also focuses mostly on early innovation stages and is less involved with later stages, including implementation (Huynh-Dagher et al. 2022). This needs to change for design to support the delivery of digital health, where the major issues lie. In this paper, we will discuss how design practices can be used

to improve digital health implementation. This topic has previously been discussed in general design research. Norman and Stappers (2015) suggest that designers should not stop after the design process but should also play an active role in implementation, which often is left to others.
Based on the current design for health research and digital health implementation research, we identify a valuable research opportunity to investigate the role of design in implementing complex digital health solutions. By complex digital health solutions, we refer to ones *"consisting of multiple behavioral, technological, and organizational components"* (May, 2006). An example could be a remote patient monitoring system issued by healthcare providers, where patients monitor their parameters at home and send data to providers. In contrast, a non-complex digital health solution could be a digital stethoscope used by healthcare professionals, requiring the involvement of fewer actors, less technical infrastructure, and less organizational change for implementation. The choice to focus on implementing "complex" digital health is made as design practices are seen to be useful when addressing these kinds of problems (Buchanan, 2009). This is further elaborated on in 2.2. In the context of this study, we start with the assumption that design is primarily the process of understanding a problem and proposing an improvement, while implementation is the process of realizing this proposed new improvement. For complex digital health, how it is to be used and integrated in a specific context must be designed; thus, both design and implementation are always present. The lines between the two processes can get blurred in digital health, as design activities such as adapting software can extend post-implementation.
The present interview study aims to understand what designers currently do to contribute to the implementation of complex digital health. By understanding how designers currently participate in the implementation process, we aim to better understand the role of design practices. In addition, this paper also aims to reflect on the relationship between the design and implementation processes. This is done to understand their differences and how the designers´ role differs depending on which phase they are in. The research questions of this study are: *(1) What practices do designers use when implementing complex digital health?* and *(2) According to designers, what is the relationship between the design and implementation processes?* To answer the research questions, we interviewed designers with experience in implementing complex digital health solutions. The structure of the paper is as follows. First, we describe the field of implementation science and the proposed potential design practices. Next, we present the methodological approach of the study: an interview study with designers with experience in implementing complex digital health solutions. Then, we present the results of this study and, lastly, we discuss the results and their implications for design as a practice for implementation.

2. Implementation and design

2.1. Implementation science

The research field that deals with integrating new health practices, such as digital health, into different contexts is called implementation science. Implementation science is *"the scientific study of methods to promote the systematic uptake of research findings and other evidence-based practices into routine practice, and, hence, to improve the quality and effectiveness of health services"* (Eccles & Mittman, 2006). The practices that are being integrated can be either a new way of working or a new artifact, such as a digital health solution. Compared to traditional clinical research, implementation science expands the scope and lifts the focus from the patient level to include the provider, organization, and policy making. Implementation research, therefore, requires trans-disciplinary research teams and can include operative partners such as front-line clinicians, patients, and administrators, as well as professionals from sociology, economics, health services research, and organizational science (Bauer et al., 2015).
A core part of implementation science is implementation strategies. They are *"methods or techniques to enhance the adoption, implementation, and sustainability of a clinical program or practice"* (Proctor et al., 2013). In addition, implementation strategies have been said to be the "how to" of changing healthcare practice (Proctor et al., 2013), consisting of specific methods and means for adopting interventions, such as a digital health solution, and sustaining them (Lomas, 1993). The implementation strategies act as guides to address barriers found through researching the fit between the intervention and the context. In an overview of implementation strategies, 73 unique strategies were identified (Powell et al., 2015), and in a follow-up study, these were grouped into nine categories of

implementation strategies (Waltz et al., 2015). These categories are: Engage consumers, Use evaluative & iterative strategies, Change infrastructure, Adapt & tailor to the context, Develop stakeholder interrelationships, Utilize financial strategies, Support clinicians, Provide interactive assistance, and Train & educate stakeholders. As implementation strategies are seen as the "how to" of implementation science, the categories can be seen as categories for how to adopt and sustain interventions. These implementation strategies will be used in the interviews to discuss where designers fit within the implementation of digital health.

