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Guest Editors

Babak A. Farshchian, Norwegian University of Science and Technology
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Elena Parmiggiani, Norwegian University of Science and Technology

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c/o Prof. Dr. Volker Wulf
Fakultät III
Universität Siegen
57068 Siegen
E-Mail: volker.wulf@uni-siegen.de

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Digital Nomads' Experiences on the Support of Digital Technologies in Relation to Social Isolation

Alice Mohlin and Niki Chatzipanagiotou

Jönköping University (JU), Sweden and Lund University (LU), Sweden

alice.mohlin@ju.se; niki.chatzipanagiotou@ics.lu.se

Abstract. The paper presents digital nomads' experiences about the support of digital technologies in relation to social isolation. Despite the abundant access to digital technologies for organizational cooperative purposes, the challenge of social isolation constitutes one of the central concerns in nomadism practices, affecting employees' choice of working arrangements. To gain further knowledge on the subject, a qualitative study through interviews with digital nomads in Sweden was conducted, and the data were further interpreted and discussed in relation to concepts of computer-supported cooperative work and the theory of symbolic interactionism. Findings show that digital nomads do not experience the digital technologies they use in their everyday work as supportive in terms of social isolation. They acknowledge the digital technologies as tools for conducting their work, not tools for interacting socially. Collective symbolic meaning is consciously assigned to the different digital technologies. The research contributes theoretically to existing knowledge within the field of computer-supported cooperative work

in regard to technology-centered nomadism as it partly fills the knowledge gap about the support of digital technologies in relation to digital nomads' social isolation. The research also contributes practically to interested stakeholders in the sense that organizations may not benefit from using digital technologies for social interaction purposes.

Introduction

Changes in the nature of work include greater possibilities of flexible working arrangements with support of technological developments, resulting in both organizational and economical profits (Bloom et al., 2015; Bloom, 2020). This location-independent work practice with a general reliance on digital technologies is referred to as nomadism, and the respective employees as digital nomads (Sadiku, Omotoso, & Musa, 2005). The challenge of digital nomadism lies in organizations incorporating practices where a proportion of their employees work away from the office, either full or part time, and dealing with the disruptions that these practices will generate (Bloom, 2020).

Despite the abundant access to digital technologies -information, communication and administration technologies and software, and devices- for organizational cooperative purposes, the challenge of social isolation is severe enough to affect employees' choice of working arrangements (Bloom et al., 2015; Waizenegger, McKenna & Bendz, 2020). In extension, digital nomads employ a variety of strategies to decrease their feelings of social isolation and increase the feeling of social interaction (Lee et al., 2019). The research field of technology-centered nomadism focuses on technologies as support systems in nomadic practices (Ciolfi & De Carvalho, 2014; Lyytinen & Yoo, 2008). Scholars support, though, that there is a need for further understanding the barriers and facilitators embedded in technology in terms of nomadic work practices and that perspectives of social and work activity aspects are lacking (Ciolfi & De Carvalho, 2014; Rossitto, 2009).

We consider it important to address the challenge of digital nomads' social isolation and to examine what role digital technologies play in the issue. Hence, the purpose of this paper is to explore the support of digital technologies in relation to social isolation among digital nomads by considering their experiences. To achieve the aim of the research, we posed the following research question: *How do digital nomads experience the support of digital technologies in relation to social isolation?*

Literature Review

Computer-Supported Cooperative Work and Nomadicity

The surge in using digital technologies for cooperative communication purposes has generated a trend of hybrid forms of working, in which employees could be distributed between physical offices and remote solutions (Bloom, 2020; de Carvalho, 2014). In practice, such forms of working are conducted in a nomadic manner, meaning that employees are allowed to work without geographical boundaries as their work relies mainly on digital technologies (Ciolfi & De Carvalho, 2014) and, thus, becoming digital nomads. Digital technologies imply information, communication and administration technologies and software, and devices offered to digital nomads by their organization to carry out their everyday work. However, research on the subject includes a higher level of complexity than the movement of people at work, and so, a part in the computer-supported cooperative work (CSCW) body of research has focused on the concept of *nomadicity* (Lee et al., 2019; Sadiku et al., 2005).

Nomadicity implies living a location-independent life and allowing flexibility for the digital nomad, however, it also implies a dependence on digital technologies and wireless communication (Sadiku et al., 2005). Rossitto and Eklundh (2007) define the concept of nomadicity as a work arrangement that encompasses the absence of a fixed workplace, and the experience of constant environmental, temporal, and technological disruptions, which makes the concept complex and its boundaries fuzzy. The research area is neither new nor unexplored (Bloom, 2020) and other similar terms to nomadicity are *nomadic computing*, *working from home*, *telecommuting or teleworking* (Bloom, Liang, Roberts, & Ying, 2015). In this paper, however, we adopt and use the term of *nomadicity*. Nomadicity is commonly divided into four categories of applied perspectives in research: a) technology-centered, b) practice-centered, c) place-centered, and d) work-life balance-centered (Ciolfi and De Carvalho (2014). While the practice-centered perspective, which focuses on work activities; the place-centered perspective, which focuses on the inconsistency of geographical location; and the work-life balance-centered perspective, are all relevant for this study, we aim at contributing to technology-centered nomadicity. In this perspective, technology is viewed as a support system of technological tools that digital nomads need (Ciolfi & De Carvalho, 2014; Lyytinen & Yoo, 2008). Lee et al. (2019) argue that there is a need for further understanding of how, when and where technology is facilitating or challenging nomadic work practices. Still, Ciolfi and De Carvalho (2014) support that technology-centered nomadicity studies often leave out the social aspects of technology use.

Communication, Social Interaction and Social Isolation

Within the field of CSCW, cooperative work is viewed as a set of interdependent activities of joint effort towards a common goal (Schmidt, 2011), in which a variety of digital systems are used in different work dimensions and collaborative activities. CSCW literature further holds a variety of classifications and categorizations of cooperative work, in which communication, coexistence, coordination, collaboration, and information sharing are included (Koch and Gross, 2006; Chatzipanagiotou, 2021). Communication for cooperative purposes refers to the common goal work through the use of technology, which refers to the capabilities of individuals and teams to share information and provide real-time feedback; and can include among others messaging, sharing documents, and video conferencing (Schmidt, 2011; Grudin and Poltrock, 2012; Chatzipanagiotou, 2021).

Previous research on nomadicity bring up issues related to cooperative communication (de Carvalho, 2014). Studies indicate that organizations are struggling with building online communication structures with all cooperative aspects connected to that. For example, Rudnicka, Newbold and Cook (2020) found that employees are struggling with increasing strain in online meetings when doing remote work; face difficulties with their colleagues' various levels of digital literacy; and that the loss of ad hoc communication makes social interaction problematic. There is also a consensus as well as empirical evidence that points to face-to-face interactions being highly important when it comes to cooperative work (de Carvalho, 2014). Still, one of the main challenges of nomadicity is the feeling of social isolation, making digital nomads to continuously employ strategies for social interaction (Lee et al., 2019). Although there is an increasing acceptance of remote cooperative communication (de Carvalho, 2014), the COVID-19 pandemic forced a whole world to accept the terms of nomadicity, however without the same extent of location independence possibilities. Wang, Albert, and Sun (2020) support that most employees and organizations had little to no experience of nomadicity and related nomadic practices before the COVID-19 pandemic. For this reason, previous knowledge on nomadicity may not be fully applicable today, and new findings may provide new insights that did not exist before the COVID-19 pandemic era.

Social isolation is an 'umbrella' term for describing an individual's lack of social connection and interaction - emotional, network related, and physical - with others (Caciopoppo and Caciopoppo, 2014) which causes negative effects to individuals. The experience of social isolation remains one of the central concerns in nomadicity (Bartel, Wrzesniewski, & Wiesenfeld, 2012; Carillo, Cachat-Rosset, Marsan, Saba, & Klarsfeld, 2021; Guimaraes & Dallow, 1999; Morganson, Major, Oborn, Verive, & Heelan, 2010; Waizenegger, McKenna, Cai, & Bendz, 2020) and

it is theoretically defined differently depending on the scientific context. Cooper and Kurland (2002) refer to *workplace-related isolation* from an organizational psychology perspective as two dimensions, in which (1) employees experience a fear of being separated from the organization due to beliefs of loss of organizational privileges and benefits, and (2) a social isolation that appears when remoteness causes missing out of informal social interaction opportunities. Wang et al. (2020) refer to isolation in two dimensions and talk about physical isolation and psychological isolation. The latter is harmful in a work context and could lead to digital nomad's frustration and decrease in job satisfaction (Golden & Veiga, 2005). This notion is further supported by arguments that the extent of which a digital nomad is away from a physical office has implications for the experience and feeling of social isolation (Allen, Golden, & Shockley, 2015).

The literature provides little, yet a variety of knowledge regarding the use of digital technologies in relation to social isolation among digital nomads. Allen et al. (2015) and Carillo et al. (2021) found that digital nomads can reduce social isolation by incorporating digital technologies-related structures with focus on social interaction. On the other hand, Hacker et al. (2020) propose that digital technologies are neither designed for nor normalized as tools for social interaction. Saatçi et al. (2020) further state that today's video-conferencing systems are flawed for their purposes, and participants in the study by Waizenegger et al. (2020) report that the change in communication patterns that occurs with using video-conferencing systems is not providing a good foundation for informal socialization. Furthermore, the use of multichannel communication support for social interaction, among other organizational purposes, is proposed to help reducing the feeling of social isolation and help maintain a 'normal' level of social interaction among colleagues (Morganson et al., 2010; Wang et al., 2020).

Theory of Symbolic Interaction

Symbolic interactionism is a sociological theory which assumes that social interactions with others is what shapes our understanding of reality (Blumer, 1986). It is based on three principles established by Blumer (1986), who developed the work of Mead (1934): (1) Humans act towards things based on the meaning that the things bring to them; (2) The meaning of such things comes from individuals' social interaction with others and the society; (3) The meaning constantly changes with an interpretive process. According to symbolic interaction, humans are understood as socially constructed individuals, whose reality is based on interaction with their environment (Charon, 2010) dependent on symbols for understanding (Charon, 2010; Redmond, 2015). The symbols are in themselves independently random, however created and assigned meaning by social interaction, and, therefore, changed by social interaction (Redmond, 2015).

That is, symbolic interaction focuses on understanding how individuals interact with one another to create symbolic worlds, and in return, how these worlds shape individuals' behavior. Thus, interaction and behavior are framed through the shared meaning that objects and concepts have attached to them and, therefore, the social world is created through interaction among individuals and their environment. The symbolic interactionism theory has been used in computer-supported cooperative work and human-computer interaction studies (e.g., Nardi, Whittaker and Bradner, 2000; Naskova, 2016;) to further understand digital technologies from a social perspective by studying symbolic meanings, which is also the case for this study.

The aforementioned CSCW concepts along with the theory of symbolic interaction formed the conceptual framework of our research, which was used to interpret and discuss our research findings.

Methodology and Methods

Data Collection

The research was conducted in Sweden during the COVID-19 pandemic; that is, in spring 2021. Thus, choices regarding the selection of participants and the methods of data collection were limited, which will be explained shortly in the text. As this research was meant to be a pilot study of a bigger research, we aimed at a relatively small sample. We do, though, acknowledge the limitations of the small number of participants. Therefore, nine digital nomads constitute the participants in this research, as shown in table I.

Table I. Research Participants Overview

Participants Overview		
Participant	Work Role	Years of experience
A	Auditor	5+
B	Sales Leader	5+
C	Commercial Partner Manager	5+
D	Regional Retail Manager	30+
E	Business Coach	30+
F	Apartment Rental Administrator	3+

G	Quality & Environmental Manager	20+
H	Marketing Communicator	25+
I	Logistics Leader	25+

The sample was purposive (Patton, 1990) as the participants were selected based on the following criteria to offer rich data regarding digital nomads' experiences with digital technologies in relation to social isolation: a) working at least five years, in order to possess sufficient work experience; b) conducting work, regardless industry, which entails daily interaction and communication with colleagues (self-employed being excluded); and c) currently working from home, as a consequence of the COVID-19 pandemic restrictions, in order to establish a significant change in participants' interaction and communication of daily work. We do, however, recognize that our participants were forced into the nomadic practice, and therefore the results may be affected by their pre-conceptions of digital technologies. In addition, we strived for gender balance among the selected participants. After the seventh interview and an initial analysis of the collected data, saturation was reached as we kept getting repetitive answers from the participants. Thus, further search for more participants was not needed for our pilot study.

We followed an interpretive qualitative approach to achieve the research aim. Interpretivism is an ideal choice for informatics researchers to understand the meanings that are constructed by people in relation to a specific situation (Patton, 2015). The interpretive paradigm is, then, suitable for exploring and interpreting the perspectives of digital nomads regarding the use of digital technologies in relation to social isolation. The qualitative methodological approach is chosen because it is appropriate to address multiple subjective perspectives of the participants (Patton, 2015) to gain an understanding of the nomadic work practices in terms of digital technologies in relation to social isolation.

The interpretive qualitative approach entailed individual semi-structured interviews as the followed method of collecting data. Through interviews, we aimed at capturing the participants' experiences and perspectives to provide us rich empirical material (Denscombe, 2017). For the interviews, we formulated and followed an interview guide with semi-structured questions. The interview guide allowed us to have a basic frame for our discussion with the participants, but also allowed us follow-up questions or clarifications, when needed. All interviews were conducted online due to the COVID-19 pandemic restrictions, they were conducted in the English or the Swedish language depending on the participants' preferences, and lasted for 40-45 minutes. All interviews were audio recorded with the participants' informed consent and were transcribed verbatim. Annotations and

notes were also taken during the interviews that helped us later during the data analysis.

Data Analysis

Thematic analysis was our analytical method. Thematic analysis is a coding process for empirical data, which unfolds in several steps to identify patterns and develop themes (Braun and Clarke, 2021). In our analysis, the interview transcriptions, the annotations, and notes were printed and brought together for the analysis. The transcribed empirical material was re-read several times until we got familiar with it and get a deeper understanding of the participants' experiences and perspectives in regard to the support of digital technologies in relation to social isolation among digital nomads. By identifying similarities, we generated a total of 289 initial codes, which were first highlighted and then transferred to a new document for further analysis. The initial codes were carefully examined for overlaps, repetitions, and/or redundant codes. Those codes were then organized into categories in relation to the research aim and research question of the study. The initial list of categories was modified after several iterations of additional re-readings until we resulted to 22 categories. The 22 categories were examined again and organized into themes. We concluded the analysis by aggregating and defining 5 themes in an explicit way. These are presented in the following section.

Findings

Theme 1: Low expectations on digital technologies for social interaction purposes

All participants agreed that digital technologies filled their work-related requirements, but not their social interaction needs. Participant C commented that: *"...it is not supposed to be the same thing"* (communicating through the systems and in real life). Participant A further stated that: *"I don't think they meet the requirements, we have like Friday coffees like 15 pm at MS Teams, but I usually don't go to those type of coffees"*, and participant I commented that: *"I think the systems have developed so much and I don't miss any functions, but from a social perspective, they are all bad"*. In addition, participant G commented that: *"The systems work, it's no problem, but it's not like the personal connection you get when you see each other in person"*. The lack of social interaction support in the digital technologies had some participants seeking social interaction outside of work or employ other strategies than reaching out to colleagues during their workday. Participant F stated that *"I call friends all the time, I call friends who study or work from home, so I know they are available, but not from my company,*

like friends outside the company". Participant A continued and stated that s/he sometimes even go to the office to decrease the feeling of social isolation, saying that *"sometimes I go to the office with a co-worker that's close to me and we work with each other"*.

To further clarify the perceptions that form the central meaning of this theme, from the used digital technologies, participants focused mainly on the use of video-conferencing systems. A central aspect of this lies in the perception of how video-conferencing systems are supposed to be used, where the participants expressed that their main function is to share screens and perform presentations of different kinds. Participant E said: *"...most often you are presenting stuff when using MS Teams..."*, participant B: *"I want to share my screen so I can show my co-workers things"*, and participant H stated that *"I would say you share your desktop more than you share your face (in the video-conferencing systems)"*. Participant A further stated that: *"It has only happened on a few occasions that I have had one-on-one calls on MS Teams for social purposes..."*. Thus, it was found that participants had low expectations on digital technologies in regard to supporting their social interaction.

Theme 2: Thresholds for initiating contact increases social isolation

Participants often compared their current working from home arrangement with their regular physical office work and concluded that the ability to 'pop by' colleagues' offices comprised an important and valuable interactive communication activity that was impaired by the thresholds that digital interaction inferred. Participant H explained that: *"Previously we all sat in the same corridor, wall to wall, so you could just shout out to get your answers, or just go into the colleagues' offices to discuss the problems"*. Participant E commented that: *"We were sitting in an open landscape, so it was very easy to just pop by and get a resolution quickly. Right now, I first have to go into the chat and see if he or she is available, I check the calendar to see if the person is free and see if I can call them. So yeah, it's a lot of extra work"*. Participant B commented that connecting with introvert colleagues could be problematic, stating that *"if you put the introvert person at home, I don't think that they'll try to connect with you. For me as a leader, I feel like I have to give more of myself to them vs when they are at the office"*.

These extra steps for initiating contact resulted in participants withdrawing from contacting their colleagues in the first place if it was not for strictly work-related and (planned and/or urgent) purposes. For instance, participant A stated that: *"You don't interact with your co-workers as much as you would have in the office, where you can just have a coffee or go on a long lunch or something"*. As participants commenced less interaction with their colleagues, the feeling of social isolation

was increased. As a consequence of this kind of thresholds, participants believed that the spontaneous interaction was lost. Participant E said: *“I mean, it’s not natural to pick up the phone and small talk with your co-workers, like ‘what happened this weekend?’ it doesn’t become natural and feels very strained and stiff”*. A notion that was supported by participant C who said: *“I would say that there is a kind of threshold to invite someone to have a quick chat (using the work’s digital technologies)”*. Based on these comments, participants expressed the experienced threshold for initiating contact as cumbersome to the extent that they commenced less interaction with their colleagues, which increased the feeling of social isolation.

Theme 3: Lack of support for ‘natural’ interaction with digital technologies

Participants recurringly came back to small talks when having social gatherings in the workplace, such as organized Swedish fikas¹, going out for lunch and talk about other things than work or having casual coffee breaks, and popping-by colleagues’ offices as ‘natural interaction’. Most of the participants’ organizations had implemented digital/virtual social gatherings during the pandemic, an initiative that was theoretically appreciated by the participants, however, not that great in practice. Participant J said: *“I can’t see myself doing that (meaning virtual “fika”), it’s so awkward...”*. Participant A agreed and said: *“...it feels a bit forced and then you feel like you are expected to talk about something”*. Participants often focused on the way that communication was performed in video-conferencing systems. Participant F commented that: *“...if you are in a physical meeting, you can tell who is about to talk, but now you can’t, so people get interrupted”*. Participant A said: *“...it’s hard to speak because everybody speaks and talks in each other’s mouths and then you can’t talk in a normal way...”*. Based on these comments, some participants further agreed on the notion that personal characteristics and usage know-how regarding the different digital technologies affect the success of communication. Participant F experienced that: *“...some people are better off in physical meetings because they are not very present, you can see that they are looking at other stuff on their screen... all people do not have a digital social etiquette”*. Participant H said: *“I think my generation is more, that we actually want to speak face-to-face, and sometimes a video conference is not enough... Younger people are used to do that already, they actually interact more on electronic devices than they do in real life and have done so for quite some time, so it’s more natural for them”*. Therefore, it was found that there is lack of support for ‘natural’ interaction in digital technologies.

¹ Fika is the Swedish custom of enjoying coffee and a treat with a friend; similar to a coffee break. *Fika* has become a concept, an attitude and an important part of Swedish culture.

Theme 4: Digital technologies lack support for variety of social interaction inputs

This finding constitutes an extension to the issues presented in previous finding (theme 3), as the social inputs referred to is an aspect related to ‘natural’ communication. Eye contact, body language and social presence were recurring in the discussion. Participant D said: *“The thing is that you pick up signals with so many senses, and when you do that by your flat screen it becomes very...flat. Because of the sensory, you only have what you see”*. Participant C commented that: *“I guess I don’t really feel the presence of the people I’m connecting with in the same way”*. Participant A elaborated and stated that: *“In a physical meeting you can tell who is about to talk, because you can read their body language...”*. Participant D said: *“When in larger physical meetings, like 20+ people, you have interaction, you have body language, you can feel what people are thinking and feeling and you can adjust what you are saying”*. This was further supported by participant E: *“The difference (from meeting in person) is that I can see all the people, I can ‘read’ them, I can see their reactions, I can see if someone is interested in what I have said and I can see if someone would like to say something or need more time to digest their thoughts”*. Participant J commented that all feelings are toned down when interacting virtually and said: *“It’s not only about the body language, it is the tension sometimes and also when there are light environments... of course you see the person laughing or waving or making jokes (in video-conferencing systems), but it’s not the same as if we were together, having a delightful moment”*.

In addition to this, some participants with managing roles also expressed concerns about having emotional conversations with employees via digital technologies, such as in the video-conferencing systems. Participant D said: *“This is not really a great way for me to do the work I want to do (virtual communication from home), which is to help the employees to perform in the best way that they can”*. While participant B said: *“When you have conversations that are a bit more deep, or more emotional, it’s harder to express yourself or know how the person in the meeting is reacting”*. Thus, it was found that digital technologies did not support the variety of social interaction inputs.

Theme 5: Digital technologies that somewhat enable social interaction

Participants recurrently focused on instant messaging systems, or online chats and agreed that somewhat enable social interaction. Mainly because they are easy to use, resemble ‘real’ informal communication and constitute a communication form that participants feel comfortable with. Participant E said: *“We use the chat in MS Teams, and it’s kind of simple to use and a good way of interacting, I must say... for me a chat is more informal”*. An additional reason for chat systems being valued

was that the communication is quick and direct. Participant A said: *“It’s very good to have that possibility to talk fast with your co-workers, it affects my experience positively, it reduces the feeling of isolation”*. Participant F commented that: *“I am very lucky to have a manager and co-workers who answers quickly”*. Participant H said: *“I mean previously (before the pandemic), in terms of e-mails, everybody expected a quick answer, but with messaging, you expect an even faster answer, and that’s why it’s more like a real conversation”*.

Another major reason for the online chat systems to be appreciated among the participants, was the ability to use graphical elements to enhance the social experience. Participant B said that: *“We do that a lot, when we want to express our feelings, like ‘this is how I feel right now’ we can send GIFs. Or if we have internal competitions everyone reacts with an emoji instead of writing ‘great job’... I actually like it very much!”*. Participant E said: *“I try to use graphical elements, it becomes a bit more fun I would say, and I think it expresses a bit more”*. Participant A agreed by saying: *“I like it when you can make it more fun with your co-workers, so we use smileys and GIFs and Memes and stuff so it’s like more personal”*. Participant G commented that: *“Of course we use them (graphical elements)! You have to have a little fun as well”*. In addition, participant G said that: *“My boss really advocates that we should send funny emojis and things like that”*. Therefore, it was found that digital technologies, such as instant messaging systems and online chats, enabled ‘easy’ and ‘informal’ communication and enhanced social experience.

Discussion

The research question for this study reads: *How do digital nomads experience the support of digital technologies in relation to social isolation?* The findings of the empirical study suggest that participants’ experiences, both when working from home and working from a physical office, display a pattern of connections between interaction and digital technologies, visualized in the following Figure I. The findings are then discussed with the theory of symbolic interactionism.

As seen in Figure I, it is suggested that interaction among digital nomads-colleagues for cooperative purposes can be roughly divided into 3 types. All of which induce requirements for certain functions when conducted remotely, and therefore connected to a specific digital technology for interaction support. The first type of interaction includes larger meetings with the workgroup or organization with the purpose of sharing information or having presentations for which functions for screen sharing, presentation hosting, and allowing many participants are required, and thus connected mainly to video-conferencing systems. The use of video-conferencing systems in this manner is supported by the findings of

Waizenegger et al. (2020), who state that video-conferencing systems are not suitable for socialization. Another dimension to this is the fact that participants perceived the video-conferencing systems flawed for discussion purposes due to flow-disturbance in conversations, confirming Saatci et al. (2020). In addition, participants commented on the formality of the use of digital technologies when saying that screens are shared more often than faces in these types of meetings.

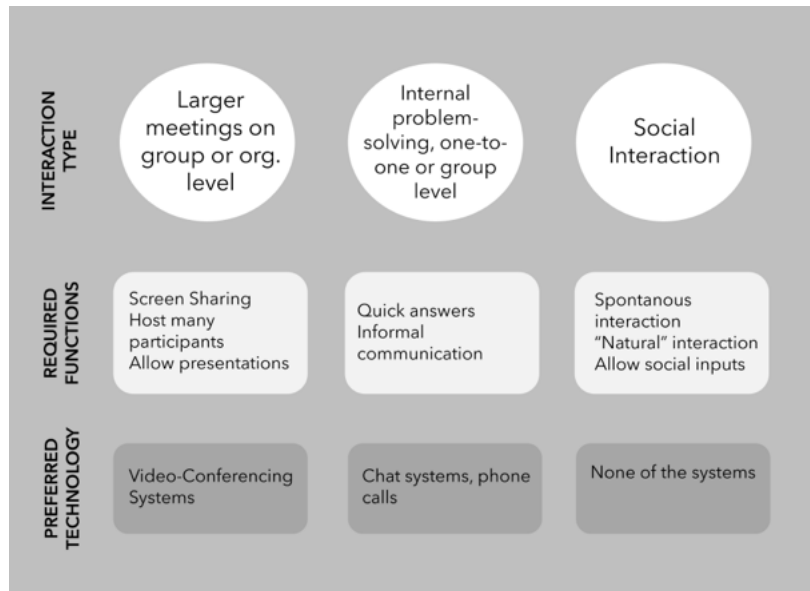


Figure I. Empirical Model of Digital Nomads' Experiences on Digital Technologies' Support for Interaction.

As seen in Figure I, the second type of interaction includes internal problem-solving and asking each other questions in smaller groups or one-to-one interaction that requires functions that allow quick answers and informal communication. From the empirical findings, it was clear that the online chat functions in the participants' everyday used systems allowed them to fill these functions. As commented by Morganson et al. (2010) and Wang et al. (2020), this type of 'natural' communication is supported by the use of multichannel use of digital technologies among digital nomads. This is visible in the findings as participants often referred to the functions of the online chat-systems as "easy" and "informal".

The third type of interaction as depicted in Figure I is social interaction. That is, all interactions with colleagues that are not directly connected to performing work tasks and often imply talking about other things than work. As aforementioned, instead of displaying and referring to social isolation, participants talked about lack of social interaction as a synonym experience. For social interaction, functions for spontaneous interaction, natural communication and means for experiencing social physical sensory inputs are required. Although the online chat systems were considered to somewhat address this type of interaction need, the digital

technologies were in general not considered supportive of social interaction according to the participants. Similarly, Hacker et al. (2020) point out that the digital technologies are not suitable for social interaction, while Ciolfi and de Carvahlo (2014) present empirical evidence that face-to-face interactions are still crucial for successful cooperation. On the other hand, Allen et al. (2015) and Carillo et al. (2021) comment that digital technologies can reduce social isolation among digital nomads. As said, this research takes the stance that social interaction decreases social isolation experienced by digital nomads in their everyday work, thus, it is suggested that none of the used digital technologies are experienced as fully supportive in terms of social isolation.

We aim at further understanding these findings by applying the symbolic interactionist perspective. Following Blumer's (1986) ideas, symbolic interactionism grounds itself on three principles: (1) Humans act towards things based on the meaning that the things bring to them; (2) The meaning of such things comes from individuals' social interaction with others and the society; (3) The meaning constantly changes with an interpretive process.

It is important to note that previous related research suggests that the experience of social isolation in relation to nomadic work is a major issue (Morganson et al., 2010; Bartel et al., 2012; Waizenegger et al., 2020; Carillo et al., 2021). Despite this, the participants did not display any significant concern regarding social isolation when talking about their work from a perspective of being digital nomads. Instead, the participants exhibited a general dissatisfaction about losing the interaction with their colleagues in terms of lack of social interaction when having to only communicate through digital technologies. Although the participants did not term this as "social isolation", their experiences are similar to what Cacioppo and Cacioppo (2014) define as the core aspects of it, e.g., lack of emotional, network-related and physical social connection and interaction.

Based on the findings, it is further clear that the notion of social interaction is strongly connected to physical aspects for the participants. When comparing communication and interaction in a physical office and through the use of digital technologies, participants often referred to physical aspects when describing social interaction. Examples of the participants were the significance of 'fika' as a social interaction activity, the need for spontaneous interaction (which was clearly an issue with the digital technologies), to experience some sort of social interaction, and the importance of physical sensory inputs such as body language, eye contact etc. From a symbolic interactionist perspective, it can be suggested that digital nomads act towards the digital technologies based on the meanings they bring to them. For example, larger meetings are characterized with a formal undertone in which one person is often in charge of the discussions (the first interaction type in

Figure I). As video-conferencing systems provide the functions for this type of interaction, digital nomads create a mental connection, or the *meaning*, between an interaction type and a digital technology and act towards it thereafter. From this perspective, the digital technologies form symbols for the people using them.

Furthermore, people re-create meaning to symbols in their everyday lives based on interaction with other people (Blumer, 1986). Thus, it can be further suggested that the respective organizations, in which the digital nomads are a part, have created mutual symbolic meanings for certain physical environments and arenas in the physical office that hold symbolic meaning of social interaction. According to the findings, such particular environments and arenas are for example coffee breaks, lunches or ‘popping by’ each others offices. This notion is supported by the fact that participants did not appreciate the digital ‘fikas’ their organizations initiated. That is, the physical gathering with cake and coffee with colleagues is a common symbol for social interaction, while having virtual meetings with the help of digital technologies is not. The digital technologies on the other hand are symbols that hold meanings that are more related to work-specific interaction, and thus stand for an environment in which you perform work. As aforementioned, Koch and Gross (2006), Grudin and Poltrock (2012) and Chatzipanagiotou (2021) categorize the cooperative activities within the digital technologies as ‘*information sharing*’, ‘*coordination*’ and ‘*communication*’. When reviewing Figure I of the empirical findings, it is clear that information sharing and coordination are sufficiently supported by the digital technologies used by the participants. Literature suggests to use these systems for socially related interaction activities in order to reduce isolation feelings (Allen et al., 2015) and create a ‘*normal*’ level of interaction (Morganson et al., 2010; Wang et al., 2020). Still, participants appeared to view the digital technologies more as tools for work-related interaction, and not as environments for social interaction purposes. For instance, video-conferencing systems are symbolically connected to larger work-related meetings and presentations based on the functions they provide. The meanings come from interactions with other digital nomads-colleagues. As they are continuously used for these purposes, changing the meaning to them can be problematic. In real life, social interaction would, according to the participants, take place in certain situations or locations in the workplace, such as places you go for lunch, common coffee rooms etc. However, when initiating social interaction activities in the digital technologies that are symbolically connected to work, the symbolic meaning of these systems are supposed to change, which could create a friction. In other words, as companies have not yet developed a digital environment that is solely symbolically connected to social interaction, meanings of the digital technologies for communication support are problematic to be dual. By not giving the conditions to create a social symbolic meaning to these systems, social interaction may not be satisfactory.

This could also be a reason for participants to consider the online chats more social, as they are symbolic platforms for social interaction outside of work. Thus, the symbolic meaning of them stay the same when they are used at work. Digital nomads' symbolic meaning towards digital technologies for social interaction constantly changes with an interpretive intention process. In practice, this is explained as that there has been no natural and interpretive development of a social digital interaction culture in an organizational context, since none of the digital technologies have been substantially implemented nor used daily by the digital nomads before the COVID-19 pandemic.

Finally, these notions are further aligned with Hacker et al. (2020) in the sense that digital technologies are not designed to make a good foundation for social interaction. In other words, the functions of the used digital technologies do not provide organizations with good conditions to create social symbolic meaning to them. In extension, the assignment of new meaning to these technologies is problematic. Subsequently, the used digital technologies are not considered to affect social isolation as they are not suitable for supporting social interaction.

Conclusion

The aim of this research paper was to explore digital nomads' perceptions and experiences of digital technologies in relation to social isolation, guided by the research question *How do digital nomads experience the support of digital technologies in relation to social isolation?* The research outcome showed that digital nomads do not experience the digital technologies they use in their everyday work as supportive in terms of social isolation. It further shows that the concept of *social isolation* does not properly describe the experience of digital nomads; instead, a lack of social interaction is more suitable to describe their situation. The participating digital nomads described social interaction in the workplace as an activity of physical nature, which could be an explanation to why none of the digital technologies used were considered sufficient for such purpose. On the other hand, findings showed that digital nomads acknowledged digital technologies as tools for conducting their work, not tools for interacting socially. Concluding, findings showed that collective symbolic meaning is consciously assigned to the different digital technologies. In addition, organizations have failed to establish digital arenas and/or tools that are suitable for, and thus can be symbolically connected to, social interaction among digital nomads-colleagues. The research thus contributes theoretically to the existing knowledge within the field of computer-supported cooperative work in regard to technology-centered nomadism as it partly fills the knowledge gap about the support of digital technologies in relation to digital nomads' social isolation. The research also contributes practically to interested

stakeholders in the sense that organizations may not benefit from using digital technologies for social interaction purposes from a digital nomad perspective, and that new arenas and/or tools may be searched for.

Limitations and Future Research

The study was conducted during times of restrictions related to the COVID-19 pandemic and participants were forced to nomadic work practices, we, therefore, suggest repeating the research now that the pandemic is over to examine whether the research outcome would be affected or not. It is also suggested that future research could apply an ethnographic inquiry to illustrate a more nuanced perspective of the topic. Furthermore, as there is an ongoing debate on how the nature of work is changing due to societal and technological developments, including the recent COVID-19 pandemic, it is also suggested that a longitudinal study could provide a deeper understanding of the topic. As mentioned, we also recognize that as a result of aforementioned restrictions, participants in this study were not engaging in nomadic work practices by choice. This aspect should be considered in relation to the findings of this study. A future research could also examine whether digital technologies are designed having the concept of *social isolation* in mind with the aim of providing suggestions to mitigate the feeling of social isolation in software design.

References

- Allen, T. D., Golden, T. D. and Shockley, K. M. (2015) 'How effective is telecommuting? Assessing the status of our scientific findings', *Psychological Science in the Public Interest*, vol. 16, no. 2, pp. 40-68.
- Bartel, C. A., Wrzesniewski, A. and Wiesenfeld, B. M. (2012): 'Knowing where you stand: Physical isolation, perceived respect, and organizational identification among virtual employees', *Organization Science*, vol. 23, no. 3, pp. 743–757.
- Bloom, N., Liang, J., Roberts, J. and Ying, Z. J. (2015): 'Does working from home work? Evidence from a Chinese experiment', *The Quarterly Journal of Economics*, vol. 130, no. 1, pp. 165-218.
- Bloom, N. 'How working from home works out', 2020, Retrieved January 28, 2022 from Institute for Economic Policy Research (SIEPR). Policy Brief June. <https://siepr.stanford.edu/research/publications/how-working-home-works-out>
- Blumer, H. (1986): *Symbolic interactionism: Perspective and method*, University of California Press, California.