2.2. Design as a practice for implementation

Using the previously mentioned definition of complex interventions by May (2006), implementing complex digital health solutions can be regarded as "wicked" problems. According to Rittel and Webber (1973), these are problems that are too complex to solve using scientific methods. To address these "wicked" problems, the designer needs to go from problem to solution without being sure how there can be a good match. To tackle ill-defined and "wicked" problems, Cross (1982) and Buchanan (2009) argue that design practices can be used. Adding to this, Simon (1996) states that design is the practice that concerns itself with how things "ought to be." Implementing complex digital health solutions in healthcare involves changing the artificial when adding the digital health solution to its context and when it is being iterated to improve the fit with the context. Due to the "wickedness" of complex digital health, implementation practice has the potential to benefit from using design practices to create and manage this change. Norman and Stappers (2015), for example, recognize that designers can contribute with their observational approaches to how things work to understand the context of the system.

3. Methodology

The study consists of semi-structured interviews with 24 designers working in the Netherlands, where the results of the first five interviews will be presented in this paper. The complete results with all 24 designers will be presented at the conference. We used an exploratory, qualitative interview approach, which allowed the informants to elaborate on their answers. Ethical approval was obtained by the Human Research Ethics Committee at the university of the first author. Participants provided informed, written consent.

3.1. Sampling

We selected the informants based on a purposeful sampling strategy to find key informants possessing specialized knowledge based on their experience (Patton, 2014). This was done by only selecting informants that fit specific criteria (Cash et al., 2022). The designers that we included (1) have a Master of Science degree in design, (2) had been a part of at least one project where a digital health solution was being implemented, (3) had their main occupation at a non-academic institution and (4) are working in the Netherlands. The first criterion ensures they have acquired a high level of design education and could therefore be considered "designers". The second criterion establishes that they have experience with the topics they will be interviewed about. The third criterion ensures that their work focuses on the practical work rather than researching the outcomes. The fourth criterion makes it easier to compare informants and helps the interviewer as he understands the Dutch healthcare environment. The first five informants presented in this paper were sampled through convenience sampling. The remaining 19 informants also all met the set criteria and were sampled with the goal of having variations regarding employer, education, and years of experience. The remaining 19 were primarily found outside the author's network. The five interviewees presented in this paper worked at different organizations and had a variety of work experience, which can be found in Table 1. The five designers also obtained their latest degrees from three different universities in the Netherlands. They were contacted via email, where a description of the interview topic was presented. The description was there to prime the participants to think of the topic before the interview and to act as a first screening for the informants, who then could accept or deny the request based on whether they thought they would be a good fit for being interviewed. The five participants that we asked accepted to be interviewed. We conducted the five first interviews between the 30th of June and the 31st of August 2023.

Table 1. Participants' background details

Participant	Title (years of experience)	Level of education	Institution affiliation
D1	Design manager (35)	PhD	Large medtech company
D2	Strategic design lead (9)	MSc	Large consultancy
D3	Manager, digitalization (14)	PhD	Academic hospital
D4	Service designer (14)	MSc	Small design consultancy
D5	CEO (23)	MSc	Medtech start-up

Note. The work experience is counted from earning their master's degree.

3.2. Data collection

The interviews followed the same interview guide, divided into four sections. Sections one, two, and four followed a semi-structured approach with a topic guide to stimulate a fluent dialogue (Fielding, 1993), while section three was more structured. This approach also allows for asking spontaneous questions depending on what seems relevant to follow up within each interview (Patton, 2014). The topics covered to answer research question 1 are how the designers see their role when implementing, the activities they conduct, and how they solve difficulties in the implementation. The topics covered to answer research question 2 are the connection between designing and implementing over time and the differences between design and implementation as processes.

The first section of the interviews focuses on introducing the informant and a project where they collaborated on implementing digital health. This section also acted as a second screening to ensure the informant had worked on implementing complex digital health. In the second section, they explained their process, the activities they conducted, and why they chose them. The third section more explicitly explored the designers´ role in the implementation process. This was done using the nine categories of implementation strategies (Waltz et al., 2015) as interview stimuli, where the informants were asked to state if they have "nothing to do with", "are involved in," or "lead" activities related to each category. If they said they lead in more than three categories, we asked them to choose two or three where they contribute the most. The fourth section focused on reflecting on the relationship between the design and implementation processes. The five interviews lasted between 45 and 60 minutes, and were audio recorded. Three interviews took place in person and two online.

3.3. Data analysis

The data was analysed inductively, where we identified patterns and grouped them into themes showing the informant's experiences implementing digital health. We followed Braun and Clarke´s (2006) six-phase approach for conducting thematic analysis. This was done with a constructionist epistemology view (Braun & Clarke, 2006). We began the thematic analysis process by transcribing the data verbatim. The first author then read through the data, familiarized with it, and noted initial ideas for codes and themes before starting to code. The coding of the data centered around the research questions. We coded the data using ATLAS.ti (v23.2.1). The first author coded all five interviews, and the second author coded a third of three different interviews. The coders then compared the codes to look for differences in coding. The two authors resolved the differences through discussion regarding each difference. The first author changed the parts of the interviews that were not a part of the comparison according to the decisions made. The first author then collated the codes into potential themes based on shared characteristics. All four reviewed the themes through discussions. Lastly, the first author wrote the presentation of the data based and selected data extracts to demonstrate the themes. The written presentation was then reviewed by all authors.

4. Results

From the qualitative analysis, we generated six themes regarding design practices used in the implementation of complex digital health (4.1-4.6). We also extracted a set of mentioned designer's abilities in relation to implementation strategies (4.6). Lastly, we reflected on the relationship between design and implementation, as mentioned by the interviewed designers (4.7). The six themes of design

practices are presented under the following headings: (4.1) bottom-up contextualizing, (4.2) co-creating, (4.3) creating representations to spark reactions, (4.4) following an iterative approach, (4.5) representing the end user, and (4.6) structuring the process of creating change. Within each theme, we present a key interview quote followed by an expansion on how the informants believe that the practice enhances the implementation process.

4.1. Bottom-up contextualizing

> *"I think designers, innovators just have the mindset of let's go out into the real world, try it, and bring these insights back to the company or to our clients in some cases […] to kind of bring the outside world inside". (D2)*

The designers describe that they understand a context by going out in the world to talk to people and observe what they are doing. This enables them to understand the context in which they are trying to integrate the digital health intervention. This also allows them to identify problems and opportunities they must look out for. Describing bottom-up contextualizing through interviewing or observing was done by four informants (D2, D3, D4, D5). Bottom-up contextualizing is done on the level where the digital health solution will be used and in the organizational structure. Being able to go out and gather information from people who have different competencies is described by D5, saying*: "We are trained to communicate about problems with different stakeholders"*. This ability to communicate with different disciplines is then used to look for the interviewed stakeholder's needs. D4 describes the purpose of conducting interviews by saying, *"... to understand their needs, to make something that would actually apply"*. By observing and talking to stakeholders within the wider system, the designers understand the context that they are implementing in, and they identify opportunities and challenges relating to making changes. D2 exemplifies what they look for when observing by saying, *"For opportunities or problems to design for […] Things that are weirdly organized or inefficient or don't work that well".*

4.2. Co-creating

> *"We know that creativity is not something that just happens. We have methods for it, so we can make other people creative in their thinking. (D2)*