- Braun, V. and Clarke, V. (2021): ‘Can I use TA? Should I use TA? Should I not use TA? Comparing reflexive thematic analysis and other pattern-based qualitative analytic approaches’, *Counselling and Psychotherapy Research*, vol. 21, no. 1, pp. 37-47.
- Cacioppo, J. T. and Cacioppo, S. (2014): ‘Social relationships and health: The toxic effects of perceived social isolation’, *Social and personality psychology compass*, vol. 8, no. 2, pp. 58-72.
- Carillo, K., Cachat-Rosset, G., Marsan, J., Saba, T. and Klarsfeld, A. (2021): ‘Adjusting to epidemic-induced telework: Empirical insights from teleworkers in France’, *European Journal of Information Systems*, vol. 30, no. 1, pp. 69-88.
- Charon, J. M. (2010): ‘*Symbolic Interactionism: An introduction, an interpretation, an integration*’, Pearson College, London
- Chatzipanagiotou, N. (2021): ‘*Managers’ Cooperative Work Practices in Computational Artefacts-Supported Library Systems*’, (Linnaeus University Dissertations; 419/2021), Linnaeus University, Växjö.
- Ciolfi, L. and De Carvalho, A. F. P. (2014): ‘Work practices, nomadicity and the mediational role of technology’, *Computer Supported Cooperative Work (CSCW)*, vol. 23, pp. 119-136.
- Cooper, C. D. and Kurland, N. B. (2002): ‘Telecommuting, professional isolation, and employee development in public and private organizations’, *Journal of Organizational Behavior: The International Journal of Industrial, Occupational and Organizational Psychology and Behavior*, vol. 23, no. 4, pp. 511-532.
- Golden, T. D. and Veiga, J. F. (2005): ‘The impact of extent of telecommuting on job satisfaction: resolving inconsistent findings’, *Journal of Management*, vol. 31, no. 2, pp. 301-318.
- Gorlick, A. (2020): ‘The productivity pitfalls of working from home in the age of COVID-19’, Retrieved January 28, 2022 from Stanford News March, <https://news.stanford.edu/2020/03/30/productivity-pitfalls-working-home-age-covid-19/>.
- Grudin, J. and Poltrock, S. (2012): ‘Computer-Supported Cooperative Work. In Interaction Design Foundation’ (ed.), Retrieved January 22, 2022 from The Encyclopedia of Human-Computer Interaction, <https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/computer-supported-cooperative-work>.
- Hacker, J., vom Brocke, J., Handali, J., Otto, M. and Schneider, J. (2020): ‘Virtually in this together—how web-conferencing systems enabled a new virtual togetherness during the COVID-19 crisis’, *European Journal of Information Systems*, vol. 29, no. 5, pp. 563–584.
- Lee, A., Toombs, A. L., Erickson, I., Nemer, D., Ho, Y. S., Jo, E. and Guo, Z. (2019): ‘The social infrastructure of co-spaces: Home, work, and sociable places for digital nomads’, *Proceedings of the ACM on human-computer interaction*, vol. 3 (CSCW), pp. 1-23.
- Koch, M. and Gross, T. (2006): ‘Computer-supported cooperative work-concepts and trends’, Retrieved February 1, 2022 from AIM 2006—Information Systems and Collaboration: State of the Art and Perspectives (AIM), https://www.researchgate.net/publication/221512200_Computer-supported_cooperative_work_-_Concepts_and_trends#fullTextFileContent.
- Mead, G. H. (1934): ‘*Mind, self and society*’, University of Chicago Press, Chicago.

- Morganson, V. J., Major, D. A., Oborn, K. L., Verive, J. M. and Heelan, M. P. (2010): 'Comparing telework locations and traditional work arrangements: Differences in work-life balance support, job satisfaction, and inclusion', *Journal of Managerial Psychology*, vol. 25, no. 6, pp. 578–595.
- Patton, M. Q. (2015): *'Qualitative research and evaluation methods'*, Sage, Thousand Oaks.
- Redmond, M. V. (2015). 'Symbolic Interactionism'. *English Technical Reports and White Papers*, Retrieved February 4, 2022 from https://lib.dr.iastate.edu/cgi/viewcontent.cgi?article=1004&context=engl_reports.
- Rudnicka, A., Newbold, J. W., Cook, D., Cecchinato, M. E., Gould, S. and Cox, A. L. (2020): 'Eworklife: Developing effective strategies for remote working during the COVID-19 pandemic', In *Eworklife: developing effective strategies for remote working during the COVID-19 pandemic*. The New Future of Work Online Symposium.
- Saatçi, B., Akyüz, K., Rintel, S. and Klokmose, C. N. (2020): '(Re)Configuring Hybrid Meetings: Moving from User-Centered Design to Meeting-Centered Design', *Computer Supported Cooperative Work (CSCW)*, vol. 29, no. 6, pp. 769-794.
- Sadiku, M. N., Omotoso, A. A. and Musa, S. M. (2005): 'Nomadic Computing: A Primer', *Management*, vol. 22, no. 4, pp. 56-64.
- Schmidt, K. (2011): *'Cooperative work and coordinative practices: Contributions to the conceptual foundations of Computer-Supported Cooperative Work (CSCW)'*, Springer Science & Business Media, Berlin.
- Schmidt, K. (2016): 'Computer-Supported Cooperative Work. In: K.B. Jensen, and R.T. Craig (eds.)', *The International Encyclopedia of Communication Theory and Philosophy*, pp. 1-5.
- Waizenegger, L., McKenna, B., Cai, W. and Bendz, T. (2020): 'An affordance perspective of team collaboration and enforced working from home during COVID-19', *European Journal of Information Systems*, vol. 29, no. 4, pp. 429–442.
- Wang, W., Albert, L., and Sun, Q. (2020): 'Employee isolation and telecommuter organizational commitment', *Employee Relations: The International Journal*, vol. 42, no. 3, pp. 609-625.

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Planning for hybrid cooperation - a design driven exploration

Juliane Busboom, Nina Boulus-Rødje
Roskilde University
Contact Author: busboom@ruc.dk, ninabr@ruc.dk

Abstract. Hybrid work has become popular in post-pandemic times, helping organisations in attracting/retaining employees by offering greater flexibility and alternative modes of working. Despite the great interest in hybrid cooperation, recent research reveals prevailing challenges with current technologies and practices. In the search for the “right setup” for hybrid cooperation, some research tends to narrowly focus on developing technical solutions for rather isolated problems. In this paper, we wish to problematize these tendencies found in the literature and shortcomings in current technologies and practices, by shedding light on articulation work-an overlooked aspect related to managing hybrid work. The paper presents Collab.ai, a fictional AI-powered calendar and planning tool that re-imagines the planning for hybrid cooperation, followed by three additional artifacts that are aimed at amplifying various aspects of Collab.ai. Using a discursive design approach, the paper and these artifacts are aimed at sparking reflections on future hybrid cooperation tools and practices.

Introduction

The professional social networking site LinkedIn, launched a new feature in 2022 which makes it now possible to search for job openings based on the preferred type

of workplace: on-site, remote or hybrid (Turner, 2022). This development indicates how organizations have adapted to the new demands of employees that came in the wake of the Covid-19 pandemic, calling for more flexible and alternative models of work (Tang et al., 2022). Today, especially hybrid models are attracting greater attention in many organizations, as they offer employees greater flexibility while still preserving a degree of control and stability for employers (Sokolic, 2022). It seems that hybrid work performs well as a concept and a managerial practice, as it has the capacity to attract and retain people by offering a partly remote and partly on-site workplace (Swain et al., 2020; Gray et al., 2020). However, when it comes to the execution and facilitation of hybrid cooperation—meaning everyday collaboration and coordination—recent research identifies a broad range of challenges related to technological infrastructure, social inclusion, and the workspace itself, which seems to slow down the desired acceleration of hybrid cooperation (Saatçi et al., 2019).

Both academics and corporate researchers are spending a considerably high amount of time and resources searching for solutions that better support hybrid cooperation (e.g., Neumayr et al. (2021)). While most researchers acknowledge that there is no one-size-fits-all solution, many of the technologies presented in their papers tend to propose technical quick fixes (Grønbaek et al., 2021; Rintel et al., 2021). Reviewing recent research literature reveals a strong quest for finding the "right setup", focusing on developing technological solutions to support and improve the execution of hybrid cooperation. However, little research could be found on the aspects of preparation and planning that are necessary to enable hybrid synchronous cooperation. In other words, not enough attention has been paid to what has been labeled as 'articulation work' (Strauss et al., 1985), meaning the informal work that is necessary to ensure smooth coordination and manage the distributed and contingent nature of work (*ibid.*). Articulation work is an integral part of managing any kind of cooperative work (Schmidt and Bannon, 1992), and it plays a larger role in distributed cooperative settings (Matthiesen et al., 2014).

However, when cooperation is not only distributed across geographical and socio-cultural boundaries, but also carried out synchronously in a hybrid setting, the importance of articulation work becomes amplified, requiring complex organizational and technical infrastructures and considerations (Duckert et al., 2022). Planning for a synchronous hybrid cooperation, necessitates a higher degree of articulation work, as it entails not only coordinating schedules and interdependent tasks, but a wide range of considerations related to the configuration—the choice and positioning—of the people (collocated and remote participants), as well as devices and tools in the physical and online workspace setup, depending on the type of cooperative task.

Looking at the features offered by current online calendars and videoconferencing tools, their overall core functionality has remained relatively consistent, with minor improvements, such as better integration with other productivity tools and for instance, the possibility to add a video-call link to a

calendar invitation. However, a video-call link is not enough to support a hybrid synchronous meeting.

Therefore, this paper is intended to spark a discussion which explores the following research question: *How might current tools and practices for preparation and planning of hybrid work be re-imagined to incorporate articulation work?* This question is ultimately intended to generate a set of speculations about future tools and practices that better support synchronous hybrid cooperation. To answer the research question, the paper starts by analyzing the technical affordances of three calendar- and planning tools and illustrates how these tools focus narrowly on booking meetings, overlooking the articulation work that needs to be carried out in order to enable hybrid synchronous cooperation. We then present Collab.ai, a fictional planning tool designed by the first author, to generate alternative conceptualizations that focus on planning collaborations rather than meetings or events, and takes into account the articulation work necessary for hybrid collaborations. To aid the speculative exercise, this core artifact is followed by three supportive artifacts intended to amplify different aspects of Collab.ai and shed light on its potential implications. As the first step of this work-in-progress, we wish to present the designed artifacts for CSCW researchers, and later for organizations working in hybrid setups, in order to generate rich reflections that can be used for the design of future tools and practices for hybrid work.

The remainder of the paper is structured as follows: in the next section, we provide a brief review of the literature about distributed hybrid work, making the case for the importance of articulation work. This is followed by an analysis of digital calendar and planning apps and a presentation of our design approach, setting the stage for presenting the set of discursive artifacts and explaining the intention behind their design.

Hybrid (Cooperative) Work

The search for the "right setup" for hybrid cooperation

While hybrid work has become a popular model of working in post-pandemic times (Sokolic, 2022; Neumayr et al., 2022), recent research reveals prevailing challenges with daily collaboration and task completion in hybrid settings, which seems to limit the presumed efficiency and success of hybrid cooperation (Saatçi et al., 2019, 2020; Teevan et al., 2020, 2022). These challenges result from the asymmetries in the relationships between people and things that unavoidably occur in hybrid settings (Duckert et al., 2022), which in turn introduce new uncertainties related to technical infrastructure, social and cultural inclusion, as well as the space in which hybrid cooperation takes place (Saatçi et al., 2019).

Underlying many of these challenges is the strong desire to find the so-called "right setup" for hybrid cooperation. This includes the right setup to avoid technical breakdowns or sound and audio problems across remote and on-site participants (Saatçi et al., 2019; Yankelovich et al., 2004; Tan and Kondo, 2008). The right

setup to avoid exclusion of remote participants when on-site participants socialize and have informal conversations (Yankelovich et al., 2007; Karis et al., 2016; Saatçi et al., 2020). And the right setup for the workspace to support aligning physical objects with virtual elements and help task completion at distance (Yankelovich et al., 2004; Saatçi et al., 2020; Augstein et al., 2022).

Subsequently, a growing number of academics as well as corporate researchers is currently exploring various technical solutions aimed at improving social inclusion through, for instance, the use of remote gaze visualization (Xu et al., 2017) and conferencing systems that actively allow for social time (Gonzalez Diaz et al., 2022; Rintel et al., 2021). Others, explore ways of alleviating the challenges of a distributed workspace through the use of malleable videoconferencing systems (Grønbaek et al., 2021; O'hara et al., 2011) and distributed tabletop activities (Rädle et al., 2014; Yamashita et al., 2011). While others, dedicate their efforts to developing solutions that improve the technological infrastructure (e.g., sound, audio and visualization) (Hradis et al., 2012). Common to these studies is a strong focus on technological tools to support the execution of hybrid cooperation (e.g., Neumayr et al. (2021)).

Nonetheless, many of the challenges associated with hybrid cooperation relate to the preparation and planning, rather than the execution of hybrid cooperation. Saatçi et al. (2020) take a first leap into this direction of focusing on planning by proposing the replacement of a user-centered with a meeting-centered approach, arguing that 'complex ecologies of people, technology, spatial, and institutional organization must be made relevant in the process of design for more inclusive hybrid meetings' (p.769). Considering the configuration of the workspace setting is always important, but it becomes more pertinent in hybrid collaborative settings. Yet many of our current technologies and practices have not been fully adapted to hybrid cooperation. Post pandemic-times, we find minor changes done in physical workspaces (i.e., adding cameras and loudspeakers to meeting rooms) and online tools (i.e., introducing new functionalities and better integration with other tools such as online calendars, collaboration apps and videoconferencing tools). But these are all rather minor adaptations, insufficient in supporting hybrid cooperation which requires much greater articulation work.

Articulating and planning hybrid cooperation

Articulation work refers to all the extra work that is necessary for handling mutual dependencies in cooperative work arrangements (Schmidt and Bannon, 1992). The concept — originally coined by Strauss et al. (1985) — refers to 'all tasks involved in assembling, scheduling, monitoring and coordinating all the steps necessary to complete a production task...' (Gerson and Star, 1986, p.166). In other words, articulation work refers to communication and coordination efforts required to achieve shared understanding and effective collaboration, and it tends to be invisible (Suchman, 1996). It 'includes both temporal co-ordination (sequencing

the inputs of different actors over time) and spatial co-ordination (ensuring that the right people and artefacts are in the right place)' (Greenhalgh et al., 2014, p.6).

The concept has played a major role in the CSCW field since its inception, generating studies that shed light on the crucial role that articulation work plays in managing the distributed nature of cooperative work (Schmidt and Bannon, 1992; Lee, 2007; Schneider and Wagner, 1992). These studies have been important in the discussions about how to design systems that better support not only the formal work, but also the "extra work" necessary to make distributed collaboration work in practice (Grinter, 1996). The general argument in CSCW has been that technological systems should be designed to reduce the amount of articulation work (Schmidt and Bannon, 1992; Schmidt and Simonee, 1996), and since the 1980s various systems have been designed to support coordination management (Grinter, 1996; Divitini and Simone, 2000).

Articulation work was found to have a critical role particularly in the management of globally distributed projects, such as in the context of global software development. In such settings, coordinating interdependent tasks and people distributed across organizational, geographical, and temporal socio-cultural boundaries becomes much more complex (Matthiesen et al., 2014). Furthermore, when distributed collaboration is carried out synchronously and in a hybrid format, it adds additional layers of complexity, as the collaborative space is composed of both a physical and a virtual workspace, introducing unavoidably multiple asymmetries in terms of access to tools, technologies, and things.

Therefore, hybrid cooperation requires a greater amount of articulation work. This includes, for instance, determining the positioning of the technological devices (e.g., camera, projector, loud-speakers) vis-a-vis the physical and remote participants, selecting the types of collaborative tools to be used (e.g., physical vs. online whiteboard), ensuring that both physical and online participants have access to the collaborative space and that it is visible for all, etc. Current technologies and practices of hybrid cooperation seem to fall short in supporting articulation work.

Every cooperation entails meetings to communicate tasks and manage dependencies. Meetings are, therefore, crucial for any cooperative arrangement, and it has been said that we have been witnessing the emergence of an increasing "meetingisation" of work which stems from the growing need for collective means of social orientation and coordination (van Vree, 2019). Digital calendars are often used to facilitate and coordinate meetings (Builtwith, 2023), as they make visible people's schedule and thus minimize the time spent on checking people's availability and convenience. Looking at the features offered by these online calendars, very little has changed since 1985. Their overall core functionality has remained relatively consistent, except for the possibility to integrate these with other productivity tools and enhanced mobile access. Furthermore, post-corona, many online calendars have added the possibility to incorporate a video-call link to accommodate online or hybrid meeting (Bergmann et al., 2022).

However, as is evident from the recent studies about hybrid work mentioned in the above section (e.g., Saatçi et al. (2019); Duckert et al. (2022)), a video-call link

is not enough to support a hybrid meeting, which requires various considerations that needs to be taken into account to accommodate both the physical and online cooperation space. Furthermore, these considerations related to the settings differ depending on the type of meeting or task. After all, there are many different types of meetings, for example, information seeking, problem solving, giving information, generation/discussion of ideas, delegation of work, inspection of fixed objects, decision making, negotiation, and presentations (Pye, 1978).

This match between the tool and the type of meeting/task has been identified as important (Easton et al., 1990), as these different types of meetings require a different setup involving different types of participants, collaborative tools and cooperative space.

To explore this match and spark thoughts around current planning practice, we designed a fictional AI powered calendar and planning app named Collab.ai that automatically matches the necessary setup of participants, tools and devices suitable for the different types of meetings. We inscribe Pye's (1978) classification in the design of Collab.ai, to make a clear distinction between the different types of meetings, and the different articulation work these require. Before we present the Collab.ai artifact, we will present an analysis of existing calendar and planning apps.

Design analysis of digital calendar and planning apps

In this section we draw upon principles of interaction design (Norman, 2013) to analyse three different but commonly used digital calendar and planning apps¹. We examine the technological affordances of Apple's iCal, Microsoft Outlook Calendar and Google Calendar, and evaluate their ability to support the articulation work necessary for hybrid cooperation.

The analysis focuses on the *visual hierarchy*, meaning the ability of the digital planning tools to guide the users to the most important elements through the use of variations in color and contrast, scale, and grouping (Gordon, 2021). This can give us an indication of the prioritization of functionalities of these applications.

All three tools define the title as the initial and thereby most important element to fill out (Figure 1). In all cases there are no constraints nor feedforwards (i.e., information that helps answer questions related to execution (doing) while interacting with an artifact) that guide the user towards a preferred type of input. While Apple iCal uses color and grouping to indicate that "location or videocall" is as important as the title, Google and Outlook Calendar prioritize the time and date as well as the involved people, before offering an input field for location. Google Calendar distinguishes between "add video conferencing" and "location", while Outlook does not explicitly offer an input field for a link to a videocall or virtual

¹ For the purpose of this paper, we decided to focus on the interface of these digital calendars as displayed in mobile devices. We acknowledge that the interface of these calendars is different when displayed on computers.

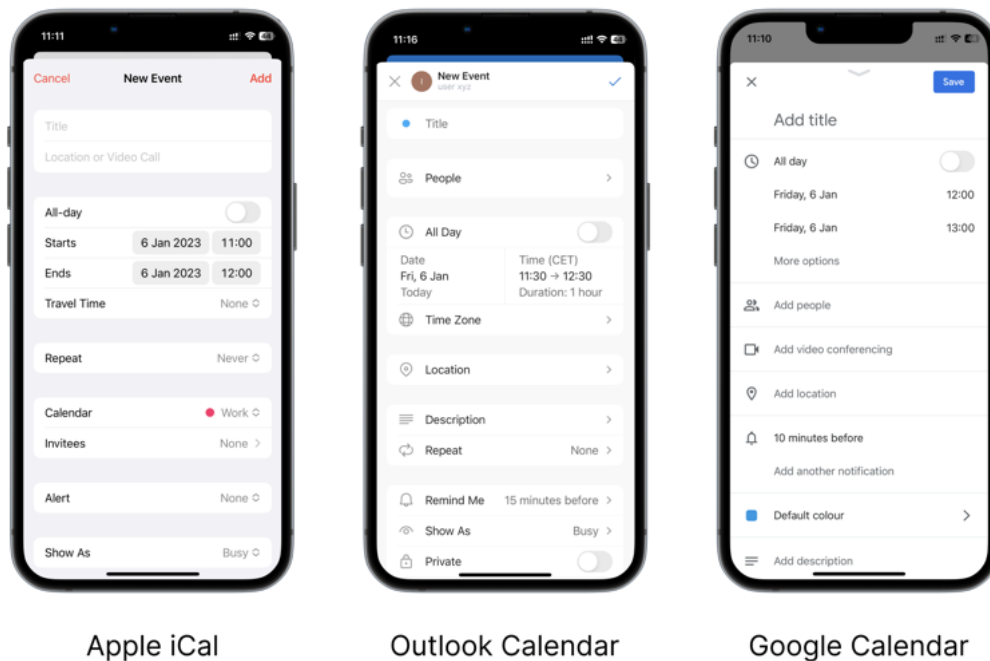


Figure 1. Comparison of common digital calendar and planning tools.

room as –in their mobile version– this is done through Microsoft’s other app Microsoft Teams. Apple iCal prioritizes time and date in the second place, and all tools provide the possibility of inserting a note or description.

To sum up, the three digital planning tools have a rather similar setup, affording generally the same functionalities in terms of planning according to title (*what*), time and date (*when*) and people involved (*who*). However, what stands out is that these tools do not afford planning for the “*how*”, meaning specifying the required features of the meeting support tool and the type of meeting it intends to support; attributes which are important for supporting hybrid cooperation (Easton et al., 1990). Since hybrid cooperation seems to have come to stay (Sokolic, 2022; Tang et al., 2022) it raises the question, why common digital planning tools have not yet adapted to these new models of working. To generate alternative conceptualizations about how such tools could be re-imagined, we draw upon discursive design.

Discursive design as a method

Using research in order to create and reflect upon alternative futures of technologies and design, have become of greater interest in contemporary HCI and design studies. This has been commonly referred to research-through-design methods, and includes for instance, speculative design (Auger, 2013; Dunne and Raby, 2013; Tonkinwise, 2014) critical design (Dunne and Raby, 2001; Dunne, 2008), adversarial design (DiSalvo, 2012), and design fiction (Bleecker, 2015).

Common to these designs is that they mobilize the language of seemingly utilitarian objects of design to communicate ideas, operate as tools for thinking through issues, and raise awareness related to psychological, sociological, and ideological consequences (Tharp and Tharp, 2019).

Thus, Tharp and Tharp (2019) coined the umbrella term "discursive design" which consolidates these different approaches and emphasizes their primary motivation which is achieving audience reflection. They highlight that discursive artifacts are 'objects of utility that carry ideas; they function (or are imagined to function) in the world but their discursive voice is what is most important and ultimately their reason for being' (*ibid.* p.51). In this way, discursive design distinguishes itself from affirmative design, as the former focuses on problematizing and legitimizing alternative discourses while the latter focuses on solving problems.

Some researchers focus on how we create futures and how we ensure that the message of the designed artifact reaches the audience in an appealing way through material expression (Dunne and Raby, 2001), scenarios (Candy, 2010; Candy and Dunagan, 2017) and other mediated artifacts (Bleecker, 2015). James Auger who coined the practice of speculative design argues that a careful management of the speculation is important for the success of speculative design projects. This is done through the development of a "perceptual bridge" between the audiences' perceptions of their world and the fictional element of the concept. The concept must be "uncanny", meaning it must appear familiar but at the same time provocative and foreign (Auger, 2013). Auger (2013) states that 'the presence of the designed artifacts in popular culture allows for the viewer to project its presence into his or her own life. Then they effectively become the protagonist in the story, playing out individual and informative roles. Their reactions become the true products of this form of design research' (p. 20). Hence, the discursive designer also works prescriptive by planning and creating artifacts. However, 'rather than driving the design toward usefulness, usability and desirability, their goal is communicative in terms of encouraging reflection and initiating subsequent debate and response' (Tharp and Tharp, 2019, p.10).

Re-imagining planning for hybrid cooperation

Our speculative exploration consists of Collab.ai—the core artifact—a fictional calendar and planning app that intends to provoke reflections on the role of articulation work in enabling hybrid cooperation. This is followed by a presentation of three additional artifacts designed to shed light on different aspects of Collab.ai.

Presenting the speculative artifact: "Collab.ai"

The interactive prototype, Collab.ai is a fictional AI powered planning tool. Contrary to current planning tools like Google or Outlook Calendar, Collab.ai

automatically configures the “right setup” of a hybrid cooperation based on just a few input factors that are typed in by the user (title, type of collaboration according to Pye’s (1978) categorization and urgency of task). In a chatbot like manner, the user receives information and instructions as well as a time and date for the upcoming collaboration (Figure 2). Collab.ai provides different proposals for configurations depending on the type of collaboration. For example, Collab.ai suggests fully virtual collaboration for information seeking purposes, as this is the most efficient format for such meetings, both in terms of productivity and in terms of cost and CO2 friendliness (Figure 2, screen 3). On the other hand, for negotiation purposes it prescribes attendance in a partly augmented physical space and explains that ‘Negotiations demand closely coupled interactions. Thus, the workspace requires you to be visible – either as an avatar, via video or in person’ (Collab.ai, 2023, negotiation case).

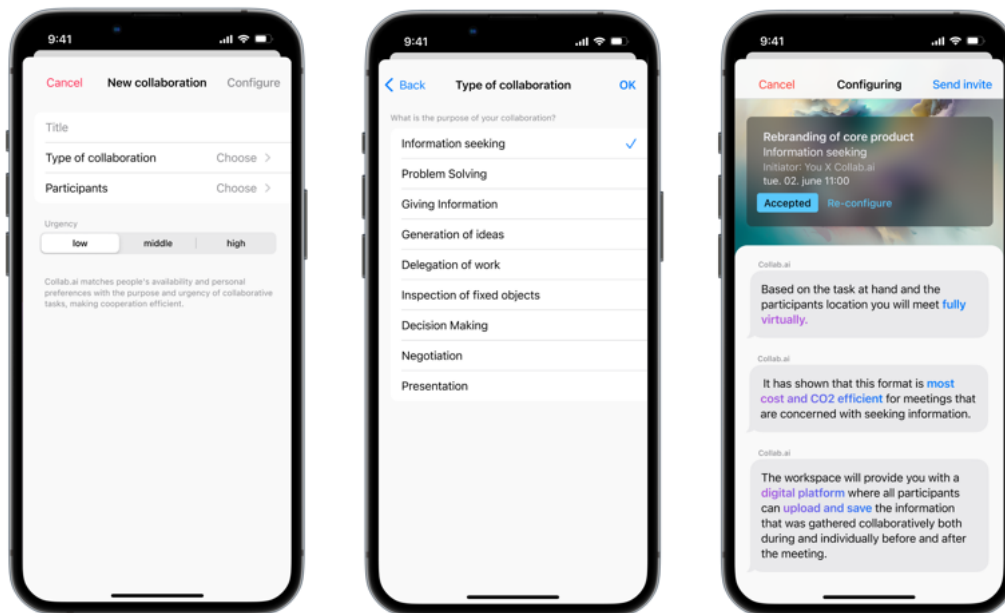


Figure 2. Three exemplary screens of Collab.ai. [Link to interactive artifact](#).

The examples demonstrate how Collab.ai takes especially care of the spatial co-ordination (Greenhalgh et al., 2014) and matches all parameters required for planning effective hybrid cooperation. In other words, Collab.ai automates the articulation work involved in preparing and planning a hybrid cooperative meeting, by identifying and selecting the appropriate people to be involved (based on their relevance, areas of expertise, availability, preference of either remote or on-site work), and matching this with the cooperative activity and its specific attributes. This includes for instance, the location, types of technical tools and devices required and other features supporting the specific type of collaboration (e.g., automatically gathering all information in one place or recording and encrypting information) (Collab.ai, 2023).

Shaping the discourse: What if "Collab.ai" was real?

Collab.ai aims at shaping a discourse-through-design to create knowledge around the role of articulation work for hybrid cooperation. Here, the user-interface-design (UI) serves as the perceptual bridge (Auger, 2013) conveying familiarity with existing systems, while the functionality shapes the intended uncanniness (*ibid.*) aimed at evoking thoughts amongst the audience. Drawing the line to phenomenology in HCI (Dourish, 1999), the idea is to make the artifact at first sight appear “ready-at-hand” and familiar to the audience, but in fact re-design the functionality in the way that the artifact itself becomes “present-at-hand” and makes the audience reflect on their actions. This moment of reflection is the moment where Collab.ai is supposed to make the audience wonder.

The first moment of wondering is prolonged by three additional artifacts (1) a job opening add, (2) a video advertisement, and (3) a newspaper article, each intended to highlight specific aspects of the core artifact.

The job position

The first artifact is a fictional job position on the professional social networking platform LinkedIn looking for a “Collaboration Manager - enhancing hybrid work environments” (Figure 3). The job position is intended to provoke thoughts around the role of articulation work and organizational effort that is required for making hybrid cooperation work.

This artifact builds on the initially mentioned finding, that current attempts of finding the “right setup” (e.g., one-dimensional technical solutions, adaptations of existing systems like Zoom, etc.) seem to be insufficient in supporting hybrid collaboration.

By introducing a new type of job – a collaboration manager – that ‘is responsible for managing and coordinating employees across digital and physical locations to ensure smooth and effective hybrid cooperation’ (Job-position, 2023, para. 1), we aim to spark thoughts on the complexity and effort of making hybrid cooperation work. By making the effort very explicit as a new type of job we want to make the audience reflect upon their own practices—which are often complex yet invisible—related to planning for hybrid cooperation. In order to make the audience think beyond typical ways of facilitating hybrid cooperation like supporting video calls (with e.g. Zoom or Microsoft Teams), the job description indicates more advanced setups of hybrid cooperation that require the collaboration manager to ‘implement and maintain cutting-edge communication and collaboration technologies such as virtual and augmented reality, AI-powered tools, intelligent automation, digital twin technology, and 5G networks, as well as coordinating team meetings and events’ (*ibid.*). Finally, the job description is directly tied to the use of Collab.ai that is described as a non-human colleague: ‘The collaboration manager will work closely with Collab.ai, the new planning tool that enhances hybrid work environments, to configure people’s availability and personal

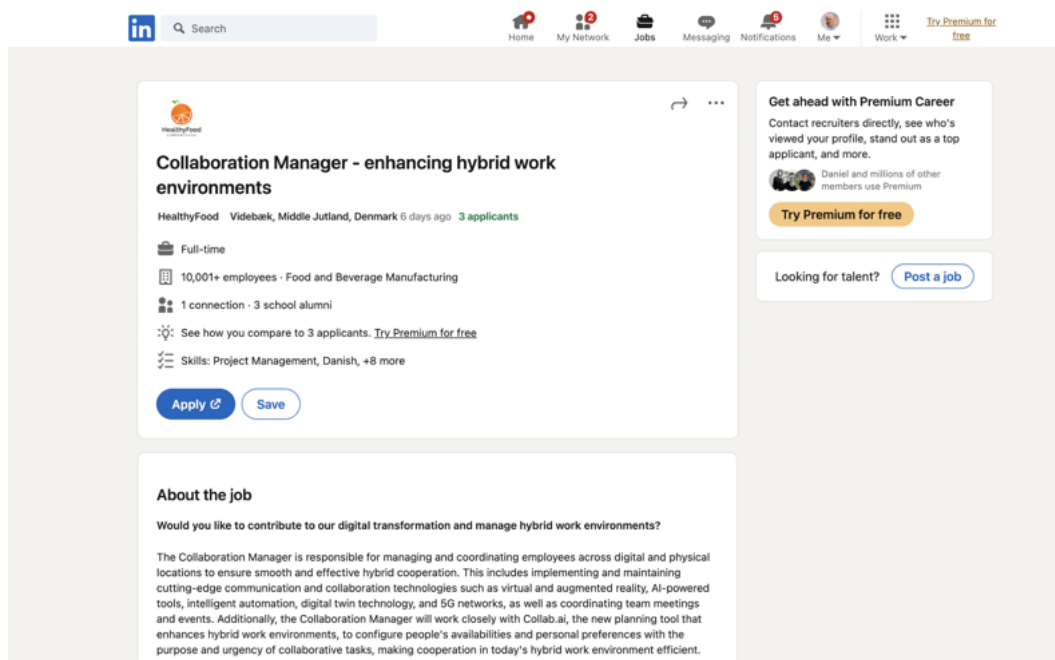


Figure 3. Fictional job posting on LinkedIn looking for a Collaboration Manager. [Link to interactive artifact](#)

preferences with the purpose and urgency of collaborative tasks, making cooperation in today’s hybrid work environment efficient’ (*ibid.*).

The advertising video

The second artifact is a fictional advertising video of Collab.ai (Figure 4), which was designed to bring forth reflections on human vs. technological intelligence regarding the preparation and planning of hybrid cooperation work, and the impact of this relationship on the autonomy to make decisions. It builds on the finding, that much of the recent research on hybrid work settings tends to narrowly focus on searching for technical solutions for rather isolated problems in the execution of hybrid collaboration. The video provocatively overstates this approach by making Collab.ai appear as an intelligent companion that claims to be better at preparing and planning for hybrid cooperation than humans.

The video visualizes how Collab.ai “configures” automatically all the relevant parameters (type of collaboration, participants availability and collaboration preferences and urgency of task) and provides instructions regarding the most suitable workspace the collaboration should take place at, defining a fitting work atmosphere as well as helpful functionality that supports the specific type of collaboration.

The video starts by explaining the purpose and functionality of Collab.ai in a normative tone and conveys the feeling of a real-world product. It is only at the end of the advertising video, that the autonomous character of Collab.ai gets clear, with the following voice-over statement: ‘Let’s be honest – after 3 years pandemic and a

lot of training working from home we haven't figured out how to plan for efficient hybrid collaboration – let's leave the job to technology' (Advertising-video, 2023). The shift in rhetoric happens right after the video shows the intelligent and automatic configuration of all parameters and draws attention to the fact that all decisions are autonomously made by technology. A functionality that is aimed at provoking thoughts on the intellectual power relations between humans and technologies, and its impact on the autonomy to make decisions.

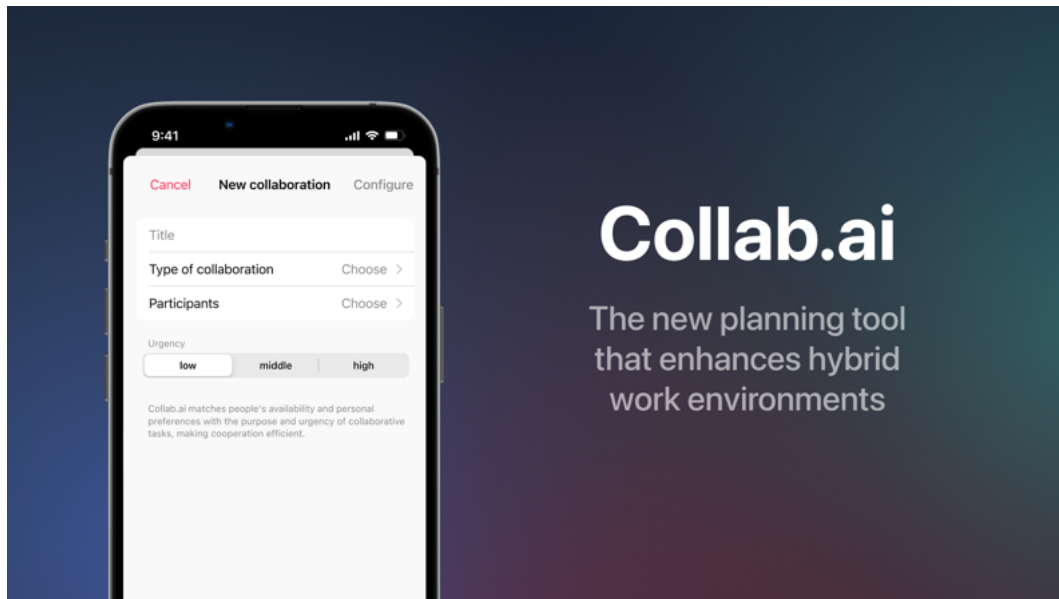


Figure 4. Start screen of the fictional advertising video for Collab.ai. [Link to video.](#)

The newspaper article

The third artifact is a fictional newspaper article (Figure 5) which is tagged as “world news” under the headline “iCal out, Collab.ai in: Apple’s latest move to optimize hybrid work with AI technology”. It was designed to provoke thoughts around the wider socio-cultural impact of changing work practices due to the rise of hybrid cooperation and builds on the initial findings from literature, that hybrid work practices have become common in many organizational contexts – especially after the pandemic. Changing practices can trigger further changes and transformations across individual, local or global levels.