When creating a change, designers want to involve different stakeholders to get them on board and for them to show how they would like the change to be made. By engaging these stakeholders in co-creation, the ones affected by the change come up with ideas for changes. This then informs the designers on how to shape the implementation. Co-creation was mentioned by three informants (D1, D2, D3). There is a mindset of the designers that, by co-creating the implementation, the most knowledgeable people about the context create the fit between context and intervention. This is regarded to mitigate risks regaring fit and to make the users less hesitant to use the new intervention. D2 also discusses how co-creation helps create awareness of the solution and create a good fit: *"If you've co-created from the start from the beginning to the end with them, they already know. They came up with those ideas themselves".* Co-creation thus helps to create the fit between the digital health solution and the context by having it being made by the people working within the context. D1 describes how the patients have helped to share their future care pathway, saying, *"They have been in Co-create sessions to define the pathways".* D1 also explains how the nursing staff enjoys creating the fit by saying: *"Well, I think there the nursing staff comes in because they need to deliver that experience. Normally, they are really at the receiving end of a new implementation, so they really like that because they're now heard in the process, they really like that".* Two informants (D1, D2) also describe the designers´ role in facilitating the co-creation. D1 mentions how they try to push the participants to create a good experience for users: *"So you're in there together and we facilitate the workshop and we champion the experience in the workshop".* D2 discusses how designers are able to make others creative: *"One of the things that you learn as a designer is that everybody's creative. You just need the right methods that fits you with the people around you".*

4.3. Creating representations to spark reactions

> *"Everybody can react to the product even if it's not there yet, and designers are really good at visualizing a product and then using that as a means to communicate with different stakeholders. It's very hard for one single discipline to communicate in everybody's language". (D5)*

Designers create representations through physical prototypes or visualizations to understand the context or digital health solution relevant to the implementations. These are used to reflect on the implementation, do tests, and get feedback from other stakeholders. Creating representations of the intervention was mentioned by all five informants, and using the representations for testing or to get feedback was also mentioned by all five informants. D2 describes it as follows: *"So I think understanding and gathering all these* [qualitative inputs], *interpreting, trying to translate it to a real tangible thing that you can share and discuss. And check if and kind of align the interpretations of these ideas".* An example of a representation of the context mentioned by D1 is "ecosystem maps" that are used to understand relationships between parties: *"So ecosystem maps, the different parties and ecosystems power".* Another example is patient journey maps mentioned by D3: *"So you have your whole workflow or your whole patient journey, and then you do the data definition based on that".* The representations are then used to spark reactions and to align different views. As exemplified by the initial quotes of this theme, visualizations can help create a common language. Similar is mentioned by D4, who says that visual representations help with creating a discussion: *"So it helps in the discussion […] to see that if you change something at one point, it will have an effect later on […]. To see the process to be able to discuss it and to improve it".* In summary, the designers highlight the role of representations in aiding communication among stakeholders. These visualizations facilitate understanding, discussion, and improvement, aligning interpretations and pinpointing key elements for change.

4.4. Following an iterative approach

> *"It's inherent of the design process because you learn during. That's what we do. As designers, we learn and we adapt the design in the process". (D1)*

To work iteratively with continuous small and large-scale testing and adjusting was done by all five informants. This was done by learning from an activity and then adjusting their image of the problem or the intervention they wish to implement. The first three themes (4.1, 4.2, and 4.3) represent learning situations designers use to reframe their understanding of the context or intervention. Three of the designers make explicit quotes about having an iterative practice (D1, D2, D5). D1 says, *"Everything is iterative, so all the feedback that we get […], we reiterate on all these things, and proceed".* Similarly, D2 states that when they learn something, they iterate the design of the intervention: *"We will learn things and adapt the care part for it, or the service blueprint. And with that, the care pathway".* It is discussed how reframing is necessary as learning new things might indicate that the problem that the team is trying to solve cannot be solved with the current design of the intervention. D5 says that by adapting after learning new things, we can make sure that our value proposition still solves a problem, although it might not be exactly as it was at the start. D5 says: *"We got the wrong problem, or we got the wrong solution to the wrong problem. You can pivot and find something else".*

4.5. Representing the end user

> *"It's obvious, being the ambassador for the user. Yeah ensure that the users are always considered and we do it for the patient and we do it for the healthcare staff". (D3)*

This initial quote answers an interview question regarding their main role in implementation. What the designers desire in the implementation is that it provides value for the end users. This steers their process of performing different activities and how they prioritize when making choices. While all five informants mentioned the aim of creating a pleasant experience for the end user, three informants (D1, D2, D3) stated explicitly that it was a part of their responsibility to ensure this was the case. D2

says: *"We're the ones who kind of are normally responsible for the their desirability aspect, but also need to translate to business and technical. So putting like people in the middle of any discovery or implementation"*. D1 also states that the designer needs to *"Be the champion of the end user".* With many stakeholders that want different things from the implementation, the designers see that what they have to guard is how the intervention affects the end users. They believe, without the good experience, the implementation will fail. This is exemplified by D3: *"For now, first are people, because I have the hypothesis that people should be at least equally satisfied with the care or more satisfied with the care".*

4.6. Structuring the process of creating change

> *"OK, we made a bunch of assumptions for this to work. […] which one is the most risky one? Let's go out and test that first so that we kind of mitigate. […] We mitigate risk in the innovation program process by focusing, knowing when to focus on what". (D2)*

The designers describe their approach to dealing with the complexities of implementing digital health solutions by promoting the necessity of creating structure and managing tasks and assumptions. They say that they are comfortable with the complexity and ambiguity that these issues pose, that they prioritize what to do first and then set up a plan for how to reach the intended fit between digital health and context. Three informants (D2, D3, D5) argued that designers are comfortable in dealing with the ambiguity that is present in complex digital health implementation. D3 said: *"I think designers are not afraid of complexity and ambiguity and insecurity"* and D2 compared designers to business consultants and said that designers are better at *"dealing with unknowns. Making best informed decisions to continue".* To start to structure the work within the complex space, the designers prioritize what to focus on and keep track and test the assumptions they make in the process. This is mentioned by three of the informants (D1, D2, D3). D2: *"Often with digital technology you have like a very long backlog of things that you want to add. So also playing a role in prioritizing those. Again balancing business and people"*. The structuring of the final delivery of the implementation was mentioned by two informants (D1, D3). Both informants used service blueprints that specify what needs to be done for each functionality in the designed intervention to function and by whom. D3 describes the service blueprints as follows*: "I think the service blueprint is important overtime to really understand how your, how it's really, how your capacity works and how you for example also start working on solutions between first and second line".* A similar description of the role of the service blueprints were given by D1 stating: *"I think what was critical is the service blueprint. Yeah, because there you describe the experience journey but also the front office and the back office. And then you describe what needs to happen".*

4.7. The designer in implementation

The results the third section of the interview are about designers stating whether they "lead" are "involved" or have "nothing" to do with nine implementation strategy categories. Table 2 shows these results, with the strategy categories that each designer considered themselves to contribute to the most marked with an asterisk. The two strategy categories that the designers believed to contribute to the most are "engage consumers" and "use evaluative & iterative strategies" which were mentioned by 4 designers. The third most mentioned category is "adapt & tailor to the context", which were mentioned by three designers. The three most mentioned implementation strategy categories also correspond to the generated themes. The themes "Bottom-up contextualizing", "Co-creating", "Creating representations to spark reactions", "Following an iterative approach" and "Representing the end user" can all be regarded to fit into the top three mentioned implementation strategy categories. The only theme that does not fit within any of the top three implementation strategy categories is "structuring the process of creating change".

Table 2. Designer's engagement with the implementation strategy categories

Implementation strategy	D1	D2	D3	D4	D5
Engage consumers	Lead*	Lead*	Lead*	Lead*	Lead
Use evaluative & iterative strategies	Lead*	Lead*	Lead*	Lead*	Involved
Change infrastructure	Lead*	Lead	Lead	Nothing	Lead
Adapt & tailor to the context	Involved	Lead*	Lead	Lead*	Lead*
Develop stakeholder interrelationships	Involved	Involved	Lead	Lead	Lead
Utilize financial strategies	Nothing	Involved	Lead	Nothing	Lead
Support clinicians	Nothing	Lead	Lead	Lead	Lead
Provide interactive assistance	Involved	Involved	Lead	Nothing	Lead
Train and educate stakeholders	Involved	Lead	Lead	Lead	Lead*