This mediated artifact emphasizes such transformational character by announcing that Apple has decided to replace its own calendar tool iCal with the new AI planning tool –Collab.ai– in response to the changing nature of work in a post-covid world. By making the audience imagine that a tech giant like Apple replaces one of their core applications, we aim at sparking reflections upon the possible consequences of changing work practices related to hybrid cooperative work.



Figure 5. Fictional newspaper article on Apples strategic decision on replacing iCal with Collab.ai. [Link to interactive artifact.](#)

Reflections and Discussions

Electronic shared calendars were released to the market in the 1980s (Grudin and Palen, 1995), providing the capacity to reduce articulation work, as they help coordinate schedules, share information, assign tasks, etc. (Clement and Wagner, 1995). While this is still the case, current electronic calendars are not suitable for supporting the additional articulation work that planning for hybrid cooperation entails, which includes careful configuration of both the online and physical workspace, accommodating the diverse needs of online and collocated participants. Collab.ai automatically carries out these tasks related to preparation and planning for hybrid work, and thereby could be argued to remove the burden from humans, by providing the “right setup” regarding the complex organizational and technical configuration that a hybrid cooperation requires. This may raise various questions related to autonomy, as Collab.ai may be seen as taking autonomy from humans to determine their schedule.

Concerns related to autonomy were already voiced back in the end of 80s, with the introduction of the first digital calendars. At that time, there were some users who felt that these tools were overriding their personal boundaries, as they were making publicly visible all appointments and tasks, while reducing autonomy over their schedules. This has later led to a new functionality whereby current online shared calendar tools offer the option to control the visibility of the various appointments and tasks in their schedules.

This, the intellectual power relations between humans and technology and its impact on autonomy is one of the topics Collab.ai seeks to provoke thoughts upon (Advertising-video, 2023). Furthermore, it seeks to address the efforts needed to make hybrid cooperation work (Job-position, 2023) as well as the wider socio-cultural implications of changing work practices (Newspaper-article, 2023).

Each of the introduced artifacts was produced with the help of latest AI software. The content of both the news report and job description was produced with the help of Open'AI's ChatGPT² software that is trained to produce text, based on a user's query. It remembers what the user said earlier in the conversation and allows the user to provide follow-up corrections. In this way, one can produce very specific and individualized texts that automatically follow certain text structures required for the intended format. In addition, it is possible to ask the AI software to imagine possible futures on a certain topic. As it is trained on existing data and able to re-configure these in new ways, the output tends to appear highly plausible. The spoken text for the advertising video was optimized by the AI powered software Wordtune³ and converted to audio with the help of the AI text to speech software NaturalReader⁴.

Making use of these three different AI software is aimed at drawing attention to the accuracy and power of today's AI tools. The AI supported production of the artifacts acts thus as a speculation itself: Speculating to what extent a tool like Collab.ai could be a real-world product that is able to manage articulation work creating more efficient hybrid cooperation.

Indeed, Collab.ai offers promising features as it automates what seems as a mundane and simple task as scheduling and planning, by learning from past scheduling patterns and user preferences, thus providing a desired plan for the cooperative task that considers both organizational and technical requirements. This assumes, however, that planning and preparing a hybrid cooperation is a simple mechanical task of finding available slots, and selecting the right people based on their areas of expertise. Delegating the autonomy to the technology to make these decisions assumes that the various meetings and tasks in one's calendar all have the same weight. However, planning a cooperative engagement requires internal knowledge about hierarchies in the organizational settings; knowledge about power relations, entailing various political tactics. This raises the question of what happens when such tasks are delegated to intelligent machines that have strong processing power but lack human intuition and internal contextual knowledge that play a role in planning and preparation of cooperative engagements?

Final words

This exploratory paper outlined methods and materials to shed light on the role of articulation work for hybrid cooperation by employing discursive design practice. It is built on latest research from the fields of CSCW and HCI, and underpinned findings from literature with an analysis of common digital planning tools.

² [ChatGPT. Link to website.](#)

³ [Wordtune. Link to website](#)

⁴ [NaturalReader. Link to website](#)

Collab.ai which was designed to enhance hybrid work, was put at the center of this research-through-design intervention, supported by three additional artifacts. This collection of discursive artifacts was produced to spark reflection and generate insights on the potentialities of articulation work for hybrid cooperation.

As a work-in-progress this research-through-design intervention aims to present the designed artifacts for researchers working with the development of practices and technologies in order to generate design reflections.

To be clear, the purpose of this speculation is not to advocate for the design of AI driven tools that completely automate articulation work and take over the autonomy and decision making from humans. The purpose of this speculation was rather to shed light on the importance of articulation work when designing tools to support hybrid cooperation and illustrate the complexity that this might entail. There are certainly some aspects of articulation work that can be inscribed in the design of planning tools, but there needs to be a certain balance preserving space for human discretionary and autonomy to make decisions.

Acknowledgments

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References

- Advertising-video (2023): 'Collab.ai. The new planning tool that enhances hybrid work environments'. <https://youtu.be/3wXpE4BcQvY>, Accessed: 17/02/2023.
- Auger, J. (2013): 'Speculative design: crafting the speculation'. *Digital Creativity*, vol. 24, no. 1, pp. 11–35.
- Augstein, M., T. Neumayr, J. Schönböck, and C. Kovacs (2022): 'Towards Hybrid Collaboration Spaces-A Model of Support Requirements for Hybrid Collaboration'.
- Bergmann, R., S. Rintel, N. Baym, A. Sarkar, D. Borowiec, P. Wong, and A. Sellen (2022): 'Meeting (the) Pandemic: Videoconferencing Fatigue and Evolving Tensions of Sociality in Enterprise Video Meetings During COVID-19'. *Computer Supported Cooperative Work (CSCW)*, pp. 1–37.
- Bleecker, J. (2015): 'Design fiction: A short essay on design, science, fact and fiction. 2009'. *Retrieved June*, vol. 16.
- Builtwith (2023): 'Google Calendar Usage Statistics'. <https://trends.builtwith.com/widgets/Google-Calendar>, Accessed: 08/02/2023.
- Candy, S. (2010): 'The futures of everyday life: Politics and the design of experiential scenarios'. *University of*.
- Candy, S. and J. Dunagan (2017): 'Designing an experiential scenario: The people who vanished'. *Futures*, vol. 86, pp. 136–153.

- Clement, A. and I. Wagner (1995): 'Fragmented exchange: Disarticulation and the need for regionalized communication spaces'. In: *Proceedings of the Fourth European Conference on Computer-Supported Cooperative Work ECSCW'95: 10–14 September, 1995, Stockholm, Sweden*. pp. 33–49.
- Collab.ai (2023): 'The new planning tool that enhances hybrid work environments. A fictional prototype'. <https://bit.ly/3njXU2D>. Accessed: 02/05/2023.
- DiSalvo, C. (2012): 'Adversarial design as inquiry and practice'.
- Divitini, M. and C. Simone (2000): 'Supporting different dimensions of adaptability in workflow modeling'. *Computer Supported Cooperative Work (CSCW)*, vol. 9, no. 3-4, pp. 365–397.
- Dourish, P. (1999): 'Embodied interaction: Exploring the foundations of a new approach to HCI'. *Work*, pp. 1–16.
- Duckert, M., E. Hoggan, L. Barkhuus, P. Bjørn, N. Boulus-Rodje, S. Bødker, N. Holten Møller, and I. Shklovski (2022): 'Work of the Future'. In: *Adjunct Proceedings of the 2022 Nordic Human-Computer Interaction Conference*. pp. 1–4.
- Dunne, A. (2008): 'Design for debate'. *Architectural Design*, vol. 78, no. 6, pp. 90–93.
- Dunne, A. and F. Raby (2001): *Design noir: The secret life of electronic objects*. Springer Science & Business Media.
- Dunne, A. and F. Raby (2013): *Speculative everything: design, fiction, and social dreaming*. MIT press.
- Easton, G. K., J. F. George, J. F. Nunamaker Jr, and M. O. Pendergast (1990): 'Using two different electronic meeting system tools for the same task: An experimental comparison'. *Journal of management information systems*, vol. 7, no. 1, pp. 85–100.
- Gerson, E. M. and S. L. Star (1986): 'Analyzing due process in the workplace'. *ACM Transactions on Information Systems (TOIS)*, vol. 4, no. 3, pp. 257–270.
- Gonzalez Diaz, C., J. Tang, A. Sarkar, and S. Rintel (2022): 'Making Space for Social Time: Supporting Conversational Transitions Before, During, and After Video Meetings'. In: *2022 Symposium on Human-Computer Interaction for Work*. pp. 1–11.
- Gordon, K. (2021): 'Visual Hierarchy in UX: Definition'. Nielsen Norman Group at <https://www.nngroup.com/articles/visual-hierarchy-ux-definition>, Accessed: 01/02/2023.
- Gray, B., L. Ciolfi, and A. de Carvalho (2020): *Made to work: mobilising contemporary worklives*. Routledge.
- Greenhalgh, T., D. Swinglehurst, and R. Stones (2014): 'Rethinking resistance to 'big IT': a sociological study of why and when healthcare staff do not use nationally mandated information and communication technologies'.
- Grinter, R. E. (1996): 'Supporting articulation work using software configuration management systems'. *Computer Supported Cooperative Work (CSCW)*, vol. 5, pp. 447–465.
- Grønbaek, J. E., B. Saatçi, C. F. Griggio, and C. N. Klokmoose (2021): 'MirrorBlender: Supporting Hybrid Meetings with a Malleable Video-Conferencing System'. In: *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. pp. 1–13.

- Grudin, J. and L. Palen (1995): 'Why groupware succeeds: Discretion or mandate?'. In: *Proceedings of the Fourth European Conference on Computer-Supported Cooperative Work ECSCW'95: 10–14 September, 1995, Stockholm, Sweden*. pp. 263–278.
- Hollan, J. and S. Stornetta (1992): 'Beyond Being There'. In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. New York, NY, USA, p. 119–125, Association for Computing Machinery.
- Hradis, M., S. Eivazi, and R. Bednarik (2012): 'Voice activity detection from gaze in video mediated communication'. In: *Proceedings of the Symposium on Eye Tracking Research and Applications*. pp. 329–332.
- Isaacs, E., M. Szymanski, Y. Yamauchi, J. Glasnapp, and K. Iwamoto (2012): 'Integrating local and remote worlds through channel blending'. In: *Proceedings of the ACM 2012 conference on computer supported cooperative work*. pp. 617–626.
- Job-position (2023): 'Collaboration Manager. Enhancing hybrid work environments'. <https://bit.ly/3EwZPGL>. Accessed: 17/02/2023.
- Karis, D., D. Wildman, and A. Mané (2016): 'Improving remote collaboration with video conferencing and video portals'. *Human-Computer Interaction*, vol. 31, no. 1, pp. 1–58.
- Lee, C. P. (2007): 'Boundary negotiating artifacts: Unbinding the routine of boundary objects and embracing chaos in collaborative work'. *Computer Supported Cooperative Work (CSCW)*, vol. 16, pp. 307–339.
- Lundberg, N. and H. Tellioglu (1999): 'Understanding complex coordination processes in health care'. *Scandinavian Journal of Information Systems*, vol. 11, no. 1, pp. 5.
- Matthiesen, S., P. Bjørn, and L. M. Petersen (2014): '" Figure out how to code with the hands of others" recognizing cultural blind spots in global software development'. In: *Proceedings of the 17th ACM conference on Computer supported cooperative work & social computing*. pp. 1107–1119.
- Neumayr, T., M. Augstein, and B. Kubicek (2022): 'Territoriality in Hybrid Collaboration'. *Proceedings of the ACM on Human-Computer Interaction*, vol. 6, no. CSCW2, pp. 1–37.
- Neumayr, T., B. Saatci, S. Rintel, C. N. Klokmose, and M. Augstein (2021): 'What was Hybrid? A Systematic Review of Hybrid Collaboration and Meetings Research'. *arXiv preprint arXiv:2111.06172*.
- Newspaper-article (2023): 'iCal out, Collab.ai in: Apples's latest move to optimize hybrid work with AI technology'. <https://bit.ly/3Nvqusr>. Accessed: 02/05/2023.
- Norman, D. (2013): *The design of everyday things: Revised and expanded edition*. Basic books.
- O'hara, K., J. Kjeldskov, and J. Paay (2011): 'Blended interaction spaces for distributed team collaboration'. *ACM Transactions on Computer-Human Interaction (TOCHI)*, vol. 18, no. 1, pp. 1–28.
- Pye, R. (1978): *The description and classification of meetings*. University College London, Joint Unit for Planning Research.
- Rädle, R., H.-C. Jetter, N. Marquardt, H. Reiterer, and Y. Rogers (2014): 'HuddleLamp: Spatially-Aware Mobile Displays for Ad-Hoc Around-the-Table Collaboration'. In: *Proceedings of the Ninth ACM International Conference on Interactive Tabletops and Surfaces*. New York, NY, USA, p. 45–54, Association for Computing Machinery.

- Rintel, S., S. Cupala, A. Sellen, J. Tang, J. Teevan, and C. Neustaedter (2021): 'Panel: Perspectives on the new future of hybrid meetings'. Microsoft Research Summit. New Future of Work. <https://www.microsoft.com/en-us/research/video/panel-perspectives-on-the-new-future-of-hybrid-meetings>, Accessed: 01/02/2023.
- Saatçi, B., K. Akyüz, S. Rintel, and C. N. Klokmoose (2020): '(re) configuring hybrid meetings: Moving from user-centered design to meeting-centered design'. *Computer Supported Cooperative Work (CSCW)*, vol. 29, no. 6, pp. 769–794.
- Saatçi, B., R. Rädle, S. Rintel, K. O'Hara, and C. Nylandstedt Klokmoose (2019): 'Hybrid meetings in the modern workplace: stories of success and failure'. In: *International Conference on Collaboration and Technology*. pp. 45–61.
- Schmidt, K. and L. Bannon (1992): 'Taking CSCW seriously: Supporting articulation work'. *Computer Supported Cooperative Work (CSCW)*, vol. 1, pp. 7–40.
- Schmidt, K. and C. Simonee (1996): 'Coordination mechanisms: Towards a conceptual foundation of CSCW systems design'. *Computer Supported Cooperative Work (CSCW)*, vol. 5, pp. 155–200.
- Schneider, K. and I. Wagner (1992): 'Constructing the 'Dossier Représentatif' Computer-based information-sharing in French hospitals'. *Computer Supported Cooperative Work (CSCW)*, vol. 1, pp. 229–253.
- Sokolic, D. (2022): 'Remote work and hybrid work organizations'. *Economic and social development: Book of proceedings*, pp. 202–213.
- Star, S. L. (1991): 'The sociology of the invisible: The primacy of work in the writings of Anselm Strauss'. *Social organization and social process: Essays in honor of Anselm Strauss*, pp. 265–283.
- Strauss, A., S. Fagerhaugh, B. Suczek, and C. Wiener (1985): *Social organization of medical work*. University of Chicago Press.
- Suchman, L. A. (1996): 'Supporting articulation work.'
- Swain, V. D., K. Saha, G. D. Abowd, and M. De Choudhury (2020): 'Social media and ubiquitous technologies for remote worker wellbeing and productivity in a post-pandemic world'. In: *2020 IEEE Second International Conference on Cognitive Machine Intelligence (CogMI)*. pp. 121–130.
- Tan, A. and A. M. Kondoz (2008): 'Barriers to virtual collaboration'. In: *CHI'08 Extended Abstracts on Human Factors in Computing Systems*. pp. 2045–2052.
- Tang, J., K. Inkpen, P. Luff, G. Fitzpatrick, N. Yamashita, and J. Kim (2022): 'Living Through a Crisis: How COVID-19 Has Transformed the Way We Work, Live, and Research'. *Computer Supported Cooperative Work (CSCW)*, pp. 1–3.
- Teevan, J., N. Baym, J. Butler, B. Hecht, S. Jaffe, K. Nowak, A. Sellen, L. Yang, M. Ash, K. Awori, M. Bruch, P. Choudhury, A. Coleman, S. Counts, S. Cupala, M. Czerwinski, E. Doran, E. Fetterolf, M. Gonzalez Franco, K. Gupta, A. L. Halfaker, C. Hadley, B. Houck, K. Inkpen, S. Iqbal, E. Knudsen, S. Levine, S. Lindley, J. Neville, J. O'Neill, R. Pollak, V. Poznanski, S. Rintel, N. P. Shah, S. Suri, A. D. Troy, and M. Wan (2022): *Microsoft New Future of Work Report 2022*, No. MSR-TR-2022-3.
- Teevan, J., B. Hecht, and S. Jaffe (2020): 'The new future of work'. *Microsoft Internal Rep.*

- Tharp, B. M. and S. M. Tharp (2019): *Discursive design: critical, speculative, and alternative things*. MIT Press.
- Tonkinwise, C. (2014): 'How we intend to future: review of Anthony Dunne and Fiona Raby, speculative everything: design, fiction, and social dreaming'. *Design Philosophy Papers*, vol. 12, no. 2, pp. 169–187.
- Turner, K. (2022): 'New LinkedIn Features. Create new job alert'. In: 100+ NEW LinkedIn Features for 2022 https://www.linkedin.com/posts/president_newlinkedinfeature-keeprockinglinkedin-newfeature-activity-6987072967922884608-aWkq/, Accessed: 01/02/2023.
- van Vree, W. (2019): 'Formalisation and Informalisation of Meeting Manners'. *Civilisation and Informalisation: Connecting Long-Term Social and Psychic Processes*, pp. 291–313.
- Xu, B., J. Ellis, and T. Erickson (2017): 'Attention from afar: simulating the gazes of remote participants in hybrid meetings'. In: *Proceedings of the 2017 Conference on Designing Interactive Systems*. pp. 101–113.
- Yamashita, N., K. Kaji, H. Kuzuoka, and K. Hirata (2011): 'Improving Visibility of Remote Gestures in Distributed Tabletop Collaboration'. In: *Proceedings of the ACM 2011 Conference on Computer Supported Cooperative Work*. New York, NY, USA, p. 95–104, Association for Computing Machinery.
- Yankelovich, N., N. Simpson, J. Kaplan, and J. Provino (2007): 'Porta-person: Telepresence for the connected conference room'. In: *CHI'07 extended abstracts on Human factors in computing systems*. pp. 2789–2794.
- Yankelovich, N., W. Walker, P. Roberts, M. Wessler, J. Kaplan, and J. Provino (2004): 'Meeting central: making distributed meetings more effective'. In: *Proceedings of the 2004 ACM conference on Computer supported cooperative work*. pp. 419–428.

Clément Cormi; Khuloud Abou-Amscha; Matthieu Tixier; Myriam Lewkowicz (2023): ECSCW 2023 Exploratory Papers Instructions. In: Proceedings of the 21st European Conference on Computer-Supported Cooperative Work: The International Venue on Practice-centered Computing on the Design of Cooperation Technologies - Exploratory Papers, Reports of the European Society for Socially Embedded Technologies (ISSN 2510-2591), DOI: 10.48340/ecscw2023_ep03

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Modeling for Analysis and Design in Regulated Artifacts Ecologies (MADRAE): a Case for Cooperative Practices in Telemedicine

Clément Cormi^{1,2}, Khuloud Abou-Amscha¹, Matthieu Tixier¹, Myriam Lewkowicz¹

¹Troyes University of Technology, ICD, Tech-CICO, Troyes, France

²Pôle Territorial Santé Publique et Performance des Hôpitaux Champagne Sud, Centre Hospitalier de Troyes, Troyes, France

clement.cormi1@utt.fr; khuloud.abou_amscha@utt.fr; matthieu.tixier@utt.fr; myriam.lewkowicz@utt.fr

Abstract. The results of CSCW studies should be more effectively incorporated into software engineering practices. This paper focuses on two concepts supporting software component choice and development in IS architecture: artifact ecologies and data work. Using a case study in telemedicine, we propose MADRAE, an extension of the UML component diagram, for modeling practice-based artifact ecologies that emphasize the necessary data work. In the hospital where we tried MADRAE, it was considered helpful by the head of the IS department to analyze existing artifact ecologies and generate design and architecture proposals.

Introduction

Despite the better understanding of cooperative work offered by CSCW findings, designing applications that support cooperative work embedded into the work practice and usable by the different actors remains a significant challenge (Lewkowicz & Liron, 2019; Ludwig et al., 2018). We hypothesize that a significant contributing factor to this issue is the difficulty in incorporating these complex and intricate insights into the daily processes and toolkits of software engineers and Information System (IS) managers.

Many essential findings and design recommendations in CSCW still need to be translated into operational solutions (Christensen, Lars Rune et al., 2020; Hartswood et al., 2003). Indeed, cooperation is a dynamic process that requires ongoing support, and the systems that support collaboration must evolve and adapt over time (Bødker et al., 2016; Pipek et al., 2009). In addition, introducing a new application that supports cooperation becomes more arduous as the space of any intervention is already full of systems that might be difficult to replace or ignore (Korsgaard et al., 2022; Monteiro et al., 2013; Pollock & Williams, 2010). Thus, many CSCW researchers have shifted their focus to ‘large scale’ with concepts like artifact ecologies to describe the phenomena and identify challenges (Bødker & Klokmoose, 2012; Lyle et al., 2020).

Considering the artifact ecologies suggests studying the relationships between technology artifacts (such as computers, software, and other digital media) and the social, organizational, and cultural contexts in which they are used. This approach emphasizes these relationships' dynamic, interconnected, and evolving nature and seeks to understand how technology and society co-evolve over time. Focusing on the artifact ecologies provides insights into how new technologies are adopted, used, and transformed in various settings and how they shape and are shaped by the people, organizations, and communities that use them.

Such an approach poses a fundamental challenge for the design of technology that supports cooperation. Thus, new systems that support cooperation often must integrate with various existing systems, devices, and platforms. This can create challenges with interoperability and increase the number of tasks humans need to perform, such as collecting, analyzing, and interpreting data from multiple artifacts. Bonde et al. (2019) refer to these activities related to data management as *data work*. Data work can require collaboration and coordination among individuals with different backgrounds and expertise and are essential for decision-making, problem-solving, and sense-making in various domains (Grisot et al., 2019; Islind et al., 2019). However, data work is sometimes perceived as a burden due to its magnitude, redundancy, and invisibility (Bjørnstad & Ellingsen, 2019; Cabitza, Ellingsen, et al., 2019; Vallo Hult et al., 2019).

In order to effectively support cooperative practices in complex domains like healthcare, it is essential to make the ecologies of artifacts and data work visible to software engineers and IS managers. One way to achieve this is through

modeling, which plays a critical role in software design and development. Enriching modeling with insights about artifact ecology and data from CSCW research can help software engineers and IS managers better consider the complexity of cooperative practices. Modeling is often used in software development to analyze how a system is used (Kramer, 2007). Models provide a shared understanding of the system and can be used to identify design flaws and catch errors early on, improving the efficiency and quality of the software (Kautz et al., 2018). Furthermore, modeling can improve communication and collaboration between stakeholders with different technical backgrounds.

We propose MADRAE (Modeling for Analysis and Design in Regulated Artifacts Ecologies) as an extension of the UML component diagram based on a telemedicine case study. MADRAE allows for modeling practice-based artifact ecology, emphasizing the data work needed in the system. Although there is no specific UML diagram for representing artifact ecologies, the component diagram is a good candidate for the job. This diagram shows the structure of a set of systems or subsystems and can represent the components and artifacts that make up an artifact ecology. However, the diagram notation still needs to be extended to fully capture the social and cultural aspects of the artifact ecology. MADARE extends the diagram to represent the complex and dynamic relationships between artifacts, tools, people, and social and cultural norms in collaborative work environments.

Based on a case study in telemedicine, we present the use of MADRAE to enable the modeling of practice-based artifact ecology that emphasizes the data work required in the system. We present the results of a formative evaluation with the head of a general hospital IS department and discuss the benefits and limits of our approach and future work for MADRAE.

Related work

In this section, we first analyze the existing literature on artifact ecologies and data work to highlight the importance of considering these aspects when designing technologies. Then, we focus on modeling languages and their role in reflecting the complexity of work practices.

Artifact ecologies

Whether to work, communicate, or play, everyone creates and evolves within their digital environment, their *artifact ecology*, i.e., “the set of physical artifacts that a person possesses, and that allows a certain level of interactivity through digital technologies” (Jung et al., 2008).

Three decades ago, Krippendorff (1989) already argued that it was impossible to distinguish between software, hardware, and devices when it came to

computing. In line with this work, Bødker and Klokmoose propose integrating these three components in their definition of artifact ecology (Bødker et al., 2016; Bødker & Klokmoose, 2012).

The concept of artifacts ecology allows for the study of the practices of individuals in isolation (Dittmar & Dardar, 2014; Jarrahi et al., 2017; Jung et al., 2008; Sørensen & Kjeldskov, 2014), and how individuals collaborate through these technological artifacts (Bardram & Bossen, 2005b; Bødker et al., 2016; Larsen-Ledet et al., 2020). Larsen-Ledet and colleagues (2020) show, for example, that during a collaborative writing task, the individual artifact ecology of the co-authors partially overlaps to form an aligned one. The authors describe how the actors gather and construct their individual artifact ecologies to support their practices, some of them being collaborative. We can relate the work of Bardram et Bossen (2005a) on coordination in hospitals with those of (Larsen-Ledet et al., 2020) when certain artifacts of the aligned ecology (whiteboards, schedules, post-it notes, etc.) play a particular role in the coordination of activities between actors.

Aligned artifact ecologies are dynamic and evolving as activities change and new needs arise (Bødker et al., 2016). For example, within an organization that is not very constrained, such as a volunteer association, the initially aligned ecology is primarily shaped by the individual ecologies of its actors. However, as the organization grows and structures itself, the ecology evolves to meet new needs. For example, when a communication department is created within an association, the FACEBOOK page created by the founding members and serving as the only intermediary for internal and external communication is replaced by a newsletter sent by MAILCHIMP for internal communication and supplemented by TWITTER and INSTAGRAM accounts for external communication (Bødker et al., 2016).

Many synonyms for ‘artifact ecology’ are used in the literature, from digital assemblages to artifact constellations. Still, we agree with Lyle et al. (2020) to use the term artifact ecology to describe the set of artifacts (software, hardware, and devices) that a person (or a group of persons) uses and that allows a certain level of interactivity through digital technologies, while supporting their cooperation.

Data work

The notion of *data work* refers to the activities and tasks performed by a human actor that are related to collecting, managing, analyzing, and interpreting data (Bonde et al., 2019). Many researchers in CSCW highlight the role of data work to support decision-making, problem-solving, and sense-making in various domains such as organizations, communities, and networks. These studies show that data work involves individual and collective efforts and often requires collaboration, coordination, and communication among people with different backgrounds, expertise, and perspectives.

For example, Islind et al. (2019) describe the manual work of translating and compiling data from different sources in oncology follow-up and remote patient monitoring. Similarly, Grisot et al. (2019) highlight how nurses in a Swedish hospital who follow remote monitoring device users identify relevant and clinically valuable data and collaborate with patients to collect it. Thus, using data collected by a third party or reusing data requires organizing “data interoperability” that often requires “data work” (Vassilakopoulou & Aanestad, 2019).

While data work is essential for being able to make use of data (Callon & Law, 2005; Islind et al., 2019; Moser & Law, 2006; K. H. Pine, 2019; Vassilakopoulou & Aanestad, 2019), it is sometimes perceived as a burden because of its magnitude. According to several studies data work can represent up to 50% of a physician’s work time (Arndt et al., 2017; Sinsky et al., 2016).

A literature review by Cabitza et al. (Cabitza, Ellingsen, et al., 2019) characterized the different forms of redundancy, namely a particular type of data work, distinguishing replicated, duplicated, complementary, and supplementary data. Their work shows that duplicating data (i.e., putting the same data into different artifacts) has adverse effects, increasing the risk of misinterpretation and data desynchronization. When coming to health, the burden of redundancies is on the one hand, heightened when it serves non-clinical purposes such as organizational or monitoring needs. On the other hand, redundancies can support collaboration between healthcare professionals by enhancing the transmission of relevant information (Cabitza, Locoro, et al., 2019; Langstrup, 2019; Morrison et al., 2013).

Finally, data work is often associated with the notion of *invisible work* (Star & Strauss, 1999). For example, Bonde et al. (2019) show that data collected for clinical purposes need considerable but invisible and qualified data work before ready to serve research purposes (e.g., collection, standardization). For Bjørnstad et Ellingsen (2019), the visibility of a task depends on who performs it. For example, when a task is performed by a physician - who is listened to and has a high social status, it becomes recognized as “important”. They additionally argue that, by considering data work, organizations can use technology more effectively and efficiently, leading to better decision-making and sense-making.

Through our research, we seek to make the ecologies of artifacts and data work visible for designers and prescribers of systems supporting cooperative practices. We have explored this topic by looking at the potential of modeling approaches of information and socio-technical systems, which we develop in the following section.

Socio-technical Modeling and Software Engineering

Modeling can play a crucial role in supporting the design of digital tools (Kramer, 2007). Using appropriate modeling approaches may enable considering

the complex and interrelated social, technical, and organizational aspects of work (Kautz et al., 2018). CSCW research has studied and offered various modeling approaches that consider the socio-technical character of digital work and help designers understand users' practices and create digital tools that support these practices.

In their work, Simone, Divitini and Schmidt proposed ARIADNE, a notation that represents coordination mechanisms (Divitini et al., 1996). It provides a graphical language that allows designers to formally specify the coordination protocols and artifacts that form coordination mechanisms. ARIADNE allows designers to model the structure, behavior, and interconnections of components in a system and to define how they coordinate with each other to achieve their goals. The notation allows the designing of computational coordination mechanisms that are malleable and linkable, which, as we have seen above, are two important requirements for artifact ecologies.

Herrmann et al. (1999) proposed SEEME, a formal language used to model the behavior and interactions of software systems that make it possible to deal with the vagueness and imprecision inherent in socio-technical systems, as some knowledge and work organization cannot be definitively posited. SEEME provides a systematic way of identifying users' goals, motivations, expectations, constraints and dependencies between actors and systems. Using these models, designers can create digital tools tailored to the users' specific needs that effectively support their work practices.

However, both ARIADNE and SEEME has not been widely adopted in universities' syllabus or the industry and seems less known or used than other "classical" software modeling languages or notations as UML.

UML (Unified Modeling Language) is a widely used graphical language in the software development industry for visualizing, specifying, constructing, and documenting software systems. It was defined in the 1990s to unify the three existing languages for object-oriented modeling previously developed by Grady Booch, Ivar Jacobson, and James Rumbaugh, respectively. Despite its wide diffusion, UML remains controversial (Grossman et al., 2005) and is sometimes presented as unnecessarily complicated and paradoxically imprecise (Kobryn, 2002). Also, it focuses mainly on the technical aspects of the systems, hardly translating the socio-technical phenomena (Herrmann et al., 2004). UML makes it hard to reach the situated and nuanced aspects of software systems, such as collaboration and coordination among users (Suchman, 1987).

Over the years, UML has become a widely accepted language for software modeling, and many organizations and individuals rely on it to design and document their software systems. UML provides a powerful and flexible means of communicating software design information and is an essential language in software engineering curricula.

Translating key insights from fieldwork into operational systems is challenging and earlier work give essential direction towards this endeavor (Heath & Luff, 1991; Kaplan & Seebeck, 2001; Randall et al., 2005). However, our approach is less concerned on helping software engineers to embrace CSCW perspectives or to train them for fieldwork (Hartwood et al., 2003). We think worth to explore the pathway of accommodating the current tools and practices used in software engineering as an area for work. The issue then become to documents for discussion and negotiation with software engineer and IS manager, as CSCW researchers embedded in sociotechnical project.

We propose MADRAE, an extension of the UML component diagram, that allows describing insights about ecologies of artifacts and data work and, therefore, incorporates them into the design of the software. We illustrate this approach with a study conducted in the context of a telemedicine project.

MADRAE Motivation and Methodology

Before introducing our approach in developing MADRAE as well its principles and notation, we first presents the motivation for this UML extension that comes from a research in which we were involved that aimed at integrating teleconsultation tools in healthcare professionals' practices at a general hospital.

Motivation: An Inquiry about Teleconsultation Practices

The onset of our approach has been the study of teleconsultation practices at a general hospital (GH) in the Great East Region, France. In 2018, teleconsultation was inscribed in the law as a medical act reimbursed by national health insurance (Cormi et al., 2020). The hospital wanted to improve its telemedicine activities and technological support and welcomed us to get a better understanding of teleconsultation practices. The first author has been engaged in a three-year-long field study inquiring about the different teleconsultation practices at GH, observing and interviewing health professionals about their use and their work to integrate the available teleconsultation software into their work practices - in line with (Rossitto et al., 2014).

The analysis of this fieldwork (Cormi et al., 2022) accounts for various practices at the GH regarding teleconsultation. We highlight that making a full teleconsultation, in other words, a teleconsultation that matches the legal definition and can therefore be reimbursed, requires using more than one software application. Health professionals work on aligning (that is, learning, choosing, configuring, and adapting) an artifact ecology to achieve routine teleconsultation with the Hospital Information System (HIS) (Bødker & Klokmoose, 2012; Lyle et al., 2020). The diversity of the reported teleconsultation practices is mainly

supported by two teleconsultation software systems with their respective artifact ecology: TELECONSSYS and TELECONSAPP.

TELECONSSYS is the central support of an ecology that supports inter-organizational cooperation among health professionals for achieving teleconsultation with residents at nursing homes. It is an application hosted by an external vendor with different components that allows for requesting teleconsultation appointments and handles asynchronous and synchronous communication up to post-consultation reporting.

TELECONSAPP is the central element in the artifact ecology doctors use during face-to-face consultations in the hospital's outpatient department. For instance, it supposes using the HIS to access and modify electronic health records. TELECONSAPP is hosted by the regional health authority and mainly provides an audio and video channel over the Internet for achieving teleconsultation with patients already recorded in the HIS.

We found that data work is essential for conducting teleconsultations, whatever system is used. Indeed, many software components are far from interoperable (Iroju et al., 2013). We have identified that if part of this data work is overwhelming for the professionals (in particular, copy-pasting data or duplicating documents from one software to another), an essential part of this data work involves 'artful coordinating' (Pine & Mazmanian, 2017) that cannot qualify for automation (for instance, managing the notifications and reminders of patients' appointments for teleconsultations).

We report more specifically about TELECONSSYS and TELECONSAPP while presenting MADRAE. As highlighted by Bødker et al.(2016), ecologies of artifacts are evolving due to users' practices and organizational constraints, as policies, that lead to a need for knowledge. Therefore, we propose MADRAE as support for the analysis, design, and reflective choice of components of the artifact ecology.

Methodology: Modeling principles and notation

In order to incorporate insights about artifact ecology and data work into the daily processes and toolkits of software engineers and IS managers, we use to work on UML modeling language for its wide use. While there is no specific UML diagram that is designed to represent artifact ecologies and data work, we argue that structural diagrams better fit the job of representing a large artifact ecology.

Behavioral diagrams like activity and sequence diagrams help represent activities and interactions between objects in a software system. However, they do not provide a comprehensive overview of the entire system architecture, which is necessary for understanding the complex relationships between different components and their interactions with the environment. These diagrams focus on

specific aspects of the system and can become overly complex and difficult to read if we want to represent large-scale artifact ecologies.