4.8. Design in relation to implementation in digital health

At the end of the interview, the informants were asked to reflect on the relationship between designing and implementing. Three informants (D2, D3, D4) described that there is a role for design practices in implementation but that it is a more limited role. D4 says that design skills can be used in implementation but that it is not about creating new things: *"…it's far more narrow and it's more using design ideas and skills and you need designs for it. If you want to do service design you need someone who has this actual skill"*. D3 points to the fact that design is a creative endeavour, but that implementation is less so: *"An implementation process is not a design process, so it's less creative".* All five interviewees believe design happens before implementation, but that design can both be its own process that overlaps the implementation, and that design practices can be used in the implementation. When answering this question about their relationship three informants (D2, D3, D4) wanted to differentiate between design as a practice and as a phase. D2 states: *"For me, implementation is a phase in a project and design happens throughout it. In many shapes and forms"*. Similarly, D3 states *"I think design can support implementation, but designers are [in] far broader fields than implementation".* To what extent design can be used was also discussed to vary depending on the type of intervention that is implemented. D4 discussed the difference between implementing hardware and a service, saying that hardware need to be certified and manufactured, which hinders later-stage modifications. Adapting in later stages is easier for services and software because of this. Similar is said by D1, who reflects on the relationship between design and implementation by saying, *"I think by moving more into solutions, they become more and more the same".* The relationship between design and implementation is thus different depending on the nature of what is being implemented. The same topic was discussed by D4, who compares implementations of different interventions, saying: *"Sometimes you see quite a hard line because you need to have a hard line. Sometimes you see something or what I would call gradual implementation where you do have the chance to even learn more and add"*. D5's reflections differed from the others and were mostly concerned with how a lot of designers are not a part of the implementation process and how that hurts the implementation. For example, D5 said as follows: *"As a designer, you're painting a picture of the future. You're making a promise the world will be better when you have this. And when you implement it, you find out it's not that pretty picture".* D5 continues to say, *"The design consultant can only paint a picture. But it's not there to go through the hard times of implementing it".* According to this statement, this designer believes that designers are not taking part enough in implementing the digital health solutions that have been designed. The summative view presented by the designers is that, in general, some design practices can be used within implementation and that design and implementation overlap but that the extent to which design and implementation overlap depends on the type of intervention.

5. Discussion and conclusions

This study has identified design practices used when implementing complex digital health solutions and collected reflections from designers on the relationship between the design and implementation processes. This paper presents preliminary results, and the next step of the research will be to analyse the remaining interviews and include an analysis based on this larger sample in our conference presentation and a future

journal paper. The research provides a first overview of existing ways in which designers participate in implementing complex digital health solutions. In line with Norman and Stappers' (2015) expectations, we found that design skills such as problem-finding, observational skills, and managing iterations of prototyping are applied. We also identified stakeholder engagement as a core activity for designers in implementing digital health, similar to what was discussed regarding design for health by Huynh-Dagher et al. (2022), and regarding design for digital health by Duffy et al. (2022). The focus on stakeholder involvement was also clear in the comparison with the implementation strategy categories. Based on the interviews, we also identify practices that focus on using representations of the digital health solution, adapting and tailoring the intervention to the context, and using an iterative approach. These practices can contribute to reducing the issues with inadequate proof of concept and usability, as Greenhalgh et al. (2017) reported. The iterative approach, using evaluation and adaption, also contributes to the advice by Ross et al. (2018), arguing that this is an adequate way of approaching complex digital health.