We choose to work on the UML Component Diagram, which is used to model the internal structure of a system or subsystem and thus can represent the components and artifacts that make up an artifact ecology. The diagram shows the relationship between the components and their interactions with each other and external entities. With MADRAE, we extend the UML Component Diagram to represent artifact ecologies and data work, as the standard diagram may not fully capture all the social and cultural aspects of the artifact ecology. In this section, we will introduce the UML component diagram notation and our proposed extensions. These extensions are designed to help model aligned artifact ecologies within an organization and emphasize the importance of data work.

In order to check the applicability of MADRAE for IS analysis and architecture we developed several models grounded in our study of teleconsultation practices. We have then conducted a formative evaluation with the management of IS department of CHT concerned with our research. These elements are developed in the last parts of the present paper.

The Component Diagram of UML

The component diagram of UML offers a static representation of a software system as related components. While behavioral diagrams (for instance, the activity diagram or the sequence diagram) account for the behavior of software system along a temporal dimension, the interaction between component diagrams provides an overall snapshot of a complex software system architecture. A component diagram uses two key primitives:

- Component derives from the concept of Class. A component is a software module with defined requirements. A component can be substituted by another if it offers the same feature and interface. Components are connected and have interdependent relationships that respect a defined interface.
- Interface defines a contract about the availability for other components of a set of operations with their signature (i.e., parameters and return values). Each component is dependent on a set of required and provided Interfaces for its proper functioning. An interface defines an identifier that can be reused across different components as a generic element.

The inner working of a component can be detailed through diagrams too. Component diagrams are handy for showing the dependencies between components in a software system and which component provides and requires which operation from another component.

For instance, Figure 1 shows a simplified and idealized version of the schedule component of Teleconsultation software (TCSchedule) that shares data with the

general hospital planning system (HISPlanning). The detail of the IAppointment interface highlights that TCSchedule publicly exposes the exportSchedule() operation that allows HISPlanning to retrieve sets of recorded teleconsultation appointment data to stay up to date. Here we can say HISPlanning has a dependency relationship with TCSchedule. A lollipop connector notation emphasizes which component provides or consumes the operation.

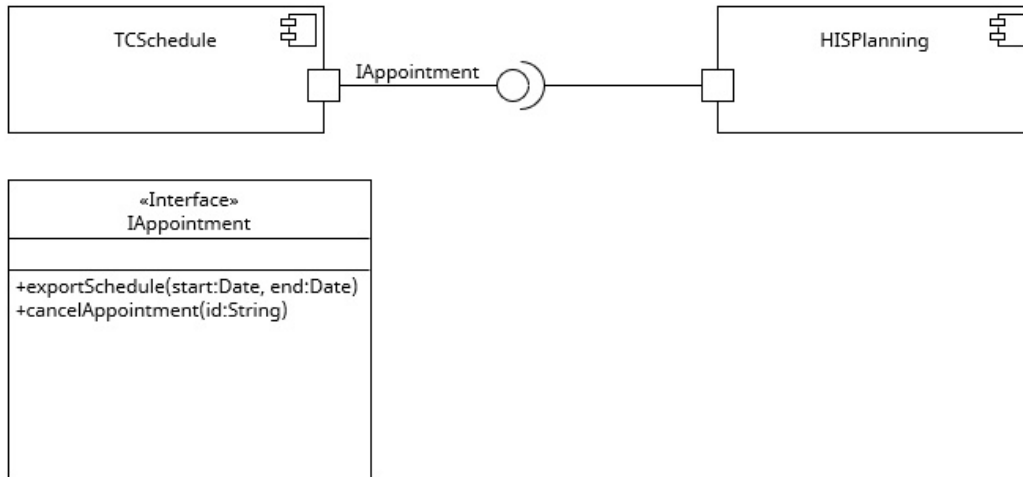


Figure 1. Top: a component diagram representing interoperability of two components with respect to the IAppointment interface / Bottom: a detailed view of the IAppointment interface definition.

As illustrated in our example, the component diagram is a key tool for exposing interoperability issues (Iroju et al., 2013). When provided and required interfaces match, as in Figure 1, the components are interoperable within the scope of the interfaces they are using.

Extensions with MADRAE

With MADRAE (Modeling for Analysis and Design in Regulated Artifacts Ecologies), we propose to reuse the UML component diagram as a basis for modeling an aligned artifact ecology that translates the knowledge gained from the fieldwork about one, or a range of, software-supported practices. The practice at stake can span across multiple organizations, as in the case of a teleconsultation where part of the software components belongs to the hospital and another to a nursing home information system, for instance.

Modeling an aligned artifact ecology and organizations

MADRAE uses the UML component diagram primitives:

- Each software that is in use in the artifact ecology is presented as a component.

- The required and provided interfaces allow accounting for automated information exchange. This also allows keeping the links with other forms of UML diagrams like the class one.
- As aligned ecologies of artifacts are not limited to the boundaries of one organization, we propose to use the UML Package notation to indicate the location of a component (see Figure 2).

Representing data work

We have frequently observed during our fieldwork that human intervention is essential to make the different artifacts of an ecology work together. We propose to highlight this data work by extending the interface notation to show actors' contributions to the information exchange between components. This way, when information exchanges between components require a human intervention, we represent this aspect as a dependency between the component and a UML Role. Another case is when an actor needs information (or triggering action) from a component; we represent this as a dependency relation between the role and the component. For instance, Figure 2 shows a situation we have observed where a medical secretary has to manually copy the appointments recorded in TCSchedule in the hospital information system (HIS) planning component HISPlanning. Classical required and provided interfaces relationships are represented to represent interoperable dependencies (i.e., IHealthRecord).

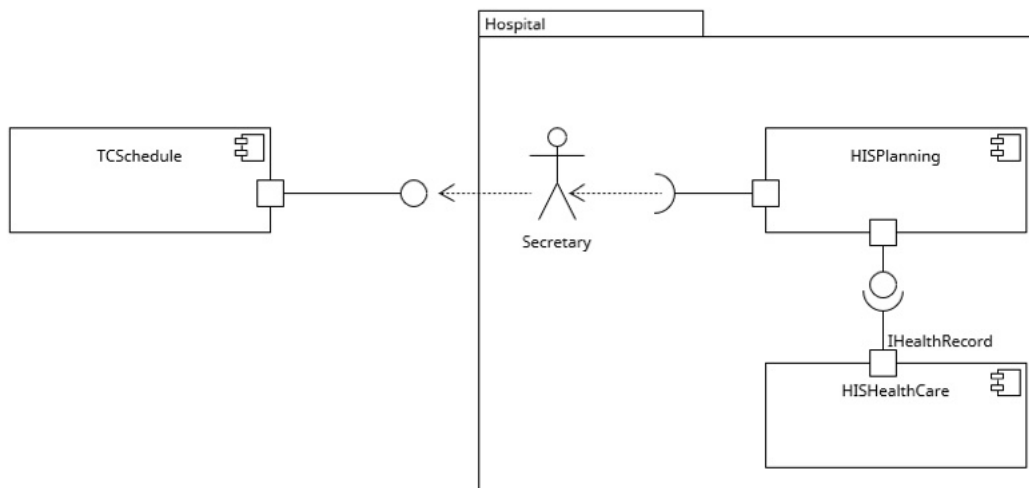


Figure 2. A basic MADRAE extended component diagram highlighting the dependency of HISPlanning software to Secretary actor to get updated information about teleconsultation appointments from TCSchedule. Note this data work can coexist with the representation of interoperable components as with HISHealthCare.

Acknowledging how a software component depends on human knowledge contrasts with the current usage and representation of UML, which scarcely deals with human actors. Therefore, emphasizing the share of human work in the sociotechnical system by making it visible is a core aspect of MADRAE.

In order to ease the reading of diagrams, the interfaces' names that define the list of available operations can remain hidden to manage the model's level of detail. However, interfaces' names still exist and have the same status as in the original component diagram (and can be detailed as in Figure 1). The introduction of the UML role in the required and provided interface relations refers to an operation triggered with the help of a graphical user interface or a form (that would be out of reach of an external software component).

Combination with other design documents

MADRAE connects with other software specifications or documents the same way UML allows for the cohabitation of multiple views in a model. In particular, the model's elements identifiers, such as interfaces or components' names, can serve as references for adding fieldwork memos, scenarios, workflow diagrams, or interface mockups that describe or define the interaction between the actors and the component. Figure 3 provides the idea of such usage.

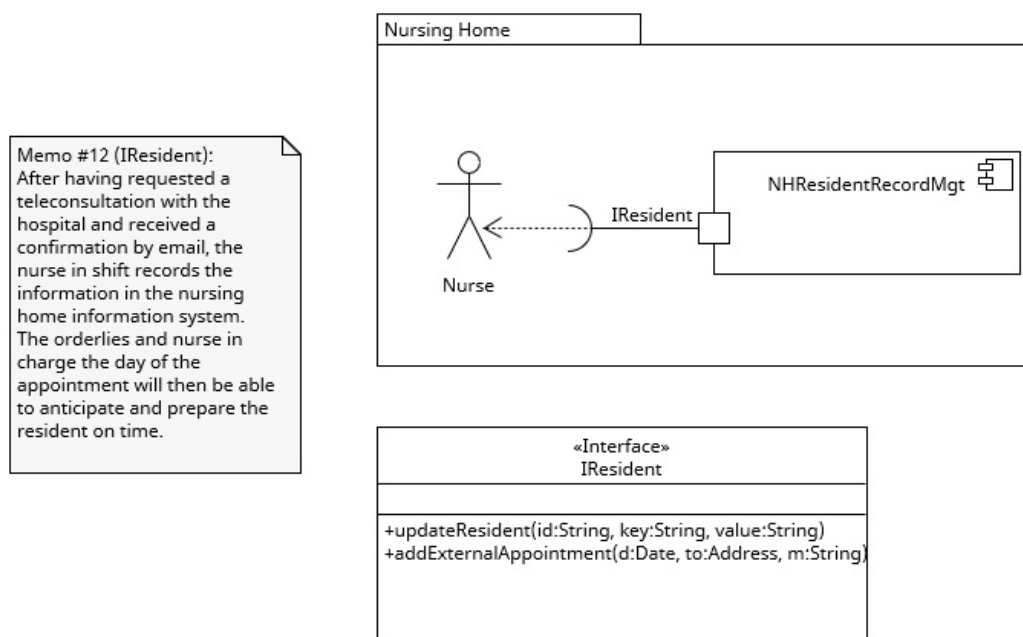


Figure 3. MADRAE extended component diagram can be used in combination with other design or fieldwork documents, here a memo.

The MADRAE component diagram extensions can be drawn using most of the current UML diagramming solutions. For instance, we have used UMLETINO (Auer et al., 2003) and LUCIDCHART to make our models.

Analysis and System Proposal with MADRAE

We demonstrate the use of MADRAE through two possible uses of the notation. The first case presents the use of the notation for analyzing an existing system (TELECONSSYS), highlighting part of the complexity of fieldwork, and spotting sociotechnical issues related to the practices of conducting inter-organizational teleconsultations. The second case shows how MADRAE can be used to generate and discuss a proposal for a new alignment of the artifact ecology (TELECONSOPT) that would improve the organization and respect the different practices.

Case 1: Analyzing an Existing Aligned Artifact Ecology

We have used MADRAE to get an overview of the artifact ecology around TELECONSSYS which supports teleconsultation between the hospital and 26 nursing homes of the region. TELECONSSYS has been designed as a standalone teleconsultation system with its own scheduling, health record, document sharing, and audio-video components, independent of the organization's information systems. The following diagram (figure 4) shows how we can represent with MADRAE the aligned artifact ecology between the hospital and one nursing home that we have observed.

A teleconsultation with TELECONSSYS starts with a nurse from a nursing home filling out a form to request an appointment among the available medical specialties at GH. The nurse indicates contextual (next availability, contact, and particular precaution) and medical information about the resident. At the hospital, a secretary checks for a nearby availability in the physician's schedule and then confirms a request for teleconsultation. The confirmation triggers the creation of a health record for the teleconsultation and the booking of an audio-video channel timeslot. A notification is also sent by email to the nursing home email box to confirm the appointment, with the useful links.

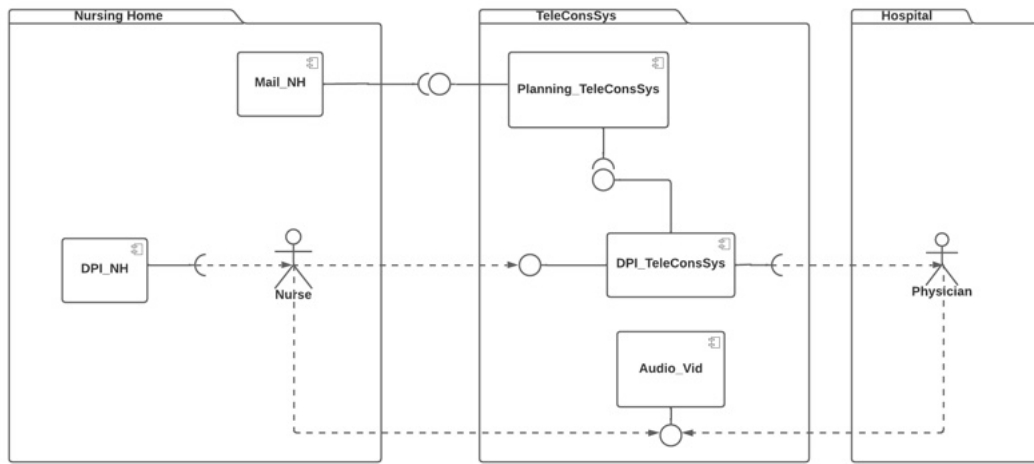


Figure 4. The ecology of artifacts and data work supporting a teleconsultation with TeleconsSys.

A teleconsultation with TELECONSSYS requires an important amount of data work; after the teleconsultation, the nursing home nurse has to copy the report and prescriptions the physician has recorded on TELECONSSYS (DPI_ TELECONSSYS) in the nursing home information system. Again, automation and interoperability are complex here, as nursing homes generally use several software systems from different vendors.

From our inquiry, we also realized that only some teleconsultations made with TELECONSSYS were reimbursed to the hospital by the national health insurance. The issue is noticeable in our diagram as no interface or data work link with a component of the HIS. Indeed, the physicians' prescriptions recorded on DPI_ TELECONSSYS are never copied into the HIS for further processing. From our interviews, we learnt that the physicians are not concerned or not aware of this requirement for the hospital to be reimbursed.

Our analysis also led us to consider an important issue that is not yet reflected in our model about the sustainability of TELECONSSYS in relation with national healthcare policies. Despite the system's capacity to support inter-organizational practices, the evolution of policy requirements in terms of security and privacy of health records put the system at risk of being unauthorized in the next few months. We will discuss the ability of MADRAE to highlight policy issues in the discussion section.

Case 2: Generating Design Proposals for Enriching an Aligned Artifact Ecology

The other teleconsultation system in use at the hospital, TELECONSAPP, offers an audio-video channel with a feature for document sharing while teleconsulting. Apart from the previous elements, the users of TELECONSAPP (e.g., healthcare professionals) depends entirely on the HIS components for scheduling an appointment, updating patient health records and prescription, and following up on consultation for reimbursement by health insurance. Therefore, the system is

especially efficient for replacing face-to-face external consultations at the hospital with teleconsultation. However, an external organization like a nursing home has no access to the hospital's HIS, making TELECONSAPP unable to support inter-organizational cooperation (Cormi et al., 2022).

Our analysis of both the TELECONSSYS and TELECONSAPP systems leads us to think of a teleconsultation system that could support inter-organizational cooperation and hospital's outpatient teleconsultation practices. MADRAE allows to present this proposal and then discuss it with the person in charge of the HIS at the hospital. This ideal system, which we name TELECONSOPT (figure 5), could support both current practices and limit time-consuming and unqualified data work.

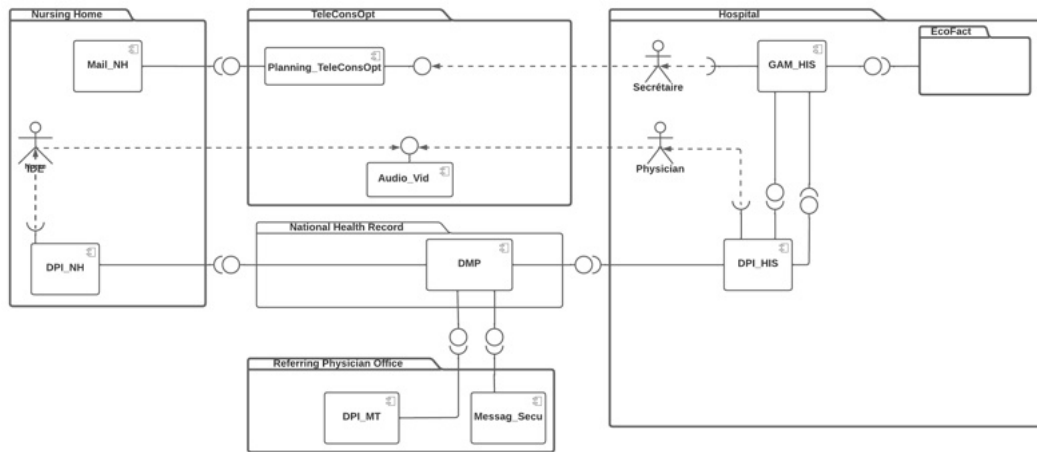


Figure 5. The envisioned ecology of artifacts and data work supporting a teleconsultation with an ideal system: TeleConsOpt. Apart from the nursing IS components intervening in a teleconsultation, the model figures the DMP component from the national healthcare record, the healthcare record (DPI_MT) and secure messaging software (Messag_Secu) of the patient referring physician. On the side of the hospital, GAM_HIS is a HIS component recording the patient administrative data in relation with payment and reimbursement (EcoFact). DPI_HIS is concerned with the patient electronic healthcare record (EHR).

As TELECONSSYS, TELECONSOPT would allow external health organizations to request teleconsultations under the human screening of the hospital secretary, who could arrange the best timeslot. As TELECONSAPP, TELECONSOPT reuse key software components from the HIS as a part of its artifact ecology. This strategy ensure health records are managed with software components that can interact with each other and are easily accessible within the hospital. The follow-up of teleconsultations to ensure reimbursement would then be straightforward and systematic.

After the teleconsultation, the patient's referring doctor would be notified that the report of the teleconsultation has been added to the national computerized healthcare record (this essential feature is lacking in the two current systems), which would ease the synchronization of health information while limiting the double entry of health records. We discuss that in the following section, as this improvement has been pointed out during the evaluation of MADRAE.

Formative Expert Evaluation

We have conducted a formative evaluation (Scriven, 1967) to get feedback from the perspective of the management of the hospital's information system about the potential use of MADRAE for analysis and envisioning a future teleconsultation system. The expert evaluation consisted of a 45-minute interview with the Head of the Hospital Information System (HHIS) in June 2022. The HHIS has followed the design, choice, and deployment of all teleconsultation software at the hospital before and while conducting our research work.

We presented the MADRAE model of the existing and already deployed TELECONSSYS and TELECONSOPT (as a potential future system). We aimed to collect appreciation and feedback from the HHIS on three dimensions: (1) the understanding of the MADRAE approach and notation, (2) the evaluation of the model of TELECONSSYS and TELECONSOPT, given their knowledge, (3) limits and suggestions for improvements.

The reception of the MADARE approach and notation (1) has been positive overall. Figure 4 of the TELECONSSYS model was presented first. The inspiration from UML has been immediately recognized and acknowledged:

"I used it a long time ago"; "UML everybody knows what it is". (Interview_HHIS)

The overall approach with the connection between UML components, the artifact ecology, and the highlighting of data work has been well understood. The HHIS pointed out that in figure 4, the model could have accounted for extra data work when after the appointment confirmation email, the nurse is supposed to connect to TELECONSSYS to fill out detailed information about the patient that the specialist doctor needs to know before the teleconsultation.

"The part when the nurse is filling out DPI_ TELECONSSYS before the teleconsultation is missing; this is especially that part that is a loss of time, and which motivates a solution with better integration." (Interview_HHIS)

As mentioned by the HHIS, the amount of information collected from nursing homes before teleconsultation is a significant drawback of TELECONSSYS as it burdens nurses. Therefore, we considered this aspect in the improved version of TELECONSOPT (fig. 5).

He also spotted and made fun of the absence of a connection between TELECONSSYS and a critical part of the HIS that enables the tracking of medical acts and, therefore, the reimbursement by health insurance.

“I would have at least represented DPI_HIS with two required connectors and nobody at the end! [laugh] Just to better show that this link is clearly missing here and that a good teleconsultation software should be an extension of DPI_HIS, not the contrary.” (Interview_HHIS)

About TELECONSOPT, the HHIS quickly spotted an issue with health record sharing across health organizations:

“I would not have done it that way... because the national healthcare record [DMP] and secured message system are the pivot point for communication if you want to comply with national policies and standards. It would help if you stored nothing inside the teleconsultation software itself. [...] You do your teleconsultation in your tool, but at the end, the report is in the DPI_HIS, which will upload data in the DMP. The nursing home information system then goes to the DMP to get the report.” (Interview_HHIS)

Overall, our expert has found MADRAE attractive. As highlighted above, the HHIS understand the approach (1) and the presented models support relevant and detailed discussion about technology and organization for teleconsultation at GH (2).

However, our expert also explained that the IT teams he manages in the service adopt a different approach “in between design and change management” and they “combine the study of users’ process with the definition of the tools to deploy”. He mentioned, “visualizing the users’ process is mandatory aside from tools and architecture” from his point of view.

The results of this formative evaluation show that MADRAE seems effective in referencing existing systems and discussing future ones. Furthermore, the overview of the artifact ecology and the associated data work helped strengthen our proposal for TELECONSOPT. Nonetheless, the approach appears incomplete to our expert for dealing with whole IT projects as we develop in the following section.

Discussion

Our approach starts from the challenges of transferring rich and nuanced results from our field study of teleconsultation practices to software engineers and information system managers. Earlier work gives essential direction towards this endeavor (Heath & Luff, 1991; Kaplan & Seebeck, 2001; Randall et al., 2005). We suggest developing another path in accommodating the current tools and practices used in software engineering and IS management as an area for work.

Based on our case study in telemedicine, we highlight the importance of better accounting for the ecologies of artifacts Lyle et al. (2020) and data work (Bonde et al., 2019). We proposed MADRAE as an extension of the UML component diagram that supports the analysis of an existing artifact ecology at the scale of a collaborative practice and that has the potential for generating design and architecture proposals for discussion with IS practitioners.

MADRAE succeeded in pointing out when data work is taking place, allowing for reflecting upon where it is needed and where interoperability should be considered. For example, data work is irrelevant for duplicating data from the hospital planning system to the teleconsultation one, especially considering that it can increase the risk of errors and is burdensome (Cabitza, Locoro, et al., 2019). Thus, MADRAE extends Cabitza and colleagues' work as it helps identify where qualified data work is, therefore, where it is needed (and where it is not). Our approach has the potential to incentive software design and information management professionals to consider data work better and envision an alternative to automated interoperability when relevant.

As shown above, the HHIS pointed out MADRAE's weakness in specifying the temporal sequence of events which he considers essential. We agree that MADRAE does not allow specifying the temporal aspects directly. Nevertheless, we have witnessed many variations in practices during our fieldwork from one medical department to another or even from one teleconsultation to another. We can assert that this diversity did not prevent health professionals from carrying out teleconsultations. While the request for modeling a temporal dimension and "user process" reported by the HHIS is interesting, it brings with it the difficulty of accounting for a diversity of practices. Therefore, we have chosen a structural modeling approach for MADRAE, leaving the actors to decide on the sequence of actions according to the available components. The temporal dimension can also be supported by combining complementary forms of modeling (i.e., graphical interface models, scenarios) and documentation (i.e., field notes), which can be attached to the interface names of the component model, as suggested in figure 3. Also, our formative evaluation is limited to one expert and the approach would benefit from other perspectives and application context.

As pointed out in our analysis of TELECONSSYS with MADRAE, policies influence the software components that can take part in artifact ecologies. For instance, storing medical records outside of a health data warehouse will be forbidden in the near future due to the evolution of the regulations related to national healthcare policies. Some research in CSCW and healthcare points to policies as an important issue (Fitzpatrick & Ellingsen, 2013; Jackson et al., 2014). We are currently considering an approach for reflecting this aspect in MADRAE. That is why the "R" in MADRAE refers to "regulated," i.e., regulations and policies constraining technology, as we ambition to further this aspect. Our suggestion so far is to tie policies with the organizations participating in our model using UML package notation. However, we must be cautious about generalizing this notation, especially when several policies partly overlap. Further work is therefore needed to strengthen policy modeling in the MADRAE approach.

Conclusion and Future Work

In this paper, we presented MADRAE, a modeling approach for sociotechnical systems which, from the study of a complex cooperative practice such as teleconsultation, makes it possible to consider the artifact ecologies and the data work involved. The approach has been demonstrated based on different cases of teleconsultation practices.

The documentation of our approach and extended notation for the component diagram is publicly available: <https://github.com/Clement-Cormi/MADRAE>. MADRAE will of course benefit from further evaluations, revisions, and applications to different work contexts beyond the case of teleconsultation. For example, the issue of finding a way to account for regulations and policies in healthcare is a current line of work on our side.

Through this work, we also hope to contribute to the overarching reflection on the translation of CSCW analysis to software design and information system management practices (Christensen et al., 2020; Lewkowicz & Liron, 2019).

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References

- Arndt, B. G., Beasley, J. W., Watkinson, M. D., Temte, J. L., Tuan, W.-J., Sinsky, C. A., & Gilchrist, V. J. (2017). Tethered to the EHR: Primary Care Physician Workload Assessment Using EHR Event Log Data and Time-Motion Observations. *Annals of Family Medicine*, *15*(5), 419–426. <https://doi.org/10.1370/afm.2121>
- Auer, Tschurtschenthaler, & Biffl. (2003). A flyweight UML modelling tool for software development in heterogeneous environments. *Proceedings of the 20th IEEE Instrumentation Technology Conference (Cat No 03CH37412) EURMIC-03*, 267–272. <https://doi.org/10.1109/EURMIC.2003.1231600>
- Bardram, J. E., & Bossen, C. (2005a). A web of coordinative artifacts: Collaborative work at a hospital ward. *Proceedings of the 2005 International ACM SIGGROUP Conference on Supporting Group Work - GROUP '05*, 168. <https://doi.org/10.1145/1099203.1099235>
- Bardram, J. E., & Bossen, C. (2005b). Mobility Work: The Spatial Dimension of Collaboration at a Hospital. *Computer Supported Cooperative Work (CSCW)*, *14*(2), 131–160. <https://doi.org/10.1007/s10606-005-0989-y>
- Bjørnstad, C., & Ellingsen, G. (2019). Data work: A condition for integrations in health care. *Health Informatics Journal*, *25*(3), 526–535. <https://doi.org/10.1177/1460458219833114>
- Bødker, S., & Klokmose, C. N. (2012). Dynamics in artifact ecologies. *Proceedings of the 7th Nordic Conference on Human-Computer Interaction: Making Sense Through Design*, 448–457. <https://doi.org/10.1145/2399016.2399085>
- Bødker, S., Korsgaard, H., & Saad-Sulonen, J. (2016). A Farmer, a Place and at least 20 Members- The Development of Artifact Ecologies in Volunteer-based Communities. *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing - CSCW '16*, 1140–1154. <https://doi.org/10.1145/2818048.2820029>

- Bonde, M., Bossen, C., & Danholt, P. (2019). Data-work and friction: Investigating the practices of repurposing healthcare data. *Health Informatics Journal*, 25(3), 558–566. <https://doi.org/10.1177/1460458219856462>
- Cabitza, F., Ellingsen, G., Locoro, A., & Simone, C. (2019). Repetita iuvant: Discovering and supporting redundancy in health information technology. *Computer Supported Cooperative Work (CSCW)*, 28, 61–94.
- Cabitza, F., Locoro, A., Alderighi, C., Rasoini, R., Compagnone, D., & Berjano, P. (2019). The elephant in the record: On the multiplicity of data recording work. *Health Informatics Journal*, 25(3), 475–490. <https://doi.org/10.1177/1460458218824705>
- Callon, M., & Law, J. (2005). On Qualculation, Agency, and Otherness. *Environment and Planning D: Society and Space*, 23(5), 717–733. <https://doi.org/10.1068/d343t>
- Christensen, Lars Rune, Erickson, Ingrid, Harper, Richard, Lewkowicz, Myriam, & Nauwerck, Gerolf. (2020). *Why Do CSCW Insights Lose Out to Management Intuitions?* https://doi.org/10.18420/ECSCW2020_WS06
- Cormi, C., Abou Amsha, K., Tixier, M., & Lewkowicz, M. (2020). How the local domestication of a teleconsultation solution is influenced by the adoption of a national policy? *European Conference on Computer-Supported Cooperative Work*, 4(1). https://doi.org/10.18420/ECSCW2020_EP06
- Cormi, C., Abou-Amsha, K., Tixier, M., & Lewkowicz, M. (2022). Considering the Artifact Ecology when Supporting the Evolution of Practices – Analyzing the Parallel Journeys of Two Teleconsultation Software in a General Hospital. *PACM on Human Computer Interaction*, 6(2), 17. <https://doi.org/10.1145/3492821>
- Dittmar, A., & Dardar, L. (2014). Studying Ecologies of Calendar Artifacts. *Proceedings of the 2014 European Conference on Cognitive Ergonomics - ECCE '14*, 1–8. <https://doi.org/10.1145/2637248.2637267>
- Divitini, M., Simone, C., & Schmidt, K. (1996). *ABACO: Coordination mechanisms in a multi-agent perspective*. 103–122.
- Fitzpatrick, G., & Ellingsen, G. (2013). A Review of 25 Years of CSCW Research in Healthcare: Contributions, Challenges and Future Agendas. *Computer Supported Cooperative Work (CSCW)*, 22(4), 609–665. <https://doi.org/10.1007/s10606-012-9168-0>
- Grisot, M., Moltubakk Kempton, A., Hagen, L., & Aanestad, M. (2019). Data-work for personalized care: Examining nurses' practices in remote monitoring of chronic patients. *Health Informatics Journal*, 25(3), 608–616. <https://doi.org/10.1177/1460458219833110>
- Grossman, M., Aronson, J. E., & McCarthy, R. V. (2005). Does UML make the grade? Insights from the software development community. *Information and Software Technology*, 47(6), 383–397. <https://doi.org/10.1016/j.infsof.2004.09.005>
- Hartswood, M., Procter, R., Rouncefield, M., & Slack, R. (2003). Making a Case in Medical Work: Implications for the Electronic Medical Record. *Computer Supported Cooperative Work (CSCW)*, 12(3), 241–266. <https://doi.org/10.1023/A:1025055829026>
- Heath, C., & Luff, P. (1991). Collaborative Activity and Technological Design: Task Coordination in London Underground Control Rooms. In L. Bannon, M. Robinson, & K. Schmidt (Eds.), *Proceedings of the Second European Conference on Computer-Supported Cooperative Work ECSCW '91* (pp. 65–80). Springer Netherlands. https://doi.org/10.1007/978-94-011-3506-1_5
- Herrmann, T., Hoffmann, M., Kunau, G., & Loser, K.-U. (2004). A modelling method for the development of groupware applications as socio-technical systems. *Behaviour & Information Technology*, 23(2), 119–135. <https://doi.org/10.1080/01449290310001644840>
- Herrmann, T., & Loser, K.-U. (1999). Vagueness in models of socio-technical systems. *Behaviour & Information Technology*, 18(5), 313–323. <https://doi.org/10.1080/014492999118904>
- Iroju, O., Soriyan, A., Gambo, I., & Olaleke, J. (2013). Interoperability in Healthcare: Benefits, Challenges and Resolutions. *International Journal of Innovation and Applied Studies*, 3(1), 10.
- Island, A. S., Lindroth, T., Lundin, J., & Steineck, G. (2019). Shift in translations: Data work with patient-generated health data in clinical practice. *Health Informatics Journal*, 25(3), 577–586. <https://doi.org/10.1177/1460458219833097>

- Jackson, S. J., Gillespie, T., & Payette, S. (2014). The policy knot: Re-integrating policy, practice and design in cscw studies of social computing. *Proceedings of the 17th ACM Conference on Computer Supported Cooperative Work & Social Computing*, 588–602. <https://doi.org/10.1145/2531602.2531674>
- Jarrahi, M. H., Nelson, S. B., & Thomson, L. (2017). Personal artifact ecologies in the context of mobile knowledge workers. *Computers in Human Behavior*, 75, 469–483. <https://doi.org/10.1016/j.chb.2017.05.028>
- Jung, H., Stolterman, E., Ryan, W., Thompson, T., & Siegel, M. (2008). Toward a framework for ecologies of artifacts: How are digital artifacts interconnected within a personal life? *Proceedings of the 5th Nordic Conference on Human-Computer Interaction Building Bridges - NordiCHI '08*, 201. <https://doi.org/10.1145/1463160.1463182>
- Kaplan, S., & Seebeck, L. (2001). Harnessing Complexity in CSCW. In W. Prinz, M. Jarke, Y. Rogers, K. Schmidt, & V. Wulf (Eds.), *ECSCW 2001: Proceedings of the Seventh European Conference on Computer Supported Cooperative Work 16–20 September 2001, Bonn, Germany* (pp. 359–378). Springer Netherlands. https://doi.org/10.1007/0-306-48019-0_19
- Kautz, O., Roth, A., & Rumpe, B. (2018). Achievements, Failures, and the Future of Model-Based Software Engineering. In V. Gruhn & R. Striemer (Eds.), *The Essence of Software Engineering* (pp. 221–236). Springer International Publishing. https://doi.org/10.1007/978-3-319-73897-0_13
- Kobryn, C. (2002). Will UML 2.0 be agile or awkward? *Communications of the ACM*, 45(1), 107–110. <https://doi.org/10.1145/502269.502306>
- Korsgaard, H., Lyle, P., Saad-Sulonen, J., Nylandsted Klokmoose, C., Nouwens, M., & Bødker, S. (2022). Collectives and Their Artifact Ecologies: CSCW 2022: The 25th ACM Conference On Computer-Supported Cooperative Work And Social Computing. *Proceedings of the ACM on Human-Computer Interaction*, 1–26.
- Kramer, J. (2007). Is abstraction the key to computing? *Communications of the ACM*, 50(4), 36–42. <https://doi.org/10.1145/1232743.1232745>
- Krippendorff, K. (1989). On the Essential Contexts of Artifacts or on the Proposition That “Design Is Making Sense (Of Things).” *Design Issues*, 5(2), 9–39. <https://doi.org/10.2307/1511512>
- Langstrup, H. (2019). Patient-reported data and the politics of meaningful data work. *Health Informatics Journal*, 25(3), 567–576. <https://doi.org/10.1177/1460458218820188>
- Larsen-Ledet, I., Korsgaard, H., & Bødker, S. (2020). Collaborative Writing Across Multiple Artifact Ecologies. *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, 1–14. <https://doi.org/10.1145/3313831.3376422>
- Lewkowicz, M., & Liron, R. (2019). The Missing “Turn to Practice” in the Digital Transformation of Industry. *Computer Supported Cooperative Work (CSCW)*, 28(3–4), 655–683. <https://doi.org/10.1007/s10606-019-09347-y>
- Ludwig, T., Kotthaus, C., Stein, M., Pipek, V., & Wulf, V. (2018). *Revive Old Discussions! Socio-technical Challenges for Small and Medium Enterprises within Industry 4.0*. https://doi.org/10.18420/ECSCW2018_15
- Lyle, P., Korsgaard, H., & Bødker, S. (2020). What’s in an Ecology? A Review of Artifact, Communicative, Device and Information Ecologies. *Proceedings of the 11th Nordic Conference on Human-Computer Interaction: Shaping Experiences, Shaping Society*, 1–14. <https://doi.org/10.1145/3419249.3420185>
- Monteiro, E., Pollock, N., Hanseth, O., & Williams, R. (2013). From Artefacts to Infrastructures. *Computer Supported Cooperative Work (CSCW)*, 22(4–6), 575–607. <https://doi.org/10.1007/s10606-012-9167-1>
- Morrison, C., Jones, M., Jones, R., & Vuylsteke, A. (2013). ‘You can’t just hit a button’: An ethnographic study of strategies to repurpose data from advanced clinical information systems for clinical process improvement. *BMC Medicine*, 11(1), 103. <https://doi.org/10.1186/1741-7015-11-103>
- Moser, I., & Law, J. (2006). Fluids or flows? Information and qualculation in medical practice. *Information Technology & People*, 19(1), 55–73. <https://doi.org/10.1108/09593840610649961>

- Pine, K. H. (2019). The calculative dimension of healthcare data interoperability. *Health Informatics Journal*, 25(3), 536–548. <https://doi.org/10.1177/1460458219833095>
- Pine, K., & Mazmanian, M. (2017). Artful and contorted coordinating: The ramifications of imposing formal logics of task jurisdiction on situated practice. *Academy of Management Journal*, 60(2), 720–742. <https://doi.org/10.5465/amj.2014.0315>
- Pipek, V., Wulf, V., & Fraunhofer-Institut für Angewandte Informationstechnik FIT and Universität Siegen. (2009). Infrastructuring: Toward an Integrated Perspective on the Design and Use of Information Technology. *Journal of the Association for Information Systems*, 10(5), 447–473. <https://doi.org/10.17705/1jais.00195>
- Pollock, N., & Williams, R. (2010). e-Infrastructures: How Do We Know and Understand Them? Strategic Ethnography and the Biography of Artefacts. *Computer Supported Cooperative Work (CSCW)*, 19(6), 521–556. <https://doi.org/10.1007/s10606-010-9129-4>
- Randall, D., Harper, R., & Rouncefield, M. (2005). Fieldwork And Ethnography: A Perspective From CSCW. *Ethnographic Praxis in Industry Conference Proceedings, 2005(1)*, 81–99. <https://doi.org/10.1111/j.1559-8918.2005.tb00010.x>
- Rossitto, C., Bogdan, C., & Severinson-Eklundh, K. (2014). Understanding Constellations of Technologies in Use in a Collaborative Nomadic Setting. *Computer Supported Cooperative Work (CSCW)*, 23(2), 137–161. <https://doi.org/10.1007/s10606-013-9196-4>
- Scriven, M. (1967). *The Methodology of Evaluation*. In: *Perspectives of Curriculum Evaluation (AERA Monograph Series on Curriculum Evaluation, No. 1)* (Tyler, R., Gagné, R. and Scriven, M., Eds.).
- Sinsky, C., Colligan, L., Li, L., Prgomet, M., Reynolds, S., Goeders, L., Westbrook, J., Tutty, M., & Blike, G. (2016). Allocation of Physician Time in Ambulatory Practice: A Time and Motion Study in 4 Specialties. *Annals of Internal Medicine*, 165(11), 753. <https://doi.org/10.7326/M16-0961>
- Sørensen, H., & Kjeldskov, J. (2014). Concepts of Multi-artifact Systems in Artifact Ecologies. *Proceedings of the Seventh International Conference on Advances in Computer-Human Interactions*, 7.
- Star, S. L., & Strauss, A. (1999). Layers of Silence, Arenas of Voice: The Ecology of Visible and Invisible Work. *Computer Supported Cooperative Work (CSCW)*, 8(1), 9–30. <https://doi.org/10.1023/A:1008651105359>
- Vallo Hult, H., Hansson, A., Svensson, L., & Gellerstedt, M. (2019). Flipped healthcare for better or worse. *Health Informatics Journal*, 25(3), 587–597. <https://doi.org/10.1177/1460458219833099>
- Vassilakopoulou, P., & Aanestad, M. (2019). Communal data work: Data sharing and re-use in clinical genetics. *Health Informatics Journal*, 25(3), 511–525. <https://doi.org/10.1177/1460458219833117>

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Configurations of the User in the Trajectory of Wheelchairs in India: Learnings for the Socio-technical Design of Smart Assistive Devices

Kanika Tuteja¹, Tommaso Colombino¹, Matthieu Tixier²

Naver Labs Europe, Meylan, France¹

Troyes University of Technology, ICD, Tech-CICO, Troyes, France²

firstname.lastname@naverlabs.com, tommaso.colombino@naverlabs.com
matthieu.tixier@utt.fr

Abstract. Many features of a wheelchair affect users' actions in a manual wheelchair, determining the overall mobility performance. Based on an ethnographic study of wheelchair users in India, we develop a trajectory analysis centered on the wheelchair as an artifact and the stages in its lifecycle from design to use. This paper focuses on the decisions made and practices in the production and acquisition phases and the consequences further down the line for the end user. In particular, we focus on how different configurations of the user across production and acquisition can make it difficult for users to find a wheelchair well adapted to their situated needs once they bring the artefact into their home and daily routines.

Introduction

Our research deals with the meaning of intelligence in the concept of an "intelligent" or "smart" wheelchair from a socio-technical perspective. Depending on the designers' perspectives, we can place intelligence in the assistive device or in the environment. It would be helpful for designers to find a balance between focusing on the wheelchair design or "designing the ecosystem" to foster the independence of people with mobility impairment (PMI). This aspect is primarily at stake in less-resourced settings, as in the Indian context.

We position our research at the intersection of assistive technology design, CSCW, and HCI4D (Ho et al, 2009). We see a rising interest in the questions of accessibility and assistive technologies in CSCW (Kameswaran et al., 2018) (Pinatti et al., 2020). Following a similar direction, we are interested in understanding the use and limits of assistive devices from a sociotechnical perspective. For CSCW, achieving successful design and innovation is considered a process where attention needs to be paid to technical possibilities within a specific social and work environment. Ethnography (Martin & Sommerville, 2004) is specifically targeted at providing rich understanding of social phenomena as it occurs in everyday settings (Randall et al., 2007).

We are interested in how technology and assistive devices can hamper or provide support for people to develop their independence in their daily lives (Scherrer, 2005) (Rumeaux et al., 2021). This phenomenon is tied to complex interdependencies between persons, assistive devices, and the environment (Bennett et al, 2018). What factors influence the opportunities and decisions of acquisition and training of an assistive device like a wheelchair? What are the challenges and the outcomes after obtaining a wheelchair? We focus our analytical contribution toward an artifact's trajectory through multi-sited ethnography (Marcus, 1995). Our trajectory analysis presents how an artifact goes through different stages, from production, acquisition, and use of the assistive device into a daily routine up to sometimes discarding it. We emphasize the critical issues that influence the decision to acquire a wheelchair and the challenges and outcomes after obtaining it. These issues stretch beyond the dialogue between designers and users through an artifact and involve stakeholders often not anticipated in assistive technology design. To understand the challenges faced by persons with mobility impairments (PMI), we examine the different configurations of the user (Iivari, 2006) at crucial decision points and describe the elements involved in how a person ends up with a particular wheelchair and how she succeeds to do something or not with it. Once the decision is made, it is often too late to re-consider the choices made in an earlier stage.

In this paper, we specifically focus on how different actors throughout the trajectory are enacting different configurations of the user and how this can lead to a mismatch of the wheelchair with the user's needs. Our notion of configuration of the user has its roots in the work of Goode (1994) dealing with the

communication skills of deaf blind children where he emphasizes the contrasting views of family, hospital or specialized schools towards the children's' abilities. The notion is also connected with Iivari (2006) on HCI practitioner's perspectives. We present example cases from our field study to illustrate different situations of acquisition and evaluation of the user as a welfare recipient in a bureaucratic process, a customer or a patient undergoing rehabilitation.

Related Work

We present the overall aim of building smarter wheelchairs and the different approaches researchers and designers are mobilizing towards this direction. Then we highlight the adoption of assistive technologies as a complex sociotechnical achievement that requires a considerable amount of work for finding a good fit between a person and a wheelchair. However, the studies on the complexity of the appropriation of wheelchairs tend to put in the background the production of the artefact and the question of how a person ends up with an assistive device for use in her daily life. We suggest that there is a need for a more longitudinal and multi-sited approach, a trajectory analysis, to account for part of the complexity and decisions that are at stake before the person with mobility impairment (PMI) even encounter her wheelchair and which could inform future approaches for the development of smarter wheelchair.

Towards "Smart Wheelchair"

Research on the design and technology components of "smart wheelchairs" covers a broad spectrum of topics and sub disciplines in the Human Computer Interaction and Human Robot Interaction fields.

One approach is focused on providing new features and improvements to the wheelchair itself. A substantial amount of research, for example, addresses ergonomic topics focused on reducing or minimizing the physical and cognitive (perceptual) requirements to navigate in a wheelchair. An example of this line of research might include adapting interfaces and controls to the specific physical and mental impairments or preferences of the users by replacing the traditional joystick-based movement interface with a voice controlled or gesture-based interface (Trivedi et al, 2013, Guedira et al, 2016, Megalingam et al, 2011)). Navigation is also a central concern with the aim to seamlessly transition between autonomous, semi-autonomous, manual and caregiver assisted navigation (Kobayashi et al, 2011), or from having smart collision avoidance technology to better navigate crowded spaces (Kuno et al, 2001).

Another stream of research focuses on developing smarter environments for wheelchair users. Here the focus shifts on integrating the augmented wheelchair with other elements of an ambient intelligent or robotic platform. This may

involve making the wheelchair the central point of control for smart home infrastructure (Cardoso Bissoli et al, 2016), or extending the capabilities of the wheelchair to integrate (and make accessible) common ICT technology like pointers and projectors (Asai et al, 2016). Finding the proper balance between equipping the person or adapting the environment to foster mobility and independence appears as the current stake. However, the study of adoption of existing wheelchairs also points to supplementary challenges as technology grows in complexity.

Adoption of Assistive Technologies as a Sociotechnical Achievement

Restoring or improving the mobility of PMI is a complex endeavour as accounted for by the rich stories shared by Scherrer (2005) about persons with spinal cord injuries and how assistive technologies support them in their daily life. The adoption of a wheelchair can be seen as a process of *adjustment* between the person and the wheelchair (Winnance, 2006). Winnance describes with nuances how such an assistive device is personalized with customizable or additional components in search for a good trade-off in terms of comfort but also paying attention to the person's current and aimed activities, as well as her living environment and relationship with formal and informal caregivers (Winnance, 2010). This adjustment goes also in the direction of the person, her body that evolves and adapts to the wheelchair with time (or as adapted to a previous wheelchair), as much as her choices towards possibilities of action that will be more or less difficult with one wheelchair setup than another.

This complex process of adjustment echoes CSCW perspectives on appropriation and how users are integrating technologies to their actions. Dourish defines appropriation as "the way in which technologies are adopted, adapted and incorporated into working practice" (Dourish, 2003 p. 467) which concurs to the end-users adapting or developing work-around to the artefacts for achieving their practical purposes. This line of work insists on how the design of technology is continuing with use (Henderson & King, 1991). This research also put a special emphasis on the social dimension of appropriation (Draxler et al., 2012) where the adaptation of technology is emphasized as a collective achievement.

The sociotechnical approach of appropriation is also in line with the concept of interdependencies in assistive technologies research and design (Bennett et al, 2018). Distancing from the widespread view that assistive technologies should bring more autonomy, this perspective focuses on the interdependency relationships that develop between the person, her assistive devices and the persons who share her life (for instance, relatives, colleagues, caregivers). Appropriation and interdependence appear as key notions to understand assistive technologies adoption as a sociotechnical achievement. However, the studies so far are mostly concerned with situations where the artifact is already there and made available to the PMI without much inquiry upward into how a person gets a specific wheelchair. We suggest that there is also a need to better understand

assistive technology production and acquisition as it has impact on the range of options available for appropriation.

Longitudinal and Trajectory Analysis of Technology

In order to develop an understanding of how a user ends up with a specific wheelchair and the consequences about how she succeeds to do something about it or not, we need to go beyond a focus on appropriation situations. We identify three different approaches in literature that expand the boundaries of appropriation: domestication, the trajectory for technology-supported elderly care work and the approach of Biography of Artefacts.

The perspective of domestication (Silverstone & Haddon, 1996) considers the steps that are occurring before, during, and after the technology is introduced. This longitudinal approach provides an analytical framework to account for different stages in the adoption of technology artifacts: appropriation, objectification, incorporation and conversion. The model supplements research on the appropriation of technology in practices (Balka & Wagner, 2006; Draxler et al., 2012) as it accounts for steps before the technology is available in the field site. Several studies on technology domestication have been conducted on work organization (Pierson, 2005), healthcare (Gaglio et al., 2016), or social media (Simpson et al., 2022). From this line of work, we keep the orientation towards furthering the analysis before and after the encounter between an artifact and its user.

Woll & Bratteteig (2019) develop a trajectory analysis of elderly care work with a focus on the role of 'welfare' and assistive technologies. Grounding their work on trajectory analysis of healthcare work (Corbin & Strauss, 1991, Strauss et al. 1985), they tie the different forms of work at stake for the elderly persons and their formal and informal caregivers along their growth in age and the worsening of their condition. In a similar vein, Pollock & Williams develop an approach of Biography of Artefacts (BoA) in order to go beyond local issues of technology adoption, that is bound to one person or organization. Despite their approach being focused on e-infrastructure and information systems we share their concerns "to engage more coherently with the ways in which longer term history and the broader context shape innovation processes and outcomes" (Pollock & Williams, 2010, p. 531). In this direction, we follow their suggestion to develop longitudinal and multi-sited studies (Marcus, 1995) to achieve a better understanding of the sociotechnical dimension of assistive technologies with the aim to inform the development and deployment of future innovation for smarter wheelchairs.

Fieldwork and Methods

Fieldwork provides insights into the user's everyday space, their day-to-day activities, their relationship with their assistive devices and their caregivers, the role of assistance, and most importantly, the trade-offs between being independent and interdependent, that is, relying on others. Given the distributed nature in space and time of assistive technology for mobility impairment in India, we have grounded our approach on multi-sited ethnography (Marcus, 1995). Among the different strategies for conducting ethnography suggested by Marcus, we choose the one of following the object, the wheelchair, as an artifact.

We have first conducted exploratory online interviews via Zoom with multiple wheelchair users and representatives in Bangalore and Delhi (n=15). Then we have organized our fieldwork in Karnataka's metropolitan city, Bangalore, and the rural town, Vijayapura. The town is located 524.9 km away from Bangalore.

Different locations for the ethnographic research were chosen: the user's house, rehabilitation center, hospitals, surgical shops, and NGOs. We also had the opportunity to visit the organization Motivation UK, a global disability charity and social enterprise providing wheelchairs and services to PMI in developing countries.

The locations were purposely chosen, as each had a different setting and faced specific complexities in relation with the wheelchair artefact. During the fieldwork, a translator accompanied us, as the majority of the users were comfortable in their native language, Kannad.

We summarize our fieldwork by location in Table I and Table II.

Table I. Fieldwork activity chart in Bangalore, Karnataka

Rehabilitation Centre	30 days of observational studies
Home visits	5 days of interviews and ethnography, 10 different houses
Motivation India	1 day visit
Production house	2 days visit (same site)
Surgical shops	1 day visit, 2 surgical shops

Table II. Fieldwork activity chart in Vijayapura, Karnataka

Rehabilitation Centre	2 days of observational studies
Home visits	7 days of interviews and ethnography, 14 different houses
Distribution camps	1 day visit
Hospital	1 day visit
Surgical shops	1 day visit, 2 surgical shops

For the analysis of the collected material, we have adopted a trajectory approach following the wheelchair as an artifact that goes through different stages from production, acquisition, and use to discarding the assistive device. This thematic analysis reflects on the ecosystem as a whole, involving the different environments, actors, and users with spinal cord injuries. Through our trajectory analysis, we emphasize the critical issues that influence the decisions to acquire a wheelchair, as well as the challenges and the outcomes after obtaining it.

Findings

In this exploratory paper, we focus our analysis on the production and acquisition stages in the trajectory of wheelchair as we focus on the question of how a PMI ends up with a specific assistive device. We also mention the use stage when we consider the decisions made along the trajectory on the situation of the user. Especially, how the user succeeds or not to do something with the assistive device they received.

Production

In our study, we encountered two organizations, ALIMCO (Artificial Limbs Manufacturing Corporation of India) and Motivation who are producing most of the wheelchairs we encountered in our fieldwork. Both organizations have different perspectives on the end user's involvement in the design process.

ALIMCO falls under the Department of Empowerment of Persons with Disabilities, Ministry of Social Justice and Empowerment, Government of India. It is a non-profit organization that has manufacturing units in Kanpur and Bangalore. We had the opportunity to learn about their process, including assembly, quality check and shipment of the devices. In conversation with the production manager of the site at Bangalore, he mentioned:

“We have everything in place from the guidelines, specification of the product to the final control check. We never felt that there was a requirement to involve users in any testing of the products. ALIMCO aims to reach the masses and allow them to have access to assistive devices. Our goal relies less on comfort and inclusivity.” (ALIMCO, Production Manager)

Motivation is a global disability charity and social enterprise that provides wheelchairs and services to disabled people and partner organizations in developing countries. The organization has multiple regional offices worldwide, and we had the opportunity to visit its regional office in India, where the regional manager explained how the organization works and how its designs cater to the Indian population. He mentioned:

“Usability testing is a deal-breaker. [...] We always try to create a prototype and pilot test it with the users before moving on to the production” (Motivation India, Regional Manager).

The organization follows the WHO guidelines and develops its wheelchair anticipating a trajectory of assessment, training, follow-up, maintenance, and repair.

Although both organizations focus on providing the assistive device, Motivation emphasizes research and has a user-centric process while ALIMCO's aim is to provide an assistive device to a larger audience, especially those who can't afford it. Motivation follows the WHO standard for design, while ALIMCO follows the BIS (Bureau of Indian Standards) and emphasizes quantity over quality. ALIMCO is directly involved in manufacturing and delivery through distribution camps. Motivation has a different approach, designing and distributing via various mediums and organizations, especially collaborations with other NGOs for distribution.

Acquisition

In India, PMIs obtain assistive devices through various mediums. These mediums could vary in location, level of injury, and financial aid. During our fieldwork, we had the opportunity to explore different acquisition mediums and organizations: provision through government welfare programs, independent purchases from surgical shops and acquisition guided with the support of NGOs and rehabilitation centers. We encountered the challenges of acquiring the wheelchair and how the lack of awareness of users' needs leads to partial configurations of the user. We observe that these limitations could lead to more complications at a later stage.

The configuration of the user as a welfare recipient

The government of India has a welfare program intended to "Assistance to Disabled Persons" (ADIP). ALIMCO wheelchairs are provided based on this scheme. The essential criteria are that one should have an income certificate that shows that your income is less than Rs. 15,000 per month (170 €). The program has three requirements: providing a Disability Certificate, an income certificate and the identity card. One scheme applies to people above the age of 60 years and the other to the younger. For ALIMCO the age threshold plays a role in limiting the choices of artifacts and the compromises that users have to make in terms of parameters like portability, range, and robustness.

The acquisition of the assistive device can take up to two to three months. Among the required documents, the Disability Certificate is the most difficult one to obtain. After the injury, the user must visit the district hospital for an evaluation. This evaluation focuses on the percentage of lower limb injuries. For instance, the user must have 40% of lower limb injury to qualify for the ADIP scheme. This approach of quantifying the impairment makes it difficult to

appreciate the complexity of a user's situated needs. In this configuration of the user, the disability certificate serves more to demonstrate that you are "disabled enough" to merit assistance from the government than to make an evaluation for finding a suitable wheelchair.

The configuration of the user as a customer

In general hospitals, wheelchair service provision is least considered or not considered. The doctor suggests to the user that the assistive device they need is a wheelchair, and they refer them to the nearby surgical shops.

Surgical shops are like any other shop but to buy assistive devices. Anyone can purchase the device at surgical shops, but the shops are mostly inaccessible to people with physical impairment. It is usually located near a hospital or a rehabilitation center for easy access. The shops are mostly inaccessible, and there is no provision of ramps for PMI to enter the shop and explore the different variations of available assistive devices. In what follows we report on the case of Swami, who recently had an accident and is dependent on the temporary wheelchair provided by the hospital. Swami is assisted by her caregiver Seema and needs a wheelchair that fits his requirements and is easy to propel. Unfortunately, Swami, who has a mobility impairment, cannot access the shop because of poor infrastructure.

Seema: We would like to buy a wheelchair for my brother-in-law, who recently got discharged from the hospital. He has a T4 spinal cord injury.

Salesman: Do you have a model in mind?

Seema: No, you can suggest to us what is the best solution.

Salesman: We have a few models available in the shop, which I can show you, or you can place an order; it will take a minimum of two weeks to deliver.

Seema: We are looking for you to help us to decide on the model.

Salesman: What's your budget?

Seema: Rs. 10,000 (120 €)

Salesman: We have three models in this budget.

It is clear from this vignette that the sales assistant and Seema are exchanging dialogue with one another. Through conversation, they asked each other for help and checked on one another's understanding of finding a suitable assistive device under the given budget. Although, there was no dialogue exchange with Swami, the concerned PMI, neither about the evaluation or the envisioned use of the assistive device. The salesman isn't aware of the importance of an evaluation process of the PMI needs, so it's more like a commercial transaction. The shop does not provide any follow-up or training.

The configuration of the user as a patient undergoing rehabilitation

The acquisition process for wheelchairs with NGOs or at a rehabilitation center differs from the above-mentioned process. During our fieldwork at Motivation India, we studied the assessment process to acquire a suitable wheelchair.

After securing an appointment, the user or the caregiver must carry the necessary documents like the Disability Certificate, Income Certificate, and ID proof on the appointment date. In a few cases, the organization opts for part funding, where the user would contribute part of it, and the rest of it, donors, come into the play. Usually, it takes from one day up to one month to identify a donor.

The acquisition process with Motivation is a three-step process involving evaluation and prescription, secondly funding and ordering and thirdly and fitting, user training, and delivery of a device.

- (1) Assessment and Prescription: To begin with the evaluation process, the organization follows the WHO guidelines for wheelchairs (Figure 1). It includes forms and a checklist that can be modified according to the context and customized per the service provision. The wheelchair assessment form captures the user's demographics and preliminary information regarding their environmental condition, occupation/lifestyle (what they do), location (urban or rural), and activities they engage in daily life. The second step is the physical examination, which focuses more on their sensory level, strength regarding their transferring capabilities, and body measurement.

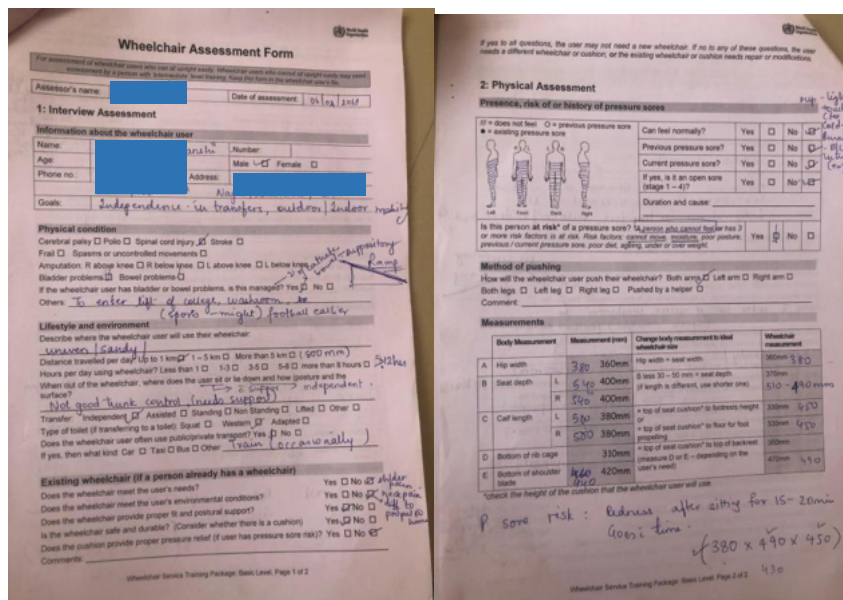


Figure 1. An example of the document used during evaluation by Motivation India that exemplifies the configuration of the user as a patient undergoing rehabilitation.

- (2) Funding and Ordering: The organization charges a minimum amount for the process. They have trained staff to perform the procedure. The organization takes around 10% -12 % of the total cost. For instance, the end-to-end service amount is Rs. 30,000 (360 €), including the price for the wheelchair, which is around Rs. 27,000, including taxes and transportation. Depending on the scenario, the user or the funder bears the cost.
- (3) Fitting, User training, and Delivery: The organization has prefabricated support devices. It depends on the case-to-case scenario; as previously mentioned, location plays an essential role. If the user is in the vicinity, Motivation take around 1-3 days and split the tasks to complete the whole process from assessment to delivery, but if the user lives far away, the organization tries to complete the process in a single day, and that takes about 6-8 hours. Fitting is complicated as it depends on the case. If there are postural issues, it can take from two hours to a day.

The evaluation process is similar to what we observed in the rehabilitation centre we visited with the APD. The difference is that APD has a three-month rehabilitation program. The program is based on the caregiver model wherein the caregiver has to stay with the user for a month to assist them in their day-to-day activities. During this time, the user can form a relationship with the wheelchair and their primary caregiver. There are different training sessions to build up their confidence.

Pushing complexity downward in the trajectory

Most of the PMIs we met who benefited from a wheelchair through the government welfare program are complaining that the assistive device they received did not fit their needs. The situation is similar with PMIs who received a wheelchair purchased from surgical shops or from hospital donation. In such cases, the users describe those wheelchairs as "Good for nothing". One of the users mentioned, "This wheelchair is fragile and low-quality; it isn't robust enough to move around in the outdoor and indoor environment. These wheelchairs are meant for transfer but not for navigation, the seating isn't comfortable for long hours, leading to more complications than solutions."

Given the reductionist view of PMIs offered through the configuration of the user as welfare recipient or customer, the complexity of mobility impairment appears thrown downwards in the trajectory. To mitigate the lack of adaptation, PMIs and their caregiver engage in do it yourself (DIY) adjustments without much supervision. For instance, in the rural part of Karnataka, Vijayapura, we observed people who tried different DIY methods out of the available options in their

natural surroundings. The idea behind this approach is to have more comfort at the lowest price possible. The case of Kanna epitomizes the issue.

Kanna manages his shop from morning to evening and takes a break in the afternoon to sleep. He mentioned:

"Sitting in the chair for long hours is stressful. Your body requires movement, and I know some sitting exercises that I perform during the day, but the seats could be more comfortable and designed for prolonged sitting hours. There is no arrangement for air passage, and it starts to sweat and become quite uncomfortable. I have tried different methods like placing an extra cushion or shifting myself to the bed after every three hours. Vijayapura is a hot city, and sweat is the normal reaction to this weather. I have been using this method of placing an auto rickshaw tier on my seat for the last six months, and that's been helpful. It creates a space between you and your seat and provides a passage for the air passage".

Along the same lines, the healthcare professional had a different point of view, as explained by Saraswati, an occupational therapist we met:

"The practice of placing an auto rickshaw tier is damaging in the long run. It affects your spine and can also be a major cause of bed sores. There are multiple solutions available in the market, but most people do not have the awareness and purchasing capacity, and that's where our role comes into the picture. We do home visits and try to guide them towards the best alternative solution."

The case of PMIs who benefited from the support of NGO and rehabilitation centers have a more favorable evolution. The configuration of the user as a patient undergoing rehabilitation appears as a better support for dealing with the complexity of mobility impairment at least in part.

However, at the rehabilitation center, users don't have access to explore the environment outside the rehabilitation center. The rehabilitation center is like a "controlled environment" where the setting is accessible, and the professional staff is there to help the person in need. In the outer or uncontrolled environment, after the rehabilitation training, the users have to cope with the problems independently without having the flexibility to return. Once a person gets discharged from the training, the outside environment surprises most of them. The need for adjustment is felt more than ever. Parul is 29 years old and he described his experiences after the rehab training as:

"The roads are full of small stones and uneven while in the rehabilitation center; I had never faced such problems. It feels like a different world, and I began searching for my comfort and requirements options."

This comment highlights that even the configuration of the user as a patient undergoing rehabilitation is not without limits, and PMIs have to rely on the support brought by informal caregivers and relatives to overcome them. The case of Raja is particularly illustrative at this level.

Raja is 38 years old and lives in a village named Vijayvada in Karnataka. He has a family of four, two kids and a wife. He is the only breadwinner for his family. He overlooks the farm while sitting on the patio area of his home. He gained independence after his time in rehabilitation.

In a conversation with him, he said:

"As far as my responsibilities are concerned, I have a daily routine of bringing my kids to school in the morning, and while coming back, I make sure that I get a can of purified water and some fruits and vegetables for my family. The only hurdle I face is the difficulty of getting on and off the scooter while not in my familiar setting. When I go out on a scooter, I always ask my friends or son to get down to buy something. I can't perform the same action. It's quite hard to explain, and I feel free and restricted simultaneously".

With time, a PMI who succeeds to appropriate their wheelchair gains the experience and skills of using their assistive device and aims at more complex activities, for instance going for errands in the city with an adapted scooter. They would benefit from having the opportunity to get back to the rehabilitation center to find proper support and training for their new aim. However, this is scarcely possible given the limited availability of such service and its focus on previously untrained PMI.

Discussion and Future Work

Our study of the production and acquisition of wheelchairs highlights the involvement of different stakeholders that stretch the issue of how a wheelchair can support the independence of PMI beyond a conversation between designers and users. The complex adjustment between a PMI and a wheelchair (Winnance, 2006) gets more or less reduced along the trajectory depending on the different configurations of the user that are enacted by the different actors involved. Depending on the location and the hospital referral, the PMI sees her situation evaluated with more or less nuances, which makes her ending with a more or less adapted wheelchair and with little support to develop their independence apart from the case of rehabilitation center training.

As we have seen, the less the complexity of the situation has been dealt with in the acquisition process, for instance by reducing a PMI to her age, income and percentage of impairment, the more this complexity will have to be dealt with at a later stage. The PMI and their caregivers will have more efforts to do to compensate for the lack of understanding of their needs through DIY adaptation

and daily work to cope with mobility impairment. Echoing the observation that it would be more beneficial to learn the use of an assistive device before the need arises (Woll & Bratteteig, 2019), we identify that the early provision and support appear key for getting benefits from a wheelchair.

The critical importance of the acquisition stage appears often neglected in wheelchair production and design. Going back to the endeavor of designing smart wheelchairs, we observe that the ambition of improving the independence of PMI in our context will certainly get lost in the trajectory. Between the focus on improving the wheelchair or the environment, there is crucial room for improvements in the process of acquisition and evaluation for helping the user and their caregivers to find a proper assistive device. Adding complexity to the wheelchair itself is a challenging proposition. A more complex or “smart” artefact requires a more detailed and nuanced evaluation of its future user situation. If not properly dealt with in acquisition, the complexities are dispatched over the shoulder of the PMI and their caregivers.

In future work we are interested in furthering our trajectory analysis on the use stage contrasting the cases of our fieldwork between rural and urban area, as well as indoor and outdoor environments. We are interested in pursuing our analysis of how the PMIs and their caregivers develop innovative ways to compensate for the lack in the trajectory. We also plan to consider how and why a wheelchair gets discarded as this situation set out a starting point for a new journey in the trajectory.

References

- Asai, Y., Ueda, Y., Enomoto, R., Iwai, D., and Sato, K. (2016): ‘ExtendedHand on wheelchair’. In: *Adjunct Proceedings of the 29th Annual ACM Symposium on User Interface Software and Technology*. pp. 147-148.
- Balka, E. and Wagner, I. (2006): ‘Making things work: dimensions of configurability as appropriation work’. In: *Proceedings of the 2006 20th anniversary conference on Computer supported cooperative work (CSCW '06)*. pp. 229-238.
- Bennett, C. L., Brady, E. and Branham, S. M. (2018): ‘Interdependence as a frame for assistive technology research and design’. In: *Proceedings of the 20th International ACM Sigaccess Conference on Computers and Accessibility*. pp. 161-173.
- Bissoli, A. L. C., Coelho, Y. L., & Bastos-Filho, T. F. (2016): ‘A system for multimodal assistive domotics and augmentative and alternative communication’. In: *Proceedings of the 9th ACM International Conference on Pervasive Technologies Related to Assistive Environments*. pp. 1-8.
- Corbin, Juliet M.; and Anselm L. Strauss (1991). ‘A Nursing Model for Chronic Illness Management Based upon the Trajectory Framework’. *Scholarly Inquiry for Nursing Practice: An International Journal*, vol. 5, no.3, February 1991, pp.155–173.
- Dourish, P. 2003. ‘The appropriation of interactive technologies: Some lessons from placeless documents’. *Computer Supported Cooperative Work (CSCW)*, vol. 12, no. 4, pp. 465-490.
- Draxler, S., Stevens, G., Stein, M., Boden, A. and Randall, D. (2012): ‘Supporting the social

- context of technology appropriation: on a synthesis of sharing tools and tool knowledge'. In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '12)*. pp. 2835-2844.
- Gaglio, G., Lewkowicz, M., & Tixier, M. (2016): "'It is Not Because You Have Tools that You Must use Them" The Difficult Domestication of a Telemedicine Toolkit to Manage Emergencies in Nursing Homes'. In: *Proceedings of the 19th International Conference on Supporting Group Work*. pp. 223-233.
- Goode, D. (1994): *A World without Words*. Temple University Press.
- Guedira, Y., Jordan, L., Favey, C., Farcy, R. and Bellik, Y. (2016): 'Tactile interface for electric wheelchair'. In: *Proceedings of the 18th International ACM SIGACCESS Conference on Computers and Accessibility*. pp. 313-314.
- Henderson, A. and Kyng, M. (1991): 'There's no place like home: Continuing Design in Use'. J. Greenbaum and M. Kyng (Eds), *Design at Work: Cooperative Design of Computer Systems*. Lawrence Erlbaum Associates, Hillsdale, NJ, pp. 219-240.
- Ho, M. R., Smyth, T. N., Kam, M. and Dearden, A. (2009). 'Human-computer interaction for development: The past, present, and future'. *Information Technologies & International Development*, vol. 5 no. 4, pp.1.
- Iivari, N. (2006): Understanding the work of an HCI practitioner. In: *Proceedings of the 4th Nordic conference on Human-computer interaction: changing roles*. pp. 185-194
- Kameswaran, V., Gupta, J., Pal, J., O'Modhrain, S., Veinot, T. C., Brewer, R., ... & O'Neill, J. (2018). 'We can go anywhere' Understanding Independence through a Case Study of Ride-hailing Use by People with Visual Impairments in metropolitan India. *Proceedings of ACM on Human-Computer Interaction (PACM-HCI)*. vol. 2. CSCW. November 2018. New York, USA: ACM Press, Article 85.
- Kobayashi, Y., Kinpara, Y., Takano, E., Kuno, Y., Yamazaki, K. and Yamazaki, A. (2011): 'A wheelchair which can automatically move alongside a caregiver'. In: *Proceedings of the 6th international conference on Human-robot interaction*. pp. 407-408.
- Kuno, Y., Murakami, Y. and Shimada, N. (2001): 'User and social interfaces by observing human faces for intelligent wheelchairs'. In: *Proceedings of the 2001 workshop on Perceptive user interfaces*. pp. 1-4.
- Marcus, G. E. (1995): Ethnography in/of the world system: The emergence of multi-sited ethnography. *Annual review of anthropology*, vol. 24, no. 1, pp. 95-117.
- Martin, D., and Sommerville, I. (2004): 'Patterns of cooperative interaction: Linking ethnomethodology and design'. *ACM Transactions on Computer-Human Interaction (TOCHI)*, vol. 11, no. 1, pp. 59-89.
- Megalingam, R. K., Prakhya, S. M., Nair, R. N. and Mohan, M. (2011): 'Intelligent home navigation system for the elderly and physically challenged'. In: *Proceedings of the 1st International Conference on Wireless Technologies for Humanitarian Relief*. pp. 535-536.
- Pierson, J. (2005): 'Domestication at work in small businesses'. In T. Berker, M. Hartmann, Y. Punie & K. Ward (eds.) *Domestication of media and technologies*. Open University Press, Maidenhead, pp. 205-226.
- Pinatti de Carvalho, A. F., Bittenbinder, S., Müller, C., David, N., Hansen, B. and Wulf, V. (2020): 'Fostering Accessibility at the Workplace through Community-based Participatory Research'. In: *Proceedings of 18th European Conference on Computer-Supported Cooperative Work. European Society for Socially Embedded Technologies (EUSSET)*.
- Pollock, N., & Williams, R. (2010): 'E-infrastructures: How do we know and understand them? Strategic ethnography and the biography of artefacts'. *Computer Supported Cooperative Work (CSCW)*, 19, pp. 521-556.