Previous design in health research showed that design is most prevalent in the early stages (Huynh-Dagher et al., 2022; Duffy et al. 2022). However, in this research, we use a sample that contributes in the later stages and find that there is a role for design there as well. At the beginning of the implementation process, the designer can contribute to understanding the problem, creating the fit between context and intervention, creating representations of the digital health solution, and facilitating co-creation sessions. The further the process moves towards an integrated digital health solution, the smaller the designer's role gets and the more the designer's practices focus on testing, evaluating, and further adapting the intervention within its context. Due to the changing nature of the implementation process, the designer thus needs to use different practices depending on how far they are in the process. Design's overlap with implementation may also vary depending on the nature of the intervention; in particular, designers recognized the constraints posed by the certification and manufacturing of hardware compared to the flexibility offered by implementing services and software. Certification creates a harder line between design and implementation as it is more difficult to adapt hardware after certification. In contrast, services and software can be continuously adapted while being introduced into the local context. How the design and implementation phases overlap likely depends on what is being implemented, but more research needs to be conducted to understand the overlap. As designers are typically involved in the early stages, they can benefit from heeding the advice of Ross et al. (2018) and van Gemert-Pijnen (2022) to think of implementation, even during the development, to ease the introduction of digital health solutions into their intended contexts. Making designers more aware of the implementation process so they can reflect on it can thus also benefit implementation.

This initial study presents limitations, particularly concerning the small sample and the setting, as all interviewees are working within the Netherlands. Using one country was done to compare roles within a single national health system, but at the same time, it hinders the international generalizability of our results. Nevertheless, we hope that this first effort will inspire more research, also internationally, on the role of design practices in implementation. Our early insights concretely demonstrate the contribution of design to implementation processes, with implications for research and practice. Future research can expand on the role of design in implementation through case studies where design practices have been used in implementation and through connecting the literature of the two fields. From a practice perspective, we hope that this research will inspire digital health implementers to use design practices, such as creating representations to spark reactions or working iteratively to implement complex digital health solutions across different contexts. By identifying ways in which design practices can improve the implementation of complex digital health solutions, we can advance our knowledge of best practices for implementation processes, contributing to the much-needed procedures for realizing ideas described by Bauer et al. (2015). This can, in turn, lead to new ways to enhance the uptake of digital health innovations and realize their benefits to improve care.

References

Bauer, M. S., Damschroder, L., Hagedorn, H., Smith, J., and Kilbourne, A. M. (2015), "An introduction to implementation science for the non-specialist", *BMC psychology*, Vol. 3 Article 32, pp. 1-12. https://doi.org/10.1186/s40359-015-0089-9