- Randall, D., Harper, R., and Rouncefield, M. (2007): *Fieldwork for design: theory and practice*. Springer Science & Business Media.
- Rumeau, P., Vigouroux, N., Campo, E., Bougeois, E., Vella, F., Van Den Bossche, A., ... & Ancilotto, J. (2021): 'Technological services in shared housing: needs elicitation method from home to living lab'. *IRBM*, vol. 42, no. 2, pp. 73-82.
- Scherer, M. J. (2005): *Living in the state of stuck: How assistive technology impacts the lives of people with disabilities*. Brookline Books.
- Silverstone, R. and Haddon, L. (1996): 'Design and the domestication of information and communication technologies: technical change and everyday life'. In Mansell, R. and Silverstone, R., (eds.) *Communication by Design. The Politics of Information and Communication Technologies*. Oxford University Press, Oxford, UK, pp. 44-74.
- Simpson, E., Hamann, A., & Semaan, B. (2022): 'How to Tame" Your" Algorithm: LGBTQ+ Users' Domestication of TikTok'. *Proceedings of the ACM on Human-Computer Interaction*, 6(GROUP), pp. 1-27.
- Strauss, Anselm L.; Shizuko Fagerhaugh; Barbara Sucek; and Carolyn Wiener (1985): *Social Organization of Medical work*. Chicago: University of Chicago Press.
- Trivedi, A. R., Singh, A. K., Digumarti, S. T., Fulwani, D., & Kumar, S. (2013): 'Design and implementation of a smart wheelchair'. In: *Proceedings of Conference on Advances In Robotics*, pp. 1-6.
- Winance, M. (2006): 'Trying out the wheelchair: the mutual shaping of people and devices through adjustment'. *Science, Technology, & Human Values*, vol. 31, no. 1, pp. 52-72.
- Winance, M. (2010): 'Care and disability. Practices of experimenting, tinkering with, and arranging people and technical aids'. *Care in practice. On tinkering in clinics, homes and farms*, pp. 93-117.
- Woll, A., and Bratteteig, T. (2019): A trajectory for technology-supported elderly care work. *Computer Supported Cooperative Work (CSCW)*, 28, pp. 127-168.

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Redrawing Public School Boundaries: An Intersection of Geography, Education Policy, and Computer Science

Andreea Sistrunk,^{1*} Nathan Self,^{1*} Subhodip Biswas,^{1*} James A. Egenrieder,¹ Kurt Luther¹, Adriana Glenn,² Naren Ramakrishnan¹

¹Virginia Tech, USA

²George Washington University, USA

Corresponding Author: sistrunk@vt.edu

Abstract. School redistricting, i.e., the redrawing of public school boundaries, is undertaken constantly across the United States. Viewing school redistricting as a collaborative intersection of distinct disciplines—geospatial optimization, education policy, and computer science—we study how we can provide better decision-support and collaboration tools to the underlying communities. We describe the traditional state of practice, currently utilized channels, emerging methods, and propose ways for advancement towards technology-infused community deliberations in the process of redrawing public school attendance zone boundaries.

* Authors contributed equally to this work. Arranged in alphabetical order of their first names.

1 Introduction

School systems are an essential and important part of community life (Mayer and Peterson, 1999), especially given that 85% of the world's almost 800 million children complete a primary education (UNICEF, 2022). The majority of schools are supported by public finances (Roser, 2021) and constitute what we know as the public school system. In an effort to maximize resources, to optimize learning, and to foster neighborhoods, public school systems traditionally assign students to their designated schools based on student age and residence proximity. As the population grows, student enrollment exceeds an assigned school building's capacity, and new schools must be built. Consequently, school children may be re-assigned to different schools, sometimes as often as every other year.

The redrawing of school boundaries is ideally a communal activity involving numerous stakeholders, including but not restricted to: parents, students, teachers, school administrators, transportation management, emergency personnel, and local community leaders (Richards et al., 2012; Deming, 2011). The changing of school assignments is a communal task and often generates a complex community response. Finding optimal solutions constitutes a socio-technical challenge that embodies many of the characteristics of what design theorists Horst Rittel and Melvin Webber have dubbed "wicked problems" (Buchanan, 1992; Rittel and Webber, 1973). Like many planning problems, they are messy and feature complex issues involving diverse stakeholders with conflicting goals and various tradeoffs. Wicked problems are ill-defined, unique, and often cause uneven impacts. Solutions are not true or false, but rather better or worse, and can take many possible paths.

Even in the most inclusive communities, transparency and collective decision making can be difficult. This is especially true when community involvement is compromised by limited ability to overcome constraints in understanding complex data. However, with the advancement of technology, complex constraints can be managed rapidly by a computer behind a user-friendly interface. User experience design can complement problems that involve land geography because human perceptions of geography rely on intrinsic understanding of proximity, consequences, distance, and significance.

We view school redistricting as a collaborative CSCW intersection bringing considerations together from spatial data understanding (the 'science of where'), algorithmic methods, and educational policy. We describe the traditional state of practice, currently utilized channels, emerging methods, and propose ways for advancement towards technology-infused community deliberations in the process of redrawing public school attendance zone boundaries. We describe how the use of interfaces can enable stakeholders to understand scenarios of school redistricting, help form and argue opinions, expand communication, build discussion threads, and improve community cohesiveness.

2 Background

2.1 Boundary Re-Assignment Framework

The scholarly literature on one of the largest public school systems in the world, the US, has focused mostly on the impact of rezoning changes, and methodologies employed in the rezoning processes, with the school as a focal part of community dynamics. The National Center for Education Statistics (NCES) reports that a minimum of 20% of the survey respondents (considered as a control sample of the population) have chosen to move homes due to school assignment (NCES, 2019). Many choose their residence based on school assignment, only to learn as they move into their new home, that it is in the midst of re-assignment of school boundaries.



Figure 1. A fictional disposition of residence assignment within a public district with three schools. Different house colors represent distinct combinations of social/economic/ethnic variations. The lines between the houses represent attendance zone boundaries. **Left:** This school assignment minimizes the distance to the school as well as the transportation costs and time to and from schools. **Right:** An alternative school assignment considers other factors in addition to proximity such as diversity, socioeconomic status, student ethnicity, etc., aiming to provide a broader representation of the whole student population within the district while maintaining contiguous attendance zones (i.e., does not generate islands) (Biswas et al., 2020a).

2.2 Factors and Current Practices

Revisions to school boundaries typically enhance the efficiency of the entire district due to the lowered costs of transportation and improved logistics. However, given differences between neighborhoods, considering only proximity may lead to more segregated schools (Fig. 1, left). On the other hand, Fig. 1 (right) provides a better distribution of the population, but might also yield an increase in cost and time for transportation to and from schools. Given the fact that physical schools cannot be moved, considering other factors beside proximity can increase the benefits students receive when they attend school, such as learning in an inclusive, diverse, well-rounded environment, representative of their entire community (Chang, 2018). Therefore, a successful school district typically takes into

consideration a variety of factors when re-drawing school attendance zones. Example factors include contiguity, diversity, and safety in attending schools (such as whether student ‘walkers’ have to cross busy roadways). Other key considerations could be the impact on property values, the perceived educational qualities of various schools, the impact on segregation/desegregation, and physical safety. Table I highlights the various factors that school planning officials often consider and present to the community in organized public discussion meetings.

A neighborhood’s socio-cultural and economic makeup can influence the ability of its constituents to participate in community deliberations. Traditional deliberations are often held on a set date, on a school night, and hosted in crowded facilities like cafeterias. The timing can be difficult for many students’ parents. Even the ones that are able to attend the debates find themselves unable to voice their opinions in rooms full of community members, pushing the physical capacity. All these restrictions do not allow different levels of understanding or learning styles of the participants. The presentations are dense in information about data and geo-spatial, education policy, and computational constraints that may alienate some participants.

Public school officials try to overcome deliberations challenges (Fig. 3, left; Traditional Community Deliberation Model) by (1) promoting an exceptional and comprehensive foundation for the information presented, (2) allowing boundary adjustments to be implemented impartially and consistently for the benefit of the entire community, and (3) promoting boundary adjustments that support efficient school district’s operations. However, the limited communication channels currently available to convey such information compromise the effectiveness of the planning officials. Often, planning departments have 2-3 planners supporting over 100,000+ students in school districts (Statistics, 2017).

The organization of school districts has long been important to how constituents interact and engage with each other as well as participate in local governance (Mann and Fowle, 1839). Well-managed school districts with thriving schools enhance community well-being, enjoy increased academic performance, and contribute to economic growth. Poorly-run districts decrease neighborhood cohesion, depreciate housing prices, promote segregation, and can contribute to population decline in extreme cases. A review of the literature highlights the importance of strong social and cultural connections in public schools supporting successful school districts (Linn and Welner, 2007), with respect to both academic performance and student well-being.

3 Related Work and Background

3.1 School Boundary Planning through a Geospatial Lens

The term “geospatial” refers to geographic space that includes location, distance and the relative position of elements on the Earth’s surface. The perception of

Table I. Factors considered in public school boundary re-assignment.

Factors	Description
Geographic Division	The land divisions must be natural such as rivers, forests, lakes, a.s.o or man-made such as highways, bridges, buildings, a.s.o. Traversing them is often difficult.
Political Jurisdictions	Generally follows the state rules and does not directly reflect on students' achievement.
Development	In boundary re-assignments the future approved land developments are considered.
Contiguous school boundaries	It is considered a very important criteria. Efforts are continuously made to not create "islands" when parcels of land are being re-assigned.
Current/Projected School Capacity	Overcrowded schools are more likely to have larger class sizes to accommodate all students. Smaller class sizes are associated with better outcomes for students.
Cohorts/Split Feeders	There is some evidence to suggest that split feeders may benefit some students by allowing them to establish new social networks. At the same time, for other students, the disruption to their social networks may negatively impact their emotional well-being.
Effective use of new and existing school facilities	A primary consideration of rezoning is to promote an equitable distribution of resources avoiding over- or under-utilization of facilities. A practical guideline often followed is to ensure that schools are operating at 80–120% of their capacities. In achieving this objective, school administrators also aim to minimize the long-term use of mobile or modular classrooms.
Proximity	The school boundaries are usually designed to keep students proximal to their assigned schools. Proximity is typically measured by distance traveled using established modes of transportation (e.g., bus, car). School districts also aim to encourage walking as a primary means of transportation to promote healthier students, to sustain a cleaner environment, and to reduce transportation costs. Proximity criteria also aim to preserve adjacencies of neighborhoods and their contiguity.
Accessibility	Accessibility is related to proximity in that it aims to make reasonable efforts for students in a SAZ to attend taking into consideration natural and man-made barriers (e.g., major roads, geographic features). Accessibility also must take into account students with special needs or other considerations.
Minimizing the student re-assignment	School rezoning often is designed to encourage the link between schools and their underlying living communities by promoting the concept of community schools and avoiding the splitting of communities between schools, whenever possible. Planning officials tend to avoid splitting planning zones for this reason.
Preserving and supporting the demographic distributions	Demographic characteristics of students and communities are considered in school rezoning typically to ensure that schools reflect the demographic makeup of the communities they are intended to serve. Other distributional characteristics involve supporting students who are subscribed to English-as-a-second-language (ESL) programs and free/reduced meal programs. This criterion is extremely controversial, with some citizens strongly in favor of it and others strongly opposed to it. Residential segregation is the most important cause of school segregation, so having schools resemble neighborhoods is not universally considered a desirable objective.
Stability	This criterion aims to create boundaries that promote long-term stability. During school boundary process meetings, past rezonings are often brought up by parents as a reason for not wanting to move to a new school. Hence planning officials avoid moving planning zones that have been reassigned in the recent past, e.g., in the past 3-4 years.
Cluster alignment	The alignment of elementary, middle and high schools into cohesive operational clusters (constituting a unified school feeder system) in which students remain with their educational cohorts to the greatest extent possible is often a key objective. This means that a middle school rezoning must take into consideration not just middle school students, but also their mapping to elementary schools and high schools.
Student's health/safety	The mental health of students may be impacted by boundary adjustments in cases where there are disruptions to students' social connections.
Birth-to-Kindergarten	The ratio helps planning departments to predict growth or decrease in future school population.
Achievement	Maximizing student achievement and availability of needed resources is a focal target.

geography brings a powerful visual dimension to data in the form of maps that facilitate communication and discourse among stakeholders.

When data are associated with geographic coordinates entities, the spatial perspective emerges from mapping the location as well as other environmental aspects. These aspects can play a role in social factors related to the performance of schools and students. To account for all details simultaneously, an integrated framework for gathering, managing, and analyzing data (Hogrebe et al., 2012) could be a viable solution. Further, researchers have suggested the need for geographers' involvement and graphical analysis tools for enhancing education policies (Lubienski and Lee, 2017). The use of Geographical Information System (GIS) affirms the value of traditional geographical frameworks applied to educational policy (Mann and Saultz, 2019).

GIS functionality brings deeper insights into large volumes of data with the ability to identify patterns, relationships, and situations that would otherwise not be available in decision-making. The operation of a school district generates a large amount of feature-rich geospatial data which can be used by school planners and policymakers to study, analyze and propose actions (Yoon and Lubienski, 2018a).

Advances in digital mapping enhance traditional geographical frameworks and have led to the emergence of qualitative, quantitative, and mixed approaches in studying education policy in a geospatial context. Among notable qualitative researchers, Yoon et al. (2018) identified similarities in spatial ethnic and socioeconomic neighborhood homogeneity, yet highly segregated schools in terms of opportunities and achievement. Alternatively, broad quantitative approaches like Richards (2014) give a nationwide perspective of the contiguity of school boundaries in the US and discuss patterns of segregation. This approach enabled a wide range of analysis and argumentation of geospatial perspectives, rooted in the science of geography. Focused quantitative analyses like Hogrebe and Tate (2019) show correlations between levels of segregation and isolation in metropolitan areas, for example, in a St. Louis, Missouri school district, where the authors further connect these with student achievement. A parallel study recommends

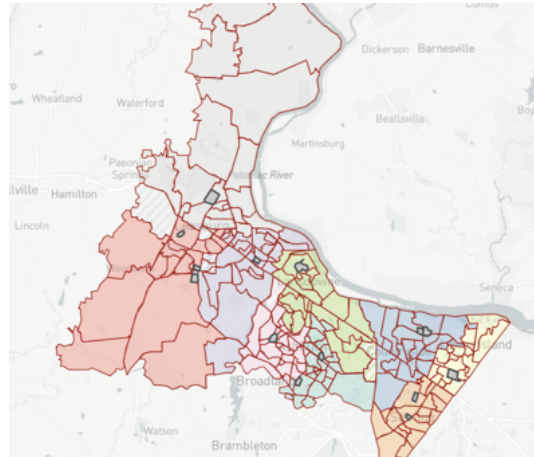


Figure 2. Example of a map using visual cues for proximity, contiguity, compactness, assignment and other data already available in public school systems. Each school's footprint is colored in dark grey. The neighborhoods are delimited by dark red lines. Each area assigned to a school is comprised by several neighborhoods and has a different color. Mid-left, grey-hashed is represented a neighborhood that is in community deliberations for new assignment from one school to another due to overcrowding.

policy and program revision given concrete data on “racial disparities in health, educational, and economic outcomes” (Purnell et al., 2018).

3.2 School Boundary Planning through an Educational Policy Lens

Education policy has a long history of advancing equity for all students and avoiding gerrymandering in the process of neighborhood assignment. Gerrymandering,¹ better known in the redistricting of political representation districts, generally refers to the process of (re)drawing district boundaries to confer an advantage on one group over another, generally on the basis of political affiliation (i.e., partisan gerrymandering), socio-economic status, or unlawfully, on the basis of race or ethnicity (i.e., racial gerrymandering). Applied to the realm of education, gerrymandering may be conceived of as evidence of a process by which educational boundaries are altered to exclude certain students living relatively close to a school in favor of other students living farther away. Gerrymandering of educational boundaries has been blamed for altering students’ access to educational opportunities (Richards and Stroub, 2015), leading to diminished equity and diversity. Educational research literature sometimes highlights particular circumstances of carefully chosen boundaries — with transparent and supportive community deliberations — as means towards more diverse schools in the context of segregated neighborhoods (Richards, 2014; Yoon and Lubienski, 2018b).

In the best interest of the community and school students, a school district’s governing board may consider a range of factors in redrawing the boundaries. We have presented some of the prevalent ones in Table I. It is impractical to optimize all factors simultaneously; a school board typically aims to support a range of easily quantifiable factors to the greatest extent possible.

The mixed methods of GIS applied to educational policy bring to light an array of new possibilities. A case is made for using traditional quantitative analysis as some aspects of human geography can be overlooked. Additionally using heavily qualitative approaches might not be transferable or have a limited holistic perspective. While emerging mixed methods of research are noted (Taylor, 2018), such integrative research is not yet the benchmark and its implementation shows a different level of understanding of the items at hand and subsequent controversy (Yoon and Lubienski, 2018b).

Further on, the rise of critical geographical information systems (CGIS) added methods and practice to the human geography interaction in the revolving controversy of boundary adjustments, promising to constructively engage GIS science with computation sciences (O’Sullivan, 2006) and human sciences (Thatcher et al., 2016). An intersection of all these research disciplines allows for the potential of a broader and deeper understanding of implications in

¹ For visual cues on gerrymandering, refer to <https://www.washingtonpost.com/news/wonk/wp/2015/03/01/this-is-the-best-explanation-of-gerrymandering-you-will-ever-see/>

education policy and its applicability in rezoning school districts, beyond the political pedestal (Vidovich, 2007).

Researchers have advocated the use of mathematical programming and optimization models to aid labor-intensive educational planning and decision-making for a long time (Lachene, 1969; McNamara, 1971; Johnstone, 1974). Despite these recommendations, literature shows only a handful of works delving into the quantitative aspect of the school rezoning problem (Franklin and Koenigsberg, 1973; Schoepfle and Church, 1991; Armstrong et al., 1993; Lemberg and Church, 2000; Bulka et al., 2007; Bruno et al., 2014). The slow adoption of these scientific models by educational administrators and planning specialists was often the result of the unavailability of geospatial data, large-scale geospatial data processing techniques, or a principled way to model the design constraints involved in the process, especially in the context of school rezoning. Very recently, Biswas (2022) has leveraged the idea of semi-supervised learning with geospatial data to develop techniques for user-guided adjustment of school boundaries.

3.3 School Boundary Planning through a Computer Science Lens

Rich geospatial data and the presence of multiple constraints from education policy require mathematical formulations that could be suitable for a crowdsourcing interface available for community decision-making. In this context, computer science could be the ideal medium between the applicability of mathematical formulations and usability to support and enrich the users' experience. Here a "constrained clustering" algorithm (Basu et al., 2008) would enable stakeholders to graphically modify the school boundaries in real-time. Basic distributions can be aided by easy mathematical formulations on compactness, proximity, accessibility to schools to preserve the mapping to neighborhood communities and prevent potentially-unnecessary displacement of students. The cluster alignment criteria would be essential in accounting for demographic data especially when establishing diversity. The projected use of current and future school facilities can dimension the need for current and future physical facilities. The geographic criteria such as proximity, accessibility, minimizing student re-assignment, and cluster alignment can be readily computed using traditional shortest-path algorithms. Indices of cluster overlap can be made available as filters. In education policy, this data is already collected about each school. Leveraging school-owned information provides real-time details about overcrowded or under-crowded areas.

Additionally, contiguity refers to whether the school attendance zone is comprised of one continuous region and compactness pertains to the shape of that region. The literature on compactness is vast (Niemi et al., 1990) and can be used to provide simple ranked measures for understanding how different rezoning plans fare without bogging down users with the mathematical details of how these measures are computed. Figure 2 exemplifies the visual advantage of showing users maps of a school district that communicate more than just the geography of

the land. Here a user could distinguish different attendance areas in different colors. They as well can visually distinguish each neighborhood, represented by a red line. Further data can be made available when the user hovers over the map. This data could include the name of the neighborhood, school, attending students, natural barriers, school capacity, a.s.o. If this attendance zone would be in a process of re-assignment/ should boundary change effort, then information about this change could be made available such as the school a neighborhood is proposed to be assigned from and to.

4 Research Approach

4.1 Limitations of a Single-domain Focus

Education research studies conducted in the aftermath of school redistricting efforts focused on the process' controversy. For instance, a 2016 study by Siegel-Hawley et al. (2017) concluded that while the decision-making process was contentious and opaque, the stakeholders' community response argues for supporting broad-based participation and alignment with democratic objectives. An earlier study by Carey (2011) notes how school planning officials make use of simplistic, spreadsheet-based methodologies — which is still the status quo in many school districts — and uses assumptions for predicting future budgetary, personnel, and facilities planning of schools.

Education policy studies often fail to recognize how geography can be unforgiving. Controversy pointed to gerrymandering overlooking the impact of creating adjacent neighborhoods, with distinctly different race, ethnicity, or socio-economic diversity, especially when situated in dense and often more complex urban settings (Richards, 2014). Neighborhood geography is an important consideration for the ability to obtain diverse community engagement. Time and resource constraints are more prevalent in low-income, diverse neighborhoods, where attending in-person deliberations is difficult. Using only in-person meetings limits social and demographic inclusion. We have noticed traditional research assumed current practices of public school rezoning (National Research Council and Institute of Medicine, 2010; Ingraham, 2021) as an unchallenged constant in deliberations. Most often research in the space is questioning the participants' or planning officials' intentions. No current study challenges the limited channels of communication or questions the lack of updates in the use of technology. From a computer science lens, crowdsourcing assumes the user knowledge as adequate. That is, current crowdsourcing as a voting activity does not typically aim to increase the knowledge of the pooled population towards an optimal group decision. It assumes prior knowledge aiming to inform or pool rather than teaching it.

4.2 Human-Centered Field Work

To understand the state of practice, between 2017 and 2022, our team attended 17 in-person community deliberations available in counties proximal to our university campus, using participant-observation and ethnographic data collection methods. We summarize here our observations and some related design implications:

- Given a choice, a parent would almost always create and vote for plans that move some planning zone other than his/her own, even if the plan overcrowds their child(ren)'s school. This reluctance often showed a lack of understanding and consideration of the fact-driven data presented to them.
- Parents' perspectives regarding rezoning were often subjective, leading them to make decisions based on emotions rather than facts, which resulted in their support for certain plans. Both parents and other stakeholders seemed to ignore some potential consequences of their choices, which included the creation of sub-optimal school attendance zones (SAZs) that could lead to costly future rezoning processes for the school board.
- Throughout the boundary process, there was a surge in stakeholder participation, with many community members asking the same questions at the same time through various mediums such as phone calls, emails, or face-to-face meetings. This caused chaos and added a significant burden on the school officials towards the end of the process.

Design Implication: To avoid such a situation in the future, there is a need for a system that can encourage or even require stakeholders to express their opinions in a timely manner. This would allow the school district more time to consider different options. Another solution could be the implementation of a system that enables the community to calculate and visualize the long-term consequences of different dispositions.

- A significant number of parents could not attend public hearings due to scheduling conflicts, which particularly affected single-parent households, parents working multiple shifts, or those who had children at home requiring special care.

Design Implication: Considering intellectual and developmental disabilities could weigh in for introducing an online interface could significantly improve the ability of families needing additional accommodations to participate in the process, as it would enable them to engage asynchronously. This would also benefit immigrant families whose language proficiency often acts as a barrier in fast face-to-face exchanges.

- The conventional process for proposing alternative plans involves parents filling out forms and submitting them to planning officials for review. In most cases, parents are required to conduct their own background research and long-term planning to effectively articulate their proposal. The process is highly procedural and primarily paper-based, lacking dedicated technology to facilitate such a complex task. This results in a slow turnaround time, creating additional work for already resource-strapped

facilities and the planning office.

Design Implication: To address these issues, a community crowd-sourcing enabling platform could be implemented. This platform would not only raise awareness of how proposed changes affect the spatial configuration of SAZs, but also provide insight into other quantitative and qualitative criteria.

5 Emergent Field: Computer Science + Geography + Education Policy

5.1 Trusting the People, Challenging the Framework

In light of the prevalent controversy found in both the literature review and fieldwork, we decided to take a different approach and assume that both the community and planners had legitimate concerns. We also hypothesized that, with the use of appropriate technology, participants would be able to better understand and articulate their points, leading to fewer redundant questions for planners. We propose that an emerging field could draw from the best practices of three domains and complement each other, potentially creating an opportunity for cohesive community deliberations.

5.2 Leveraging Visual Analytic Support to Understand Algorithmic Clustering

Sense-making of large datasets remains time-consuming and onerous for manual analysis, and is increasingly entrusted to machine learning techniques for finding, clustering, and summarizing data (Hossain et al., 2012). Verbal or written explanations of these mathematical formulations could be overwhelming. However, visual analytics can overcome some of these drawbacks by leveraging the complementary strengths of human cognition and computation. Human sensemaking abilities remain essential (Crouser and Chang, 2012) and can add value to dynamically generated “context slices” that give participants just enough information to complete a task and move an analysis forward. We adapt this approach from paid crowd-sourcing markets to the context of school district planning, recognizing that like crowd workers, busy parents and other stakeholders often have limited attention and time in which to make a meaningful contribution. These “micro-activities” showed utility in urban design challenges, but have not yet been adapted for the context of school rezoning. (Mahyar et al., 2018), and could further be expanded to complex spatial data. Here a “context slice” involved in the “micro activity” could be defined as a plan that needs improvement.

Sub-tasks and context slices could be indexed in the system so that participants can naturally search for sub-tasks and solve them accordingly. Interaction data gathered in this process can be compared across participants, neighborhood assignments, and seek to identify patterns in the interactions (Rzeszotarski and

Kittur, 2012). These results, in turn, can be compared against theories and findings from prior work, e.g. components of the sense-making loop (Pirolli and Card, 2005) and collaborative visual analytics (Heer and Agrawala, 2008). Participant suggestions regarding techniques to augment their sense-making efforts could be considered alongside the performance-related findings and existing technologies to straighten future design considerations.

5.3 Reducing the Learning Curve in Geographically-enabled Crowdsourced Deliberations

While crowdsourcing practices provide an opportunity to qualitatively discern between quantitative outputs, it often relies on consistency in participants' knowledge. Crowdsourcing was successfully utilized in basic tasks such as image labeling, categorizing, and transcribing. More recently, researchers have designed complex workflows and leveraged AI support to enable crowdsourcing of complex sensemaking tasks. Some examples include (i) creating a taxonomy of many diverse items (Chilton et al., 2013), (ii) performing a bottom-up analysis of a large corpus of qualitative data (André et al., 2014), and (iii) making decisions about placing a street intersection (Mahyar et al., 2018).

Crowdsourcing progress could be seen in experimentation that allows all users to learn and complete the crowdsourced objective simultaneously. While this idea can be easily applied to a variety of domains, in the current context it can be achieved in the process of composing different scenarios and relies on the user's persistent efforts to optimize a plan. The trial-and-error experimentation would result in iterative learning (Callander, 2011; Sosna et al., 2010), and the results of the efforts would add to the submitted plans or opinions on previously submitted plans. Adapting techniques used for other genres of complex planning tasks (e.g., vacation itineraries (Zhang et al., 2012), conference session organizing (Kim et al., 2013)) to the complex GIS data (Armstrong et al., 1993) can aid depth to the current practice, and constitutes a distinct momentum for advancing crowdsourced decision-making.

5.4 Diversity and Privacy-Preserving Identifiers

In the education policy domain, demographic and socio-economic identifiers are very important to account for, but often difficult for planning officials to maintain during traditional debates due to the possibility to reveal too much identifiable data. However, these issues can be addressed in a platformized boundary deliberation by using inclusion filters with user-submitted plans. For example: (i) a user's info could be suppressed when a plan is displayed or when online discussions are carried out about a plan, (ii) users could be directed to explore alternatives when submitted plans overlap, and (iii) users could be encouraged to review alternative plans aiming to optimize diversity when a change in boundaries is discussed.

Privacy preservation can be achieved through clustering based on predetermined criterion constraints. The criteria would not even need to be manually implemented as many indices already exist, e.g., Simpson's index (White, 1986) and Theil's entropy index (Theil and Finizza, 1971). Simpson's index may be interpreted as the probability that two students in a given school belong to different racial/ethnic categories. Theil's index captures racial/ethnic segregation of a school district and is increasingly popular in the literature over various measures Iceland and Weinberg (2002) owing to its flexibility as a measure of multi-group or dual-group segregation and its ability to distinguish segregation from racial/ethnic composition. While exposure and isolation are often dependent on the demographic composition of neighborhoods, segregation in schools usually correlates with racial/ethnic composition. Raw measures like exposure and isolation can be misleading when used in without such context, but can yield valuable information when considered in conjunction with Simpson's and Theil's indices.

5.5 Explainable Public School Rezoning Design

The experimental learning features of the proposed platform can reveal a true/false value (Doan et al., 2003) to reason and develop mechanisms to identify succinct descriptions. Algorithms for redescription mining may be especially apt here (Zaki and Ramakrishnan, 2005; Parida and Ramakrishnan, 2005; Ramakrishnan et al., 2004). For instance, these algorithms are capable of providing system-generated explanations, such as, '*Plan B is the same as plan A except it optimizes for cluster alignment by re-organizing two planning zones.*' To promote transparency and enable stakeholders' understanding of the short and long-term outcomes of their choices, a proposed boundary plan should be accompanied by narrative summaries and their impact on present and future school capacity. The ability to try various scenarios could enable users to both understand the constraints and become cognizant of the consequences. This would be a key capability to help direct debate support from feelings to facts.

5.6 Clustering with Constraints

The first law of geography, Tobler's Law, is, "Everything is related to everything else, but near things are more related than distant things." Tobler's Law can be translated to computer science algorithms as a set of objects in such a way that objects in the same group are more similar to each other than to those in other groups (Jain et al., 1999). In this way, we can form clusters of similarity. Computational sciences are good at using clustering algorithms to obtain solutions that satisfy all constraints. Moreover, research has demonstrated the potential of clustering algorithms to perform well on geospatial polygons for rezoning problems (Joshi et al., 2011; Miranda et al., 2017). These methods, known as constrained clustering algorithms (Basu et al., 2008; Dinler and Tural, 2016), have the potential to support the user-guided adjustment of school boundaries for:

- *size constraints* specifying the capacity of schools (Zhu et al., 2010),
- *contiguity constraints* ensuring geographically continuous school boundaries (Drexler and Haase, 1999), and
- *pairwise constraints* supplied as *must-link/cannot-link* constraints for deciding whether to keep two geospatial units together/separate in a cluster.

However, school rezoning is a multi-faceted problem with diverse stakeholders and multiple objectives. Our research suggests to avoid enforcing a composite objective function that optimizes all criteria, but rather to make explicit considerations so the community can achieve a shared understanding of the future directions and common objectives. This is because algorithmic techniques described above will only be effective if we can flexibly leverage human experience and judgment to propose rezoning alternatives.

6 New Opportunities and Future Work

Initially, our research focused on advancing algorithm development for school redistricting (Biswas et al., 2019, 2020b, 2022, 2023) and piloting an integrated interface called Redistrict (Sistrunk et al., 2022) to demonstrate proof-of-concept feasibility. As our work progressed, we recognized the potential of integrating spatial analytic approaches with classical CSCW methods. This intersection holds great promise, particularly when viewed as an emerging domain that encompasses the following:

- Computer Science: algorithmic computation and the best practices of HCI and usability;
- Geography: spatial data and visual proximity, and;
- Education Policy: constraints and considerations as previously presented.

We suggest conducting further testing of these concepts on the suggested platform and algorithms to explore how they can extend the dynamics of community cooperative work across various disciplines.

As applied to the problem of public school rezoning, this intersection of disciplines can help us move from the traditional literature focusing on controversy (Carey, 2011), to listening to the community. We propose that current distrust in public school deliberations Boughanem (2021) are a manifestation of a lack of support, under-utilization of technology, and non-standardization of objectives. In order to support stakeholder input and ensure factual feedback at all levels, it is crucial to develop technologically viable, holistic solutions.

For instance, Figure 3 offers a side-by-side comparison between the traditional community deliberation model -that uses face-to-face, phone, and e-mail communications and a proposed inclusion of more technology into community deliberations by additional means of communication - computers and mobile phone with connectivity to a user interface. The figure expands the Time/Space matrix traditionally used in CSCW (Johansen, 1988) to include centralized and decentralized active discussions. The use of a visually-rich, interactive platform

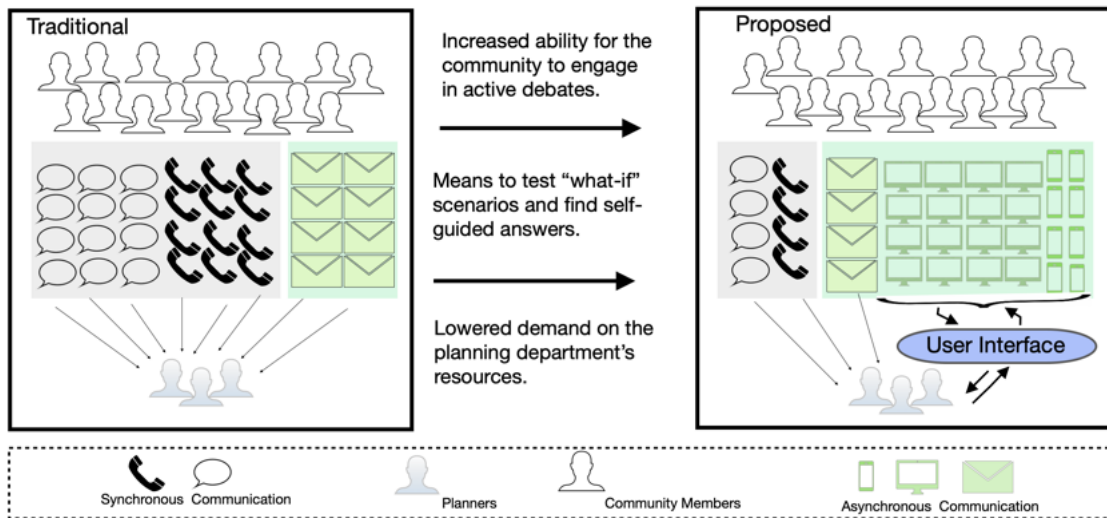


Figure 3. Traditional vs Proposed interactions during public school boundary deliberations. Synchronous and asynchronous crowd engagement through various mediums of communication.

exemplifies how community debates can sustain stronger individual discussions by expanding the means of exchanging information and allowing for both face-to-face and asynchronous collaboration. These tools also enable users to compute what-if scenarios and learn about the consequences of different decisions.

When conflicts arise, various approaches can be taken to address the problems Kriplean et al. (2012). For instance, the interface design can adopt a preventative approach by flagging obvious inequities. In this context, participating users will be motivated to address the deficiencies before the plan is made available to the broader community or before they submit it. Supporting explainability, as mentioned earlier, can aid in this objective, as these plans are likely to require similar explanations or justifications. This approach also promotes cohesiveness in individual discussions and reduces the number of simultaneous, identical questions from the community.

When it comes to rezoning processes, community deliberation is crucial, given the diverse array of stakeholders involved. While hands-on workshops with collaboration tools have proven effective in supporting informed public engagement in other municipal planning projects (Girling et al., 2017), such an approach has not yet been applied to the unique challenges presented by school rezoning.

We propose that selecting and working around a common platform can serve public deliberation fruitfully. This platform would serve as a hub for community discussion, allowing stakeholders to share their ideas and perspectives in a transparent, collaborative environment. Such a platform would enhance public participation in the rezoning process and ensure that all stakeholders have access to the same information, enabling informed decision-making. Moreover, platformization would foster a sense of ownership and accountability among stakeholders, as it would enable them to visualize the impact of their requests on

the broader community. By promoting transparency and accountability, this approach would create a sense of trust between the community and planning officials, resulting in more constructive and effective deliberations.

7 Conclusion

The particular needs of diverse communities can reverberate through their ability to understand and participate in communal work, such as the process of deciding school zone boundary assignments. We argue that recent scholarship from a convergence of disciplines – computer science, geography, and education policy – is ready to bridge the knowledge gap. Specifically, we envision a socio-technical system that uses visual scaffolding in the presentation of complex geospatial data and provides indiscriminating access with asynchronous participation ability aided by the prevalence of phones, laptops, and broadband access to the Internet.

While the availability of technology and connectivity could have been the perfect add-on support for traditional boundary deliberations prior to the Covid-19 pandemic era, it becomes even more relevant given new social norms for public safety / physical distancing and a broader understanding of remote collaboration. Generalized virtual deliberations would not only support current norms for public health and safety, they would also increase accessibility by allowing more time and flexibility to parents to review and participate in the process. Online public school deliberation efforts would be more conducive to family life as well as allow additional input from a segment of the population traditionally underrepresented, due to constraints caused by family needs, employment, and other restrictive situations.

The uneasiness of the public school boundaries change process can be the start of a learning process for all members of the community, supporting communal crowdsourced deliberations, and in turn engage a more cohesive, broad, and informed decision-making process. These advancements are facilitated by mathematical models and algorithmic methods, but their optimization for use in the community has been historically proven to be conducive to human decisions and is best supported by cooperative work. Therefore we propose the intersection of a multi-domain CSCW emerging field and see possible expansion of other similar convergences as worthy areas of exploration.

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References

- André, P., A. Kittur, and S. P. Dow (2014): ‘Crowd Synthesis: Extracting Categories and Clusters from Complex Data’. In: *Proceedings of CSCW 2014*.
- Armstrong, M. P., P. Lolonis, and R. Honey (1993): ‘A spatial decision support system for school redistricting’. *URISA journal*, vol. 5, no. 1, pp. 40–52.
- Basu, S., I. Davidson, and K. Wagstaff (2008): *Constrained clustering: Advances in algorithms, theory, and applications*. CRC Press.
- Biswas, S. (2022): ‘Spatial Optimization Techniques for School Redistricting’. Ph.D. thesis, Virginia Tech.
- Biswas, S., F. Chen, Z. Chen, C.-T. Lu, and N. Ramakrishnan (2020a): ‘Incorporating Domain Knowledge into Memetic Algorithms for Solving Spatial Optimization Problems’. In: *Proceedings of the 28th International Conference on Advances in Geographic Information Systems*. New York, NY, USA, p. 25–35, Association for Computing Machinery.
- Biswas, S., F. Chen, Z. Chen, C.-T. Lu, and N. Ramakrishnan (2022): ‘Sampling-based techniques for designing school boundaries’.
- Biswas, S., F. Chen, Z. Chen, C.-T. Lu, and N. Ramakrishnan (2023): ‘Memetic Algorithms for Spatial Partitioning Problems’. *ACM Trans. Spatial Algorithms Syst.*, vol. 9, no. 1.
- Biswas, S., F. Chen, Z. Chen, A. Sistrunk, N. Self, C.-T. Lu, and N. Ramakrishnan (2019): ‘REGAL: A Regionalization framework for school boundaries’. In: *Proceedings of the 27th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems*. pp. 544–547.
- Biswas, S., F. Chen, A. Sistrunk, S. Muthiah, Z. Chen, N. Self, C.-T. Lu, and N. Ramakrishnan (2020b): ‘Geospatial Clustering for Balanced and Proximal Schools’. *Proceedings of the AAAI Conference on Artificial Intelligence*, vol. 34, no. 09, pp. 13358–13365.
- Boughanem, H. (2021): ‘Boundaries’. *FCPS*.
- Bruno, G., A. Genovese, C. Piccolo, and C. Sterle (2014): ‘A location model for the reorganization of a school system: the Italian case study’. *Procedia-Social and Behavioral Sciences*, vol. 108, pp. 96–105.
- Buchanan, R. (1992): ‘Wicked problems in design thinking’. *Design issues*, vol. 8, no. 2, pp. 5–21.
- Bulka, B., R. Carr, E. Jordan, P. Rheingans, et al. (2007): ‘Heuristic search and information visualization methods for school redistricting’. *AI Magazine*, vol. 28, no. 3, pp. 59–59.
- Callander, S. (2011): ‘Searching and learning by trial and error’. *American Economic Review*, vol. 101, no. 6, pp. 2277–2308.
- Carey, K. D. (2011): *School district master planning: A practical guide to demographics and facilities planning*. R&L Education.

- Chang, A. (2018): ‘We can draw school zones to make classrooms less segregated. This is how well your district does.’. *VOX*.
- Chilton, L. B., G. Little, D. Edge, D. S. Weld, and J. A. Landay (2013): ‘Cascade: crowdsourcing taxonomy creation’. In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. New York, NY, USA, pp. 1999–2008, ACM.
- Crouser, R. J. and R. Chang (2012): ‘An Affordance-Based Framework for Human Computation and Human-Computer Collaboration’. *IEEE Transactions on Visualization and Computer Graphics*, vol. 18, no. 12, pp. 2859–2868.
- Deming, D. J. (2011): ‘Better schools, less crime?’. *The Quarterly Journal of Economics*, vol. 126, no. 4, pp. 2063–2115.
- Dinler, D. and M. K. Tural (2016): ‘A survey of constrained clustering’. In: *Unsupervised learning algorithms*. Springer, pp. 207–235.
- Doan, A., P. Domingos, and A. Halevy (2003): ‘Learning to match the schemas of data sources: A multistrategy approach’. *Machine Learning*, vol. 50, no. 3, pp. 279–301.
- Drexler, A. and K. Haase (1999): ‘Fast approximation methods for sales force deployment’. *Management Science*, vol. 45, no. 10, pp. 1307–1323.
- Franklin, A. D. and E. Koenigsberg (1973): ‘Computed school assignments in a large district’. *Operations Research*, vol. 21, no. 2, pp. 413–426.
- Girling, C., R. W. Kellett, K. S. Booth, N. Mahyar, K. J. Burke, and A. Krahn (2017): ‘Collaboration Tools to Support Informed Public Engagement’. In: *Landscape Research Record*, Vol. 6. pp. 264–278.
- Heer, J. and M. Agrawala (2008): ‘Design considerations for collaborative visual analytics’. *Information Visualization*, vol. 7, pp. 49–62.
- Hogrebe, M. C. and W. F. Tate (2019): ‘Residential segregation across metro St. Louis school districts: Examining the intersection of two spatial dimensions’. *AERA Open*, vol. 5, no. 1, pp. 2332858419837241.
- Hogrebe, M. C., W. F. Tate, and J. E. Morris (2012): ‘Geospatial Perspective: Toward a Visual Political Literacy Project in Education, Health, and Human Services’. *Review of Research in Education*, vol. 36, pp. 67–94.
- Hossain, M. S., P. K. R. Ojili, C. Grimm, R. Müller, L. T. Watson, and N. Ramakrishnan (2012): ‘Scatter/gather clustering: Flexibly incorporating user feedback to steer clustering results’. *IEEE Transactions on Visualization and Computer Graphics*, vol. 18, no. 12, pp. 2829–2838.
- Iceland, J. and D. H. Weinberg (2002): *Racial and ethnic residential segregation in the United States 1980-2000*. Bureau of Census.
- Ingraham, C. (2021): ‘This is the best explanation of gerrymandering you will ever see’.
- Jain, A. K., M. N. Murty, and P. J. Flynn (1999): ‘Data clustering: a review’. *ACM computing surveys (CSUR)*, vol. 31, no. 3, pp. 264–323.
- Johansen, R. (1988): *Groupware: Computer support for business teams*. The Free Press.
- Johnstone, J. N. (1974): ‘Mathematical models developed for use in educational planning: A review’. *Review of educational research*, vol. 44, no. 2, pp. 177–201.

- Joshi, D., L.-K. Soh, and A. Samal (2011): 'Redistricting using constrained polygonal clustering'. *IEEE Transactions on Knowledge and Data Engineering*, vol. 24, no. 11, pp. 2065–2079.
- Kim, J., H. Zhang, P. André, L. B. Chilton, W. Mackay, M. Beaudouin-Lafon, R. C. Miller, and S. P. Dow (2013): 'Cobi: A Community-Informed Conference Scheduling Tool'. In: *Proceedings of UIST 2013*.
- Kriplean, T., J. Morgan, D. Freelon, A. Borning, and L. Bennett (2012): 'Supporting reflective public thought with considerit'. In: *Proceedings of the ACM 2012 conference on Computer Supported Cooperative Work*. pp. 265–274.
- Lachene, R. (1969): 'The Application of Operations Research to Educational Planning in Organization for Economic Cooperation and Development'. *Efficiency in Resource Utilization Education, Paris: OECD*.
- Lemberg, D. S. and R. L. Church (2000): 'The school boundary stability problem over time'. *Socio-Economic Planning Sciences*, vol. 34, no. 3, pp. 159–176.
- Linn, R. L. and K. G. Welner (2007): 'Race-conscious policies for assigning students to schools: Social science research and the Supreme Court cases'.
- Lubienski, C. and J. Lee (2017): 'Geo-spatial analyses in education research: the critical challenge and methodological possibilities'. *Geographical Research*, vol. 55, no. 1, pp. 89–99.
- Mahyar, N., M. R. James, M. M. Ng, R. A. Wu, and S. P. Dow (2018): 'CommunityCrit: Inviting the Public to Improve and Evaluate Urban Design Ideas through Micro-Activities'. In: *ACM Human Factors in Computing Systems (CHI 2018)*. Montréal, Québec, Canada.
- Mann, B. and A. Saultz (2019): 'The Role of Place, Geography, and Geographic Information Systems in Educational Research'. *AERA Open*, vol. 5, no. 3, pp. 1–5.
- Mann, H. and W. B. Fowle (1839): *Common school journal*, Vol. 1. Marsh, Capen, Lyon, and Webb.
- Mayer, S. E. and P. E. Peterson (eds.) (1999): *Earning and Learning: How Schools Matter*. Brookings Institution Washington, DC.
- McNamara, J. F. (1971): 'Mathematical programming models in educational planning'. *Review of Educational Research*, vol. 41, no. 5, pp. 419–446.
- Miranda, L., J. Viterbo Filho, and F. C. Bernardini (2017): 'Regk-means: A clustering algorithm using spatial contiguity constraints for regionalization problems'. In: *2017 Brazilian Conference on Intelligent Systems (BRACIS)*. pp. 31–36.
- National Research Council and Institute of Medicine (2010): *Student Mobility: Exploring the Impacts of Frequent Moves on Achievement: Summary of a Workshop*. Washington, DC: The National Academies Press.
- NCES (2019): *The Condition of Education*. <https://nces.ed.gov/pubs2019/2019144.pdf>: (accessed May 27, 2020).
- Niemi, R. G., B. Grofman, C. Carlucci, and T. Hofeller (1990): 'Measuring compactness and the role of a compactness standard in a test for partisan and racial gerrymandering'. *The Journal of Politics*, vol. 52, no. 4, pp. 1155–1181.
- O'Sullivan, D. (2006): 'Geographical information science: critical GIS'. *Progress in Human Geography*, vol. 30, no. 6, pp. 783–791.

- Parida, L. and N. Ramakrishnan (2005): 'Redescription mining: Structure theory and algorithms'. In: *AAAI*, Vol. 5. pp. 837–844.
- Pirolli, P. and S. Card (2005): 'The sensemaking process and leverage points for analyst technology as identified through cognitive task analysis'. In: *Proceedings of International Conference on Intelligence Analysis*, Vol. 2005. pp. 2–4.
- Purnell, J. Q., M. Goodman, W. F. Tate, K. M. Harris, D. L. Hudson, B. D. Jones, R. Fields, G. Camberos, K. Elder, B. Drake, et al. (2018): 'For the sake of all: civic education on the social determinants of health and health disparities in St. Louis'. *Urban Education*, vol. 53, no. 6, pp. 711–743.
- Ramakrishnan, N., D. Kumar, B. Mishra, M. Potts, and R. F. Helm (2004): 'Turning CART wheels: an alternating algorithm for mining redescriptions'. In: *Proceedings of the tenth ACM SIGKDD international conference on Knowledge discovery and data mining*. pp. 266–275.
- Richards, M. P. (2014): 'The gerrymandering of school attendance zones and the segregation of public schools: A geospatial analysis'. *American Educational Research Journal*, vol. 51, no. 6, pp. 1119–1157.
- Richards, M. P. and K. J. Stroub (2015): 'An accident of geography? Assessing the gerrymandering of school attendance zones'. *Teachers College Record*, vol. 117, no. 7.
- Richards, M. P., K. J. Stroub, J. V. Heilig, and M. R. Volonnino (2012): 'Achieving diversity in the Parents Involved era: Evidence for geographic integration plans in metropolitan school districts'. *Berkeley J. Afr.-Am. L. & Pol'y*, vol. 14, pp. 67.
- Rittel, H. and M. Webber (1973): 'Dilemmas in a general theory of planning policy science'.
- Roser, M. (2021): 'Access to basic education: Almost 60 million children of primary school age are not in school'.
- Rzeszotarski, J. and A. Kittur (2012): 'CrowdScape: interactively visualizing user behavior and output'. In: *Proceedings of the 25th annual ACM symposium on User interface software and technology*. pp. 55–62.
- Schoepfle, O. B. and R. L. Church (1991): 'A new network representation of a "classic" school districting problem'. *Socio-Economic Planning Sciences*, vol. 25, no. 3, pp. 189–197.
- Siegel-Hawley, G., K. Bridges, and T. J. Shields (2017): 'Solidifying segregation or promoting diversity? School closure and rezoning in an urban district'. *Educational Administration Quarterly*, vol. 53, no. 1, pp. 107–141.
- Sistrunk, A., S. Biswas, N. Self, K. Luther, and N. Ramakrishnan (2022): 'Redistricting Practices in Public Schools: Social Progress or Necessity?'. In: *Proceedings of 20th European Conference on Computer-Supported Cooperative Work*.
- Sosna, M., R. N. Trevinyo-Rodríguez, and S. R. Velamuri (2010): 'Business model innovation through trial-and-error learning: The Naturhouse case'. *Long range planning*, vol. 43, no. 2-3, pp. 383–407.
- Statistics, N. C. E. (2017): 'Enrollment, poverty, and federal funds'. *Digest of Education Statistics*.
- Taylor, C. (2018): *Geography of the 'new' education market: Secondary school choice in England and Wales*. Routledge.

- Thatcher, J., L. Bergmann, B. Ricker, R. Rose-Redwood, D. O'Sullivan, T. J. Barnes, L. R. Barnesmoore, L. Beltz Imaoka, R. Burns, J. Cinnamon, et al. (2016): 'Revisiting critical GIS'. *Environment and Planning A*, vol. 48, no. 5, pp. 815–824.
- Theil, H. and A. J. Finizza (1971): 'A note on the measurement of racial integration of schools by means of informational concepts'. *The Journal of Mathematical Sociology*, vol. 1, no. 2, pp. 187–193.
- UNICEF (2022): 'Multiple Indicator Cluster Surveys'. *Demographic and Health Survey*, 2021.
- Vidovich, L. (2007): 'Removing policy from its pedestal: Some theoretical framings and practical possibilities'. *Educational Review*, vol. 59, no. 3, pp. 285–298.
- White, M. J. (1986): 'Segregation and Diversity Measures in Population Distribution'. *Population Index*, vol. 52, no. 2, pp. 198–221.
- Yoon, E.-S., K. Gulson, and C. Lubienski (2018): 'A brief history of the geography of education policy: Ongoing conversations and generative tensions'. *AERA Open*, vol. 4, no. 4, pp. 2332858418820940.
- Yoon, E.-S. and C. Lubienski (2018a): 'Thinking critically in space: toward a mixed-methods geospatial approach to education policy analysis'. *Educational Researcher*, vol. 47, no. 1, pp. 53–61.
- Yoon, E.-S. and C. Lubienski (2018b): 'Thinking critically in space: Toward a mixed-methods geospatial approach to education policy analysis'. *Educational Researcher*, vol. 47, no. 1, pp. 53–61.
- Zaki, M. J. and N. Ramakrishnan (2005): 'Reasoning about sets using redescription mining'. In: *Proceedings of the eleventh ACM SIGKDD international conference on Knowledge discovery in data mining*. pp. 364–373.
- Zhang, H., E. Law, R. Miller, K. Gajos, D. Parkes, and E. Horvitz (2012): 'Human computation tasks with global constraints'. In: *Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems*. New York, NY, USA, pp. 217–226, ACM.
- Zhu, S., D. Wang, and T. Li (2010): 'Data clustering with size constraints'. *Knowledge-Based Systems*, vol. 23, no. 8, pp. 883–889.

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Generativity Practices in EHR Implementation: A Case Study of the Transition from Design to Usage

Nora O. Ringdal and Babak A. Farshchian
Norwegian University of Science and Technology (NTNU), Trondheim, Norway
nora.o.ringdal@ntnu.no; babak.farshchian@ntnu.no

Abstract. This paper explores the concept of socio-technical generativity within the context of a large-scale platformization project in the healthcare sector. Despite generativity being a central topic in the development and evolution of digital platforms, there are few empirical studies on its implications for the practices involved in platformization. This study investigates how the process of generativity changes during the transition from design to use. Our preliminary findings reveal that it is a continuous process that is not limited to the platform's existing affordances and that the controlled top-down practice in design is replaced by parallel ad hoc practices during use. We discuss how shadow systems can be viewed as a breakdown in the generativity process as well as challenges arising from scaling and interconnections. Finally, we emphasize the critical role of management in facilitating generative processes.

Introduction

It is a marathon, and we may have run only 2 of the 42 kilometers.

The quotation above is from an interview we had with one of the leaders in a large-scale digitalization project in municipal healthcare. The two kilometers that the interviewee refers to is the effort spent on the initial customization of the purchased software package –involving more than 400 domain experts – while the remaining 40 kilometers refer to the work that is left to do after the implementation project is over and the software package is put to use. This project, like many modern digitalization projects, combined the acquisition of standardized, packaged, half-built software on the one hand, with the customization of this software to the local needs of the buyer on the other (Pollock et al., 2007).

The preliminary findings from our case study presented in this paper show how the initial customization project – despite its large size, duration, and cost – did not manage to deliver a product that could be used by all the employees in the municipality. As a unit leader in the municipality – whose unit had to use the final software – told us: “The vendor always showed us what was possible to do with the product and not what it could actually do for us right now” and that “what we received at the end was not what we asked for.” Paradoxically, another unit leader told us that the customization project had resulted in increased innovation and efficiency in his unit and that his unit continued to innovate on top of the delivered product also after the project was over.

The software product in discussion is an electronic health record (EHR) system aimed at providing a unified health record – and associated workflow support – across primary and secondary healthcare in the central region of Norway. The product is one of the leading EHR systems in the world (Foundation Systems developed by Epic). The platformization project has been ongoing for several years and has recently transitioned from a three-year design phase to daily use (through a so-called go-live event). Studies of EHR implementation in primary (Rahal et al., 2021) and secondary care (Priestman et al., 2018) point to multiple socio-technical challenges related to staff training, the difficulty of changing routines and practices, user involvement, limited resources, etc.

Most EHR systems utilize the so-called platform model where the software is divided into a core and a periphery (Rodon Modol and Eaton, 2021). A digital platform is generally defined as a “software-based product or service that serves as a foundation on which outside parties can build complementary products or services” (Tiwana, 2014, p. 5). The foundation is the core, while the complementary products and services – often developed by the organizations that will use the final product – constitute the periphery. We also define platformization as the “organizational, social, financial and technological transformation that an organization often must go through to effectively utilize a platform model” (Farshchian et al., 2021, p. 2). Due to their broad areas of impact, digital platforms lead to not only a customized product but also to organizational change that, in turn, requires reconfiguration of

the technological base (Leonardi, 2009). Platformization is therefore not a linear process with design following use.

To better understand the process of platformization, in this paper, we use the lens of generativity to interpret our initial findings from a set of observations and interviews. Generativity is defined as “technology’s overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences” (Zittrain, 2006, p. 1980). Generativity has recently become a central topic in the development and evolution of platforms (Grisot and Vassilakopoulou, 2013; Msiska and Nielsen, 2018), where it is often regarded as a form of innovation (da Rocha and Pollock, 2019). Generativity is a suitable lens to study platformization processes because these processes often must generate new affordances on top of already established platform cores. Importantly for practice-oriented studies, generativity is increasingly considered a complex socio-technical practice (Grisot and Vassilakopoulou, 2013; Msiska and Nielsen, 2018).

In this paper, we want to explore the concept of socio-technical generativity and its implications for the practices involved in platformization. Our exploration is based on the above-mentioned study of a platformization project in the domain of healthcare. The preliminary data analysis demonstrates several properties of socio-technical generativity.

First, while most research on generativity assumes that generativity is restricted to the affordances provided by the core platform, our data shows that users not only build on these platform affordances but they also introduce new ones that are not based on platform affordances but can be used to extend the core platform. Second, our data show how generativity practices change in the transition from design to use, going from a controlled top-down practice to several parallel and apparently ad hoc practices. Our data also demonstrate challenges related to the scale and the interconnection between generativity practices and their consequences for management. In this way, our paper adds to the body of literature about socio-technical generativity through a case study in progress.

In the rest of the paper, we present relevant literature from digital platforms and generativity, before we present our preliminary findings from our case study and conclude with a discussion and our plans for future research.

Background

This study is based on the literature on digital platforms and digital affordances provided through boundary resources (Tiwana, 2014; Hein et al., 2019). Affordances can be actualized by using the generativity of the platform (Zittrain, 2006; Msiska and Nielsen, 2018).

Affordances in generic digital platforms

Digital platforms are complex socio-technical systems (Lyytinen et al., 2017). The platform architecture consists of a platform core and a periphery (Tiwana, 2014). The platform core is shared across the users of the platform and is often difficult to change (Rodon Modol and Eaton, 2021). The periphery consists of functionality that is developed by the so-called complementors who develop additional components and services on top of the core. The periphery is connected to the core through boundary resources (Ghazawneh and Henfridsson, 2013) such as application programming interfaces (APIs). These are the “generative” parts of the platform ecosystem (Thomas and Tee, 2022) that increase the platform’s digital affordances (Hein et al., 2019). Markus and Silver (2008, p. 622) define IT-related affordances as “the possibilities for goal-oriented action afforded to specified user groups by technical objects”.

Digital platforms are examples of generic software systems. Such systems are “brought into being through an intricately managed process, involving the broader extension of a particularized software application and, at the same time, the management of the user community attached to that solution” (Pollock et al., 2007, p. 1). The organization that will use the platform needs to take advantage of the generativity of the platform to create its own value-adding complements by actualizing the platform’s affordances (Hein et al., 2019). According to Ellingsen and Hertzum (2019, p. 2), this is a challenge because “while configuration makes some functionalities easy to set up, it also restricts the space of possible functionalities to those envisioned by the designers of the configuration facility”.

Electronic health record (EHR) systems have been adopting the above core-periphery division to make their solutions more flexible so that users and the vendor can add modules on top of the core functionality (Monteiro et al., 2013). This process involves actors such as system implementors and users working together to configure it for their specific needs. Due to their broad areas of impact, digital platforms lead to organizational change that, in turn, requires reconfiguration of the technological base (Leonardi, 2009). Platformization is therefore not a linear process with design following use.

Generativity

The noun “generativity” is derived from the verb “generate” and denotes the ability to produce or create something (Thomas and Tee, 2022). Generativity was originally a quality attributed by Zittrain (2006) to the internet but has since been applied to discuss deliberate generative platforms like Google, Apple, and Facebook and their ecosystems of complementors (da Rocha and Pollock, 2019).

Zittrain (2006) presents four important criteria for generative technology:

1. Capacity for leverage: The more effort the technology saves, the more generative it is. Technology with good leverage makes difficult jobs easier.

2. **Adaptability:** Relates to flexibility both in terms of using the technology as it is but also whether it allows changes to be made by its users.
3. **Ease of mastery:** Refers to how easy it is for the users to understand a technology as well as the effort required to adapt it.
4. **Accessibility:** How easy it is to use and control the technology, which can be influenced by financial, legal, and secrecy barriers.

Other characteristics that facilitate generativity are modularity, openness, standardization, and incompleteness (Pauli, 2021). Generativity directly relates to a technology's affordances. For a platform, the actualization of affordances through boundary resources leads to generativity (Hein et al., 2019).

Generativity is a socio-technical phenomenon. According to Grisot and Vassilakopoulou (2013), generativity is a key aspect of information infrastructures, and the negotiations between standardized – core – and generative – peripheral – features is a socio-technical process. Similarly, Ansell and Torfing (2021) argue that generativity arises from collaborative interaction between stakeholders to solve problems. They also argue that generativity requires governance “that facilitates and enables the emergence of productive interaction among distributed actors” and define platforms as generative institutions that may support co-creation. Thomas and Tee (2022) conducted a systematic literature review and developed a conceptual framework based on different theoretical perspectives on generativity. They argue that generativity is a "sociotechnical system where social and technical elements interact to facilitate combinatorial innovation, and where generative fit and governance play a central role” (Thomas and Tee, 2022, p. 256).

Despite the socio-technical aspects of generativity, only a few practice-related studies have been conducted to empirically investigate generativity in platforms (Msiska and Nielsen, 2018; da Rocha and Pollock, 2019; Vestues and Knut, 2019). In the following, we will provide a short overview of the findings from these studies.

Msiska and Nielsen (2018) developed the concept of socio-technical generativity in the context of an open-source healthcare platform used in developing countries. They argue that socio-technical generativity consists of two dimensions: social relationships and technology capacities. The attributes of social relationships are aligned directedness, heterogeneity, mutual directedness, appropriate permissions, and action opportunities (Msiska and Nielsen, 2018). The attributes of technology capacities are based on Zittrain (2006)'s four criteria for a generative technology discussed above.

da Rocha and Pollock (2019) investigated the processes of generativity and generification by analyzing data on the relationship between a platform owner and its customer. They found that tight control, boundary resources, and asymmetric relationships did not discourage customers from “a generative venture”. In their case, generativity “was fueled by customer necessity of complementing the platform with key functionalities for its operations”.

Vestues and Knut (2019) did a case study of a large public service organization going from a silo-based system to modular applications, allowing teams to work

more autonomously. They found that platformization increases generativity within organizations by expanding the available resources and better connecting the resources together. They introduce the concepts of “decoupling” and “recoupling” to describe the process of establishing an appropriate modular architecture to enhance resource density (decoupling) and the process of establishing practices and roles that facilitate resource integration (recoupled into cross-functional teams that perform continuous software development).

Case and method

Case description

In 2022, a healthcare platform called Helseplattformen was implemented in the region of Central Norway. The aim was to replace the different medical record systems used in both primary and secondary healthcare with one common EHR. The vendor of the EHR is the American company, Epic Systems Corporation. The product, hereafter called Epic, was procured in 2019, and a local company called Helseplattformen AS (hereafter called HP) was created. HP is owned by user organizations, i.e., St. Olav hospital which is the largest university hospital in the region, and Trondheim municipality. Other municipalities in the region and primary care actors are joining and taking part-ownership in the company as they join.

The organization of the platformization process is shown in Figure 1. To configure and customize Epic to the Norwegian setting, HP hired tens of *application analysts*. In addition, the role of *subject matter experts (SMEs)* was created. These are domain experts from user organizations who were recruited by HP in 20%, 40%, or 60% positions, to represent their field in the design and implementation process. More than 400 SMEs were hired in primary and secondary healthcare to represent the almost 40 000 healthcare workers in the region. SMEs play a key role in the evolution of the platform which includes providing direction and feedback on their field of work to design the workflows and content, approving the workflows before implementation, participating in testing, and assisting in making the training materials for the end-users.

A third important role is that of *super users* – i.e., selected users who are in charge of training other users post-implementation. There are approximately 900 super users in the municipality of Trondheim. The primary healthcare services in Trondheim municipality consist of more than 80 units with 9000 employees that serve 200 000 citizens.

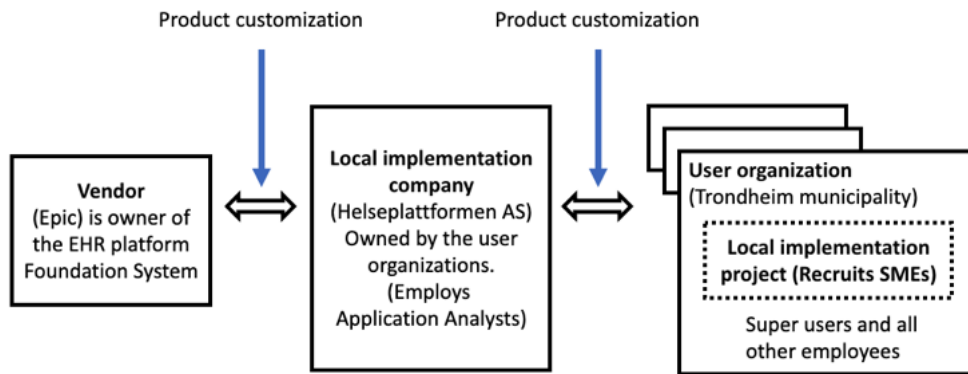


Figure 1. The different actors involved in the platformization project..

The "go-live" date – i.e., the date the customized Epic software is delivered to the user organizations - for primary healthcare in Trondheim municipality was May 7th, 2022, after being postponed twice. The software was simultaneously implemented across all of the over 80 healthcare units within the municipality.

In this study, we visited two different units in the municipality approximately six to eight months after go-live to understand more about how they are using Helseplattformen, how their work practices have changed, and how they are working to optimize the solution and practices.

Interviews were conducted with super users, SMEs, and managers at each unit, as well as managers in the local implementation project (see Table I). One of them manages the SMEs and is referred to as the *champion*.

Unit 1

The first unit that we visited was a front-line coordinative unit that receives inquiries and applications from citizens. The cases that this unit receives are distributed among the caseworkers who process them and make decisions. They work first line together with the Norwegian Labour and Welfare Administration (NAV) and general practitioners (GP). They collaborate closely with NAV and GPs, in addition to the hospital which is second line. In Trondheim municipality, this unit serves as a coordinative unit between the 80 executive units. They are the connecting link between the hospital and primary healthcare. These services also exist in other municipalities in the region, which are often organized differently due to smaller scales. As there was no existing solution for case management in Epic, a new application was built for this unit during the initial implementation project.

Unit 2

The second unit that was visited is a free day service that offers mapping, conversations, follow-up, and guidance for people with psychological challenges.

The application this unit is using was built for the home care units in the municipality, however, it was built with the intention of also being used by this unit. It was therefore customized and not built for them. Unit 2 mostly conducts 1-1 consultations with patients.

Research method

The research strategy is an exploratory case study based on qualitative research methods. Data has been collected over a period of two years; however, this paper focuses on data collected after go-live. Observations were conducted at the different units to get an understanding of their work practice and interviews were conducted with different actors, including SMEs, super users, unit managers, and managers in the local implementation project. Interviews were recorded and transcribed and lasted on average about an hour. Observations were documented using extensive field notes. Observations were not recorded.

A qualitative analysis was performed on the data using NVivo. The first step was to identify codes in the transcriptions and field notes, before dividing them into conceptual categories and identifying patterns. These patterns were used to identify the overall themes.

Table I. Data collection methods.

Method	Data
Observation	1 day at Unit 1 (approximately 5 hours) 1 day at Unit 2 (approximately 5 hours)
Interview	2 Super users (primary healthcare) 2 SMEs (primary healthcare) 2 Unit leaders (primary healthcare) 2 Managers (local implementation project in Trondheim municipality)

Findings

In this section, we present our findings concerning the different units, the routines they have created post-go-live, and how they continue to optimize and generate solutions.

Support for optimization and innovation

Prior to the implementation of Helseplattformen, Unit 1 and another unit in the municipality were utilizing a shared calendar within their medical record system to plan patient stays. However, Helseplattformen lacked a similar planning tool, forcing them to devise an alternative solution independent of the platform by creating a shared spreadsheet. They had requested similar functionality within

Helseplattformen well in advance of go-live, yet the SME in the domain remains uncertain as to why the request has not been fulfilled. It is unclear to the SME whether the request is infeasible to configure, too costly, or simply not a priority for Helseplattformen. The SME says regarding the shared spreadsheet that

They almost have to have a shadow system like that, because the system is simply not good enough. (...) We need a development that I do not think Helseplattformen has the answer to themselves, because they most likely haven't done it before. If they had the answer, they would have done this a long time ago, because we asked for it long before go-live. We told them that this is not going to work

In the same unit, they have made physical boxes with printed inquiries and applications to make sure that none of the incoming cases “go missing” in the system. The overview of pending cases in Helseplattformen was not satisfactory according to one of the super users. A large cardboard box is therefore standing in the middle of their open-plan office space, full of paper folders. Regarding the physical folders of outstanding cases, the SME says that this shadow solution might be due to insufficient training of the users.

According to the SME in the domain, Unit 2 has emerged as the most successful unit within the municipality concerning the implementation of Helseplattformen. This unit has initiated the development of novel functionalities by building on top of an application from Epic and has also identified more effective routines soon after go-live. The SME gives an example of when a super user was playing around in the system and discovered a solution in relation to the patient plan and made this ahead of a scheduled meeting with the patient. This led to the super user only spending one minute to document a visit. According to the SME, this improved routine and efficiency is about the interest of the super user for computers and service development. As mentioned, Unit 2 has also started to develop new services that build on an existing application in the Epic system. It is an application that will notify the patient about necessary forms to fill out and provide various information regarding the treatment that the patient is under.

Approximately eight months after go-live the SMEs' main task is to test different workflows to optimize the routines. They collaborate with SMEs from other units in the municipality on testing and playing around with the system. They do not have access to change anything in the system or in the user interface (they cannot develop or build, only customize their own personal screen). If they find a good way of doing something, they tell the caseworkers at the unit, that “this is how you should do things now”. They rarely speak to the application analysts anymore because they are busy with the other municipalities and hospitals in the regions that are going live.

Epic has an impressive dashboard for managers that provides them with a lot of information. Sometimes even too much information. One of the managers mentioned that when she started to use Helseplattformen, the dashboard of the managers was showing a list of the ten best and ten worst employees based on case

handling time. This information was quickly removed from the manager's personal dashboard.

Challenges of large-scale generativity

According to the champion, "personalization of your screen is possible, but if the user wants new tests, navigators, or a new tab with some specific information, they [the different service areas and municipalities] must agree on it." The champion uses the example of video consultation and whether the window should close automatically or not after a consultation has finished. At some units at the hospital, they want it to be manual but that will affect the municipality as well, which is why they need to have a say in it and participate in the discussion. In order to make sure that their data becomes structured the units must coordinate with other units to make sure that they are filling in the same information in the correct fields and that they name the field similarly (for example deciding whether a field is named "sleep" or "sleep quality").