Braun, V. and Clarke, V. (2006), "Using thematic analysis in psychology", *Qualitative research in psychology*, Vol. 3 No. 2, pp. 77-101. https://doi.org/10.1191/1478088706qp063oa
Buchanan, R. (2009), "Thinking about design: An historical perspective", In: Meijers, A. (Ed.), *Philosophy of technology and engineering sciences*, Elsevier, North-Holland. pp. 409-453. https://doi.org/10.1016/B978-0-444 -51667-1.50020-3
Digital Health Center of Excellence (DHCE). (2020), *What is digital health?* [online] U.S. Food and Drug Administration. Available at: https://www.fda.gov/medical-devices/digital-health-center-excellence/what-digital-health (accessed 23.09.2023).
Cafazzo, J. A. (2020), "Design for digital health", In: Sethumadhavan, A. and Sasangohar, F. (Eds.), *Design for Health: Applications of Human Factors*, Academic Press, Cambridge, pp. 47-65. https://doi.org/10.1016/B978-0-12-816427-3.00003-8
Cash, P., Isaksson, O., Maier, A., & Summers, J. (2022), "Sampling in design research: Eight key considerations", *Design studies*, Vol. 78, 101077. https://doi.org/10.1016/j.destud.2021.101077
Cross, N. (1982), "Designerly ways of knowing", *Design Studies*, Vol. 3 No. 4, pp. 221-227. https://doi.org/10.1016/0142-694X(82)90040-0
Duffy, A., Christie, G. J., & Moreno, S. (2022), "The challenges toward real-world implementation of digital health design approaches: narrative review", *JMIR Human Factors*, Vol. 9 No. 3, e35693. https://dx.doi.org/10.2196/35693
Eccles, M.P., Mittman, B.S., (2006), "Welcome to implementation science", *Implementation Science*. Vol. 1 Article 1, pp. 1-3. https://doi.org/10.1186/1748-5908-1-1
Fielding, N and Thomas, H. (2001), "Qualitative Interviewing", In: Gilbert, N (Ed.), *Researching Social Life. 2nd edn*, SAGE Publications, Thousand Oaks, pp. 123-143.
Greenhalgh, T., Wherton, J., Papoutsi, C., Lynch, J., Hughes, G., Hinder, S., ... and Shaw, S. (2017), "Beyond adoption: a new framework for theorizing and evaluating nonadoption, abandonment, and challenges to the scale-up, spread, and sustainability of health and care technologies", *Journal of Medical Internet Research*, Vol. 19 No. 11, p. e8775. https://dx.doi.org/10.2196/jmir.8775
Huynh-Dagher, S., Lamé, G., Duong, T. A., & Jankovic, M. (2022), "Design research in healthcare: a systematic literature review of key design journals", *Journal of Engineering Design*, Vol. 33 No. 8-9, pp. 522-544. https://doi.org/10.1080/09544828.2022.2123702
Lomas, J. (1993), "Diffusion, dissemination, and implementation: who should do what?", *Annals of the New York Academy of Sciences*, Vol. 703 No. 1, pp. 226-237. https://doi.org/10.1111/j.1749-6632.1993.tb26351.x
May, C. (2006), "A rational model for assessing and evaluating complex interventions in health care", *BMC Health Services Research*, Vol. 6 Article 86, pp. 1-11. https://doi.org/10.1186/1472-6963-6-86
Norman, D. A., and Stappers, P. J. (2015), "DesignX: complex sociotechnical systems", *She Ji: The Journal of Design, Economics, and Innovation*, Vol. 1 No. 2, pp. 83-106. https://doi.org/10.1016/j.sheji.2016.01.002
Patton, M. Q. (2014), *Qualitative research & evaluation methods: Integrating theory and practice*, SAGE publications, Thousand Oaks.
Proctor, E. K., Powell, B. J., and McMillen, J. C. (2013), "Implementation strategies: recommendations for specifying and reporting", *Implementation Science*, Vol. 8, Article 139, pp. 1-11. https://doi.org/10.1186/1748-5908-8-139
Rittel, H. W., and Webber, M. M. (1973), "Dilemmas in a general theory of planning", *Policy Sciences*, Vol. 4 No. 2, pp. 155-169. https://doi.org/10.1007/BF01405730
Ross, J., Stevenson, F., Dack, C., Pal, K., May, C., Michie, S., ... & Murray, E. (2018), "Developing an implementation strategy for a digital health intervention: an example in routine healthcare", "BMC health services research", Vol 18 No. 1, pp. 1-13. https://doi.org/10.1186/s12913-018-3615-7
Simon, H (1996), *The sciences of the artificial (3rd edn)*, The MIT Press, Cambridge, Massachusetts.
van Gemert-Pijnen, J. E. W. C. (2022), "Implementation of health technology: Directions for research and practice", *Frontiers in Digital Health*, Vol. 4, 1030194. https://doi.org/10.3389/fdgth.2022.1030194
Wachter, R. (2016), Making IT work: harnessing the power of health information technology to improve care in England. London, UK: Department of Health, 1-71.
Waltz, T. J., Powell, B. J., Matthieu, M. M., Damschroder, L. J., Chinman, M. J., Smith, J. L., ... and Kirchner, J. E. (2015), "Use of concept mapping to characterize relationships among implementation strategies and assess their feasibility and importance: results from the Expert Recommendations for Implementing Change (ERIC) study", *Implementation Science*, Vol. 10, Article 109, pp. 1-8. https://doi.org/10.1186/s13012-015-0295-0
WHO. (2019), Digital health. https://www.who.int/health-topics/digital-health#tab=tab_2 (accessed 2023-03-17).