They also need to coordinate with units within the same domain as it is not given that they develop the same workflows. As an example, the offices working on case management should be developing the same routines and practices to ensure that all citizens have the same case management no matter if they live in the south or north part of the city. After go-live, they started to develop different practices, but the SME told the users that the primary objective is compromised if the users operate in a fragmented manner, stating "It is important that we work in the same way. Think the same way". It is particularly important that there is a joint decision if someone wants to remove something because the end-users are not aware of the different applications and how they are connected. It has therefore happened that things have been removed or changed that has made it difficult or impossible for employees at other units to do their job properly. According to the champion, the ones who made this decision had forgotten to think about the ripple effects.

For this reason, they are currently working on a decision-making structure for changes in workflows and other big changes they want to make in the system. Not just for the common solution between the municipality and the hospital, but also because it is a common solution for several municipalities. This is happening eight months after go-live for the municipality and two months after go-live for the hospital.

The leader of the implementation project in the municipality refers to meetings where domain experts from the municipality sat together with domain experts from the hospital. These meetings led to a realization among the hospital wards that "it is actually in the municipality the citizens live". Many citizens are never at the hospital, some are hospitalized for a short period of time, while some are chronic patients and have a greater need for cooperation between healthcare services. The experts' interaction during these meetings facilitated a clearer understanding among hospital wards regarding the workings of the municipality. Additionally, it was mentioned that primary and secondary have different cultures.

A decision-making structure had been created before the project started but the leader of the local implementation project says that “I don’t think a single case went all the way to the top. We managed to agree”. One of the SMEs also mentions that the municipality has had to accept decisions not because they want to but because it is the right thing to do.

The role of key stakeholders

In the context of Helseplattformen, the champion acts as a boundary spanner who facilitates communication and translation of vocabulary between the users, Helseplattformen, and the vendor. In addition, the municipality has made significant efforts to ensure that their voice is heard during the process of configuration and building. Despite these efforts, the champion reports feeling marginalized and compares their treatment to that of a ward in a hospital. In retrospect, the champion believes that many decisions made 2-3 years ago would have been different if they had possessed the knowledge they have now. Moreover, they received advice to avoid making significant changes immediately after go-live, as it has been observed in other countries that such changes ended up being reversed to the initial solution.

The super users also act as boundary spanners after go-live as they are the ones who know how the system works in use – and not the SMEs. Regarding the SMEs, the leader of the local implementation project mentions that even the work practices have changed during the implementation process in some units. In some cases, they have had to employ new SMEs during the last three years. The leader says

[New SMEs] come in fresh with, ‘yes, but we work like this in 2022. We don’t work like we did in 2019’.

The practices of caseworkers have undergone significant changes since 2019 when the SMEs were hired by Helseplattformen AS. However, it is worth noting that the caseworkers themselves have also changed during this period, with a generational shift occurring within one of the units. The manner in which tasks were performed in 2019 is not necessarily representative of current practices in 2022.

During usage of the system, the SMEs play a critical role in continually developing new solutions and optimizing the workflow. The SMEs make decisions on behalf of the employees in their domain, which may also involve other municipalities. According to one SME, this poses a significant challenge, particularly given that they are the only SME within their specific domain. As such, the SME requested two employees, with whom they could collaborate and exchange ideas, specifically people that are not super users. The SME ended up collaborating with two experienced caseworkers on a weekly basis to make decisions and improve the workflow.

The biggest challenge of the implementation according to the leader of the implementation project in the municipality is the changes in work practice and organizational development. Many healthcare workers were under the impression

that they were supposed to receive an updated version of "Gerica" - "Gerica 2.0" - which would involve only minor changes to the screen but would allow them to continue working in the same manner as before go-live. However, the implementation was designed explicitly to facilitate a change in work practices. The system was created to promote a collaborative, cooperative, and different manner of interaction among healthcare workers - necessitating a change in the way of working. The leader of the implementation project says that

I wasn't completely honest about how difficult it was going to be after we went live (...) Some people thought that as long as we go-live everything would be fine and then three months later I come back and say that this is just the beginning.

It is also mentioned by the leader of the implementation project that

The municipal director has instilled in us now that it is innovation and constantly reaching for new things that will be the goal. Because you no longer get to a point where 'now we've done it and then we can relax for 2 years'. We are constantly exposed to new challenges.

Discussion

Our preliminary findings are in line with earlier studies that depict generativity as a complex socio-technical process. Our data also show that generativity happens at several layers ranging from individual personalization to organizational decision-making. In the municipality, there are generative communities that are developing generative processes, but the technology is not generative enough to support local differences at the level of units in the municipality. The different processes happening in the two units are both important for generativity.

Types of generativity

Much of the literature on generativity assumes that generativity is bounded by what is already built in the platform core and supported by its boundary resources. This type of supported generativity from the vendor is what we have seen in the initial platformization project when the platform was configured and adapted to user requirements. During use, however, we observe several examples that can be regarded as unsupported generativity.

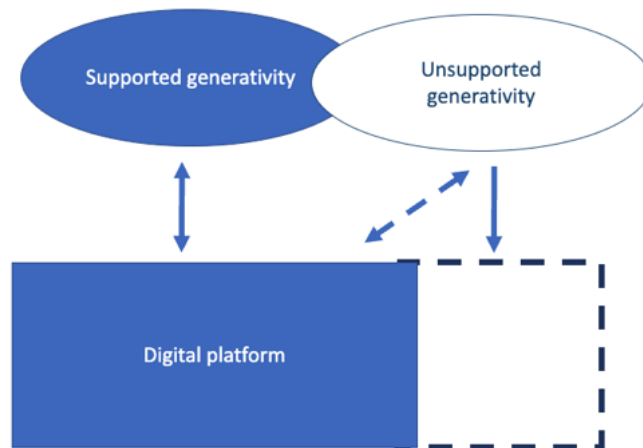


Figure 2. Generativity is based on the affordances provided by the platform..

The situation is depicted in Figure 2, which shows how some generativity is based on the affordances provided through the platform’s generic attributes, but others are solutions built outside of the platform due to a lack of affordances. One of the shadow systems that were created by the end-users at Unit 1 can be regarded as an example of unsupported generativity where “plan-ability” is not afforded by the platform (Hausvik and Thapa, 2017). One can argue that these shadow systems would not have been developed if the platform was not introduced in the first place. In this way, we propose that they are examples of unsupported generativity that need to be considered in further development of the platform. Table II shows an overview of the generated artefacts that were either supported or not supported by Epic.

Table II. Overview of generated artefacts at the different units..

	Supported generativity	Unsupported generativity
Generated artefacts	<ul style="list-style-type: none"> • Personalization of dashboard for managers (Unit 1 and 2) • Care companion app (Unit 2) • "Build" for mobile application (Unit 2) 	<ul style="list-style-type: none"> • Shared spreadsheet (Unit 1) • Physical boxes (Unit 1)

When considering the different kinds of generativity, it is important to investigate the underlying conceptual model used in the platform core. The Epic system was initially developed for hospital usage, specifically designed for one-on-one consultations – as done in Unit 2. However, this approach may not be appropriate for the coordination among numerous actors which is largely what the municipal healthcare system in Norway is based on. In response, shadow systems have been developed more frequently in Unit 1, which primarily focuses on coordination.

The shadow systems that were created in Unit 1 – i.e., the unsupported generativity - can be seen as a form of breakdown in the generativity process. Or it can be seen as an idea for design and an opportunity for platform innovation. From a supported generativity perspective, the creation of the shared spreadsheet can be interpreted as a breakdown because the missing functionality was already requested prior to go-live, according to the SME. It is also not clear why the request was not complied with, which further supports the notion that it is a breakdown. Such incompleteness of a generic platform can lead to generativity, which in turn can be generified (da Rocha and Pollock, 2019). This example is also in line with Vassilakopoulou and Grisot (2012)'s understanding of generativity, which emphasizes actors' knowledge, skills, and creativity in producing unanticipated outcomes. The creation of unexpected change is nevertheless governed by the platform vendor. Regarding the physical box of outstanding cases, it is more likely that this shadow system is caused by a lack of training or exploration than technological restrictions. According to the SME, the functionality needed to filter cases is already available in the system. Either way, the system does not afford the necessary possibility of action.

Transition from design to use

Our data demonstrate a significant shift in the processes that support generativity in the municipality, from design – pre-go-live – to use – post-go-live. During the design phase, the implementation process was a formal waterfall process controlled by the vendor (Ringdal and Farshchian, 2022). However, during use, the process went from a top-down, centralized management approach, to a bottom-up, decentralized approach which proved to be challenging (see Figure 3). Users who had participated in the vendor-led generativity process were required to take charge of the generativity process themselves, while simultaneously attempting to incorporate the technology into their real-world practices for the first time. This user-controlled process post-go-live has resulted in the development of shadow systems.

There are several reasons why there might be a lack of support for generativity during use. One explanation, in our view, is the way platformization projects are planned, i.e., typically using waterfall models with contractual handovers. Furthermore, due to issues that emerged during another go-live event at the hospital, the vendor and HP staff were unavailable to Units 1 and 2. Additionally, the incompatible models in technology and practice that are not uncovered before the system is in use lead to further difficulties.

Although there has been a shift in the process, the vendor and HP continue to maintain firm control, as all development and customization must go through them. Furthermore, the application analysts who possess the knowledge and access to configure the system are not as available as they were prior to go-live. Despite the leader saying that the real work starts after go-live, the process is increasingly led

by the users, restricting the opportunities for change and evolution on top of the platform.

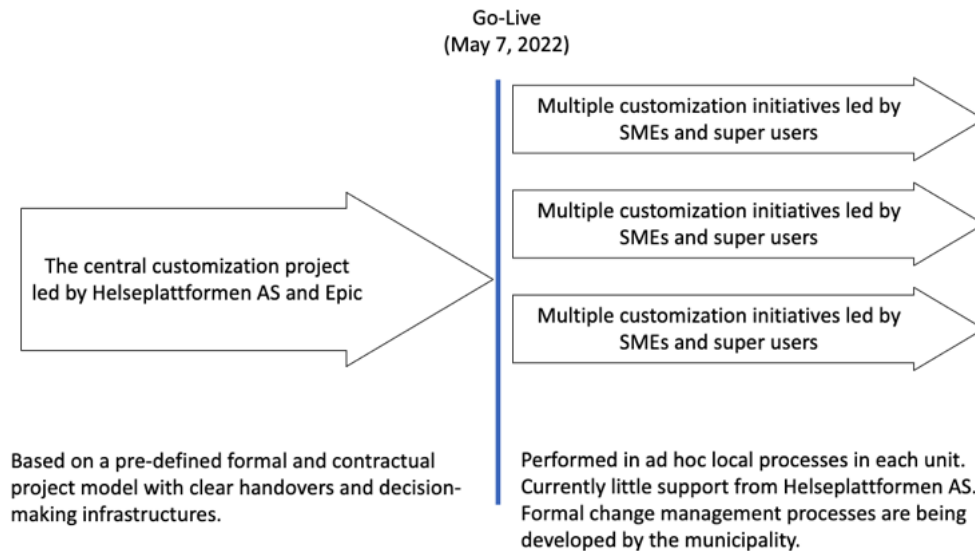


Figure 3. Change in the generativity processes from design to use..

Scale and interconnections

Due to the large number of user organizations sharing the same platform core, changes made in one unit in the municipality may have unforeseen effects in the hospital, or in other entities in the community, and/or other communities. The consequences of changes can be unknown to end users, super users, and even SMEs. Development and configuration requests are sent to the vendor and the application analysts. However, these are often busy with urgent tasks.

Even though Helseplattformen is flexible in terms of opportunities for customization, SMEs and end users are only able to personalize their private screen and generate new work practices and workflows based on the system they have (appropriate permissions). This is a collaborative task now that the units in the municipality and the hospital are more tightly coupled. The continuous development practices in the municipality are currently being organized and recoupled (Vestues and Knut, 2019). We are seeing that the user services are not necessarily congruent with the working practices of the clinicians.

Managing generativity

Creating opportunities for generativity requires continuous involvement and support from the management. Managers need to prioritize and allocate resources in terms of staff such as super users. In addition, managers need to have processes in place to promote a culture of generativity by e.g., promoting the idea of continuous improvement.

It is emphasized by several interviewees in different roles that the unit manager's role affects the facilitation of the change process. Many employees were expecting their work practices would remain the same even if a new platform was being produced. The process of implementing an EHR system is, however, not merely technical. As emphasized by the interviewees, going from a medical record system that is unstructured and based on free text to a standardized, rule-based system is a major organizational change project.

Facilitating such changes place great demands on the management at different levels. The data indicates that having the platformization project on the agenda and discussing the new system in employee meetings for more than a year before go-live was important to prepare the employees for what was coming. Improving the employees' general computer skills and redeeming super users for an extended period have also been mentioned as important measures.

It has been communicated through the whole implementation process that the benefits of implementing a common EHR are many. But it is up to the users to figure out how a new system and work practice can help them realize these benefits. According to the leader of the implementation project, it was not made clear pre-go-live that this will be a process of continuous development. There is a need for a culture of change, which is challenging in a sector characterized by complexity and intricate integration between technology and practice. However, there is a strong need for innovation in the healthcare sector.

Conclusion

Through a preliminary study of how an EHR is being implemented in a large municipality, we have shown that generativity is not limited to the design phase but is even more important when the generative platform is in daily use. Our data show that it is important to look at the breakdowns in usage not only as negative but as indications of how the platform can be improved (or organizations can be changed). Breakdowns can be more valuable sources of innovation than the pre-defined acts of generativity that are put there by the owners of the platform. The creation of shadow systems can have a generative role and the role of the management is to facilitate a culture of change. Generativity is to increase flexibility, but it is complicated in a complex context and system like a large-scale EHR system.

Future research can build on these preliminary findings to further explore the generative mechanisms of shadow systems. A recent study by Bartelheimer et al. (2023), explore the role of workarounds as a generative mechanism for bottom-up process innovation in organisations and argue that the complex process of workaround diffusion needs to be investigated further. Literature on infrastructuring could potentially provide an interesting lens to explore such generative mechanisms. The responsibilities of managers and the challenges they encounter should also be explored in much greater depth to to gain a deeper understanding of socio-technical generativity within organizations.

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References

- Ansell, C. and J. Torfing (2021): 'Co-creation: The new kid on the block in public governance'. *Policy & Politics*, vol. 49, no. 2, pp. 211–230.
- Bartelheimer, C., V. Wolf, and D. Beverungen (2023): 'Workarounds as generative mechanisms for bottom-up process innovation—Insights from a multiple case study'. *Information Systems Journal*, pp. 1–66.
- da Rocha, F. N. and N. Pollock (2019): 'Innovating in Digital Platforms: An Integrative Approach.'. In: *ICEIS (2)*. pp. 505–515.
- Ellingsen, G. and M. Hertzum (2019): 'User participation in the implementation of large-scale suite systems in healthcare'. In: *Proceedings of the 7th International Conference on Infrastructures in Healthcare 2019*.
- Farshchian, B. A., M. Grisot, S. Hochwarter, A. Sigríður Islind, M. Mikalsen, E. Parmiggiani, and P. Vassilakopoulou (2021): 'Platform-Supported Cooperative Work'. In: *Proceedings of 19th European Conference on Computer-Supported Cooperative Work*.
- Ghazawneh, A. and O. Henfridsson (2013): 'Balancing platform control and external contribution in third-party development: the boundary resources model'. *Information systems journal*, vol. 23, no. 2, pp. 173–192.
- Grisot, M. and P. Vassilakopoulou (2013): 'Infrastructures in healthcare: The interplay between generativity and standardization'. *International Journal of Medical Informatics*, vol. 82, no. 5, pp. e170–e179.
- Hausvik, G. I. and D. Thapa (2017): '" What You See is Not What You Get"-Challenges in Actualization of EHR Affordances.'. In: *Proceedings of the 38th International Conference on Information Systems (ICIS)*.
- Hein, A., D. Soto Setzke, S. Hermes, and J. Weking (2019): 'The influence of digital affordances and generativity on digital platform leadership'. In: *Proceedings of the 40th International Conference on Information Systems (ICIS)*.
- Leonardi, P. M. (2009): 'Crossing the implementation line: The mutual constitution of technology and organizing across development and use activities'. *Communication Theory*, vol. 19, no. 3, pp. 278–310.
- Lyytinen, K., C. Sørensen, and D. Tilson (2017): 'Generativity in digital infrastructures: A research note'. In: *The Routledge companion to management information systems*. Routledge, pp. 253–275.
- Markus, M. L. and M. S. Silver (2008): 'A foundation for the study of IT effects: A new look at DeSanctis and Poole's concepts of structural features and spirit'. *Journal of the Association for Information systems*, vol. 9, no. 10, pp. 5.

- Monteiro, E., N. Pollock, O. Hanseth, and R. Williams (2013): 'From artefacts to infrastructures'. *Computer supported cooperative work (CSCW)*, vol. 22, pp. 575–607.
- Msiska, B. and P. Nielsen (2018): 'Innovation in the fringes of software ecosystems: the role of socio-technical generativity'. *Information Technology for Development*, vol. 24, no. 2, pp. 398–421.
- Pauli, T. (2021): 'Pins on the Map: Navigating the Ambiguous Landscape of Generativity in Digital Platform Ecosystems'. In: *The Role of e-Business during the Time of Grand Challenges: 19th Workshop on e-Business, WeB 2020, Virtual Event, December 12, 2020, Revised Selected Papers*. pp. 75–88.
- Pollock, N., R. Williams, and L. D'Adderio (2007): 'Global software and its provenance: generification work in the production of organizational software packages'. *Social studies of science*, vol. 37, no. 2, pp. 254–280.
- Priestman, W., S. Sridharan, H. Vigne, R. Collins, L. Seamer, and N. J. Sebire (2018): 'What to expect from electronic patient record system implementation: lessons learned from published evidence'. *Journal of Innovation in Health Informatics*, vol. 25, no. 2, pp. 92–104.
- Rahal, R. M., J. Mercer, C. Kuziemy, and S. Yaya (2021): 'Factors affecting the mature use of electronic medical records by primary care physicians: a systematic review'. *BMC Medical Informatics and Decision Making*, vol. 21, pp. 1–15.
- Ringdal, N. O. and B. A. Farshchian (2022): 'The Role of Boundary Objects in Platformization Practices: A Case Study of Software Testing'. In: *Proceedings of 20th European Conference on Computer-Supported Cooperative Work*.
- Rodon Modol, J. and B. Eaton (2021): 'Digital infrastructure evolution as generative entrenchment: The formation of a core–periphery structure'. *Journal of Information Technology*, vol. 36, no. 4, pp. 342–364.
- Thomas, L. D. and R. Tee (2022): 'Generativity: A systematic review and conceptual framework'. *International Journal of Management Reviews*, vol. 24, no. 2, pp. 255–278.
- Tiwana, A. (2014): *Platform Ecosystems: Aligning Architecture, Governance, and Strategy*. Morgan Kaufmann.
- Vassilakopoulou, P. and M. Grisot (2012): 'Technology Innovation in the Face of Uncertainty: The Case of 'My Health Record''. In: *ECIS 2012 Proceedings*.
- Vestues, K. and R. Knut (2019): 'Making digital infrastructures more generative through platformization and platform-driven software development: an explorative case study'. In: *10th Scandinavian Conference on Information Systems (SCIS)*.
- Zittrain, J. L. (2006): 'The Generative Internet'. *Harvard Law Review*, vol. 119, pp. 1974–2040.

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Giving help or information? A human advisor and a chatbot answers requests from citizens

Guri Verne
Department of Informatics
University of Oslo, Norway
guribv@ifi.uio.no

Abstract. Building on CSCW research on knowledge and expertise sharing, this exploratory paper presents examples of how a human call advisor answers citizens where the call advisor takes an active role in helping the caller make their request more precise and contrasts with how a chatbot answers citizens requests. Previous research about expertise sharing is expanded to also involve expertise sharing with citizens. This paper makes a case for including research of expertise sharing between representatives of the public administration and the citizens in CSCW research. Reinvigorating empiric and conceptual research on differences between expertise and knowledge will be important to understand the challenges of providing a chatbot first for answering questions from the citizens.

Introduction

To an increasing degree, work is transferred to people in their homes in their various roles as citizens (Verne and Bratteteig, 2016), home care workers (Bratteteig and Wagner, 2013), or home office workers (Ciolfi et al., 2020). For several years public services have been closing their offices where citizens previously could meet in person to ask questions and receive guidance over the counter. As members of a modern welfare state, citizens are now expected to navigate and handle their affairs in several public domains by themselves. Previously the citizens could meet face to face with “the street-level bureaucrats”, representatives of the public sector who listened, answered questions and sometimes gave advice in how a citizen could proceed in a case. The street-level bureaucrats interpreted the laws and politics of the government in actual situations (Lipsky, 2010). Now many public services instead provide a call centre service where citizens can talk with a call advisor over the phone (Verne, 2015; Verne and Bratteteig, 2016). The call advisors share their expertise within the domain and apply it to the callers’ life situation and circumstances (Bratteteig and Verne, 2012; Verne, 2015; Verne and Bratteteig, 2016).

In 2010, the Tax Administration Call Centre in Norway received 2 740 045 calls where 2 179 278 were answered (of a population of 4 858 199, but also some non-norwegians call). Knowing the relevant rules and how they apply to you is necessary to manage your rights and duties as a citizen. The citizens do not know precisely what information is needed and why (Borchorst et al., 2012). However, management considers call centres to be an expensive, staffed service and the last few years chatbots have been presented as the first point of contact for public administrations (Verne et al., 2022).

A major research stream within CSCW has for a long time been concerned about sharing of knowledge and expertise, mostly in a commercial setting and within company boundaries. The research literature distinguishes between knowledge and expertise, where knowledge concerns factual information and expertise is seen as knowledge applied to an actual situation and circumstances and communicated between people (Ackerman et al., 2013). In the first generation of research on knowledge sharing, knowledge is seen as residing in a memory store or repository of an organisation while in the second generation expertise is seen as socially constructed and distributed (Ackerman et al., 2013; Ackerman and Halverson, 1998, 2004). The notion “expertise sharing” emphasizes the close intertwinement of work and knowledge, as well as the situated, contextual and social nature of knowledge (Ackerman et al., 2013).

In this exploratory paper, I contrast how the human call advisor answers the callers with how the chatbot answers users. The paper shows that the call advisor shares expertise with the caller while the chatbot shares knowledge which the users will have to apply to their own life situation and circumstances with little

help. In the discussion, I problematize that the citizens often must handle their affairs without help from competent representatives from the domain in question when chatbots increasingly are being put to the front of public organizations' contact with the citizens.

Call centres

Call centres are studied within CSCW where the active role of the call takers is described from several perspectives. Muller (1999) showed that the directory services operators' expertise and knowledge about their work added value to their customers' queries. Making the operators' contribution visible led the management to abandon a plan for full automation of these services. The nature of the operators' work can be described by the seemingly contradictory notions of both improvisation and choreography, indicating that the operators' work routines are a craft-like performance (Whalen et al., 2002). Flexible communication and emotional work are important for the operators to generate a good interaction with the customers (Maass and Rommes, 2007). In making a general classification scheme for the calls "fit" into the local arrangements, the operators carry out invisible work (Martin et al., 2007).

In emergency calls, local geographical and temporal knowledge of the operators is valuable and what is important in the call is emergent (Martin et al., 2007) as well as the topic of the call (Normark and Randall, 2005). Reading the emotional state of the callers to an emergency call centre was important as a high need for help was expressed by the callers as fearful and negative emotions (Svensson, 2012). The capability to delineate symptoms from non-symptoms in an emergency call depends on the operator's communicative competence as well as organizationally provided routines (Svensson, *ibid*).

Operators in a call centre for supporting independent living of elderly with care needs were involved in a dialog of "watching" and "checking" the equipment for supervising seniors at home. The operators asked the seniors to test their alarm system, and the operators called back to check if everything was ok, which in turn led to a continuous dialog. This activity was outside the protocol of the operator (Farshchian et al., 2017).

These studies are mostly about commercial or medical domains, and there is little research on call centres in a governmental domain where the callers' democratic rights and duties as citizens are at stake. In 2010-2012, I carried out fieldwork in the Tax Information Call Centre focusing on what the callers found difficult with doing taxes (Verne, 2015). Another public administration, The Norwegian Labour and Welfare Administration, introduced a chatbot as the first point of contact with the public in 2019 and I have studied the logs from citizens' chat sessions focusing on how the chatbot answers the users' request.

Chatbots

A chatbot is a computer system which a user can text or ‘chat’ with over the Internet in real time (Følstad and Brandtzæg, 2017). They are often used in customer service for commercial or productivity reasons to get answers instead of making a phone call or reading through much text. Brandzaeg and Følstad (2018) went on and studied why users choose to use a chatbot and find that they help users to obtain timely assistance or information in addition to being used for social and entertainment reasons. However, chatbots are also known to give inadequate answers and for some, humans fill in responses behind the scenes so that the chatbot’s actual performance is camouflaged (Grudin and Jacques, 2019). Many chatbots are designed for a commercial context with a focus on profit and customer satisfaction (Adam et al., 2021). As to the information provided by chatbots, there are hardly any studies within education research of how a chatbot meets the information needs of the learners (Wollny et al., 2021).

Chatbots today are usually made with some Artificial Intelligence component, usually Machine Learning, to analyze the users’ input. The responses from Anna, the chatbot in this paper, is made by experienced welfare advisors who know what people want to know from the welfare administration. Anna is a pseudonym for the chatbot in this study who is presented with a female name. This chatbot is designed as a repository of knowledge where the questions are matched to a predefined set of answers (Caldarini et al., 2022).

Verne et al. (2022) shows that the welfare chatbot sometimes gives an answer that are “disguised as correct”: the response is well formed and correct but important information for a satisfactory answer to the question is missing. The citizen will need to have previous domain knowledge to find that something is missing and ask for more information.

Knowledge and expertise sharing

The CSCW view on knowledge and expertise sharing is that knowledge and expertise are different concepts. Knowledge is seen as “facts” or decontextualized information, while expertise is seen as applied knowledge which is situated and contextualised. Expertise is shared in social ways (Ackerman et al., 2013; Ackerman and Halverson, 1998, 2004). An earlier strand of CSCW research aimed to share knowledge in large repositories to make it independent of the knowing human (Ackerman et al., 2013).

For knowledge to be available in a repository for reuse, it must be decontextualized to be relevant in other contexts than the original. When knowledge is applied in another use situation, it must be recontextualised to be meaningful and helpful in the new situation (Ackerman et al., 2013; Ackerman

and Halverson, 2003, 1998). Knowledge stored as data resides in several smaller or larger repositories such as people's individual memory, scraps of paper and large organizational internal databases (Ackerman and Halverson, 1998).

Several critique points were raised to this repository view of knowledge sharing: Decontextualization is difficult as it is not obvious in advance what will be important knowledge to be stored for future use. Decontextualization is "difficult to achieve, and even harder to achieve for complex problems" (ibid, p. 539). In addition, important for recontextualization is to know the author and her expertise. Also, maintenance of knowledge in the repository for long term use will be difficult. Finally, repository systems promote an objectified view of knowledge, where Ackerman and Halverson (1998) "found it more useful to analyze information as a duality of process and object" (p. 540).

Methodology

In 2010-2012 I carried out ethnographic fieldwork (Blomberg and Karasti, 2013; Crang and Cook, 2007) in the Tax Information Call Centre by listening-in to 474 calls from citizens to the call advisors as well as interviewing 14 employees in various positions in the tax administration and one person in a Tax NGO. During listening-in, I was sitting together with the call advisor and could hear both the caller and the call advisor, and watch what the call advisor did to answer the request. I could see the computer screen and how they looked up various information from the internal tax databases, e.g. the National Population Register, taxation registers, and letters to and from the caller.

The calls were analysed inductively focusing on the issue of the call. I could immediately see that the call advisors acted differently for different calls depending on how they understood the request: for some calls they asked for the person identification number and looked up information in tax databases, for other calls they merely explained the rules - perhaps after asking for more precise information about the caller's life situation and circumstances. Detailed methodology is given in Verne (2015).

In 2019, we received several thousand logs from chat sessions between a citizen and the welfare chatbot. Logs were read looking for sessions where the chatbot did not seem to give a very good response. First, we selected logs where the citizen explicitly expressed dissatisfaction, next we selected logs where the session did not seem to give a relevant and satisfactory response from the chatbot. Using Suchman's (2007) framework for human-computer interaction we analysed the logs to see how the chatbot used information from the user to respond to the request. In Verne et al. (2022) some of these are given a detailed analysis of how the responses matched the questions.

Sharing expertise with the citizens

Tax in Norway is widely automated (Wroldsen, 2008) and many citizens do their taxes by checking figures already prefilled from the Tax Administration. They get little experience and learn little about the tax domain (Verne, 2015). The tax call centre provides first-level response to all calls to the tax authorities, and this call centre differs from the call centres described in the CSCW literature in several ways as it is neither a commercial nor an emergency call centre; doing taxes rarely generates acute situations.

In the following I give two examples of calls from citizens to the tax call centre. The examples concern issues that relate to the citizen and his or her life situation, which is often the first thing the advisor needs to find out before answering the request. Verne (2015) suggests describing those as questions about “the shape-sorting box”, as the citizens will need to know how elements of their own life fits into the categories of tax rules and regulations. Also, of importance is how these are defined and practiced by the tax administration. The shape-sorting box illustrates the challenges of identifying and interpreting events or circumstances from one’s own life and match them with the available set of categories (Bowker and Star, 1999; Suchman, 1994a, 1994b).

Many callers merely describe their situation or a problematic tax issue that has led them to make this phone call, without formulating a question. Sometimes an advisor asks clarifying questions before reinterpreting the original question to one they can answer in a precise way relevant to the caller’s situation.

Depending on the question, there is variety in how the call advisors answers the requests. Many questions can be answered in a simple way by explaining the rules of the topic which the call advisor usually knows by heart. Often the advisor looks up the caller’s tax data in the databases of the tax administration to understand the tax situation, which is often underspecified or misleading as told by the caller and give relevant explanations and advice.

The callers’ requests are often formulated as statements or claims more than a question. For example, a caller describes her situation (e.g., “I have not received an answer to my complaint”) which leads the call advisor to look up in the internal tax system if she can find any indication of an explanation there. Often the call advisors help a caller by disentangling a problematic tax issue (Bratteteig and Verne, 2012) and point to steps the caller can take to proceed with their case.

A prominent feature of the tax call centre as a workplace (Luff et al., 2000) is that communicating with the callers takes more of the call advisors’ workday than communicating with their co-workers. During their call duty they rarely interact with their colleagues; they can answer most requests without looking up digital or paper-based information. However, they often look up data about the caller in the internal databases.

In the following, I present two calls where the call advisor actively helps the callers to understand and proceed with their own tax issue. (NAV is the welfare administration that also handles pension).

Example 1. *The caller opens by explaining that she has recently received her first pension payment. She had expected that no taxes would be deducted, but the welfare agency has withheld 30% of her payment. Nils explains that this has happened because she has not updated the basic information for her tax card. The caller seems surprised and says “They told me nothing about this at NAV”. Nils will post her a form so that she can update her tax card information. The caller explains that she will need an exemption card, and Nils explains how to fill in the form. The caller explains that she received her first pension payment on Friday. Nils fills in the entries in the form with the caller’s pension and already paid taxes and closes the call by saying “You just sign there and return the form to the address listed”. After the call he comments to me “People think that everything happens automatically. But it doesn’t”. (20111121-10)*

Many callers expect that their taxation may change when they retire, but they do not know how. This caller was not aware that she herself had to manually update her personal information in the Tax Administration’s databases for the correct amount of tax to be withheld from her income when she retired. The advisor helped by situating and contextualising her tax knowledge by applying the rules to the caller’s life situation, explained steps the caller could take to update her figures and helped her in practice to report the changes.

In many phone calls, the callers described a life situation that would make it extra challenging for them to handle his or her tax issues. Some had recently lost a husband or wife, and in addition to the emotional strain had little knowledge about doing the taxes since this had been handled by the deceased. One man was in hospital, seriously ill and confused, but still tried to handle the value assessment of his house on the phone. Many were recently divorced and had become single parents with a more pressed economic situation. Others had lost their work; some had work that brought them far away from home. One man was calling from a fishing vessel far out in the sea; another man was homeless and living on welfare benefits. The call advisor helped them in handling their tax affairs in a challenging life situation.

In some situations, the call advisor helped when citizens needed tax information in contact with other institutions, as in the next example.

Example 2. *The caller requests a tax certificate (“ligningsattest”) to ask her bank for a loan. Advisor Nils says, “That says nothing, are you sure that is what you want?” The caller reads out loud a text from the bank that explains what she will use it for, and Nils understands that she needs a copy of the full Tax return form. He prints it out, puts it in an envelope and sends it to her address recorded in the population register. (20111010-3)*

Nils knows that many callers mix up the need to provide the tax certificate with the need to provide the full tax return form as documentation in different situations. He contextualizes the request with a clarifying question about what the caller needs to document so that he can give what the caller needs when he asks for something else. The tax certificate is not sufficient in situations where the citizen is required to document details of personal fortune or debts. The advisors know and can explain the difference.

Citizens often receive conflicting or confusing information from e.g. friends or the media. Misunderstanding and errors in their tax affairs may have serious consequences for them. Advisor Jan Tore said that the Tax Administration is “an agency with enormous possibilities for sanctioning you if you make a mistake, and I think this prevents people from finding out things on their own”.

“Shape-sorting” issues are often about terminology and what a term or tax concept will mean in practice for a citizen. The call advisor knows which points need to be clarified and asks questions for the citizens to be more precise on issues of importance for the application and relevance of the tax rules and regulations. Many call for a confirmation to what they have found out themselves.

The call advisors gave both factual information about the laws that applied in particular situations and recontextualized and situated the laws to the actual life situation and circumstances as the citizen explained. Quite often the caller was not able to describe their tax situation, at least to the level of precision the advisor needed for a good answer, and in such cases the adviser looked up the various databases of the tax administration to see how the citizen was represented there. Through blending what the citizen explains with what the advisor can see in the databases, the call advisor learns about the caller’s tax situation and recontextualise the rules based on what they find there about the caller’s life and tax situation. The advisors adapt what they say to the impression they get of the caller’s knowledge about tax and perhaps also to how they express their understanding about e.g., economy, numbers or percentage calculations.

Presenting information to the citizens

All answers from the welfare chatbot Anna are made by experienced welfare advisors who know what kinds of questions the citizens often ask. All answers are in this respect correct. However, the matching of the citizens’ questions to answers is done by Machine Learning. This analysis matches the user input sentences with the stored questions and selects the answer to give from the best fit between question and answer. In Verne et al. (2022) some of these chat sessions are given a detailed analysis of how the responses matched the questions.

This machine learning analysis plays an important role as it sometimes happens that a “correct” answer is given to the wrong question, i.e., a different question than the citizen asked. The chat sessions show how the citizens’ requests

provide very little contextual information, probably because the chatbot's introductory text asks for short questions. In the chat session there is no human advisor present that can ask the citizen for clarifying questions. The following examples from the chatbot also concerns the shape sorting box where the welfare rules and regulation need to be matched with the citizen's life situation.

Example 3.

The citizen	The chatbot	Comments and explanations
	My name is Anna and I am a chatbot. I am best adapted to answering short questions. Remember to include what type of benefit you are asking about. How can I help you?	The chatbot's opening phrase. Anna is a female pseudonym for the welfare chatbot.
Going to have a child, what do I have to apply for?	Sorry, but I do not understand what you are asking. I will understand you better if you write short questions and include which benefit it is about. Can you try to ask the question in a different way? <ul style="list-style-type: none"> • Need more help (button) • No (button) 	
How do I get money when I am expecting a child?	The day on which the payment is transferred depends on the benefit in question. You can see the payments from WA on Your payments on WA's website, but they will not be displayed until they have been credited to your account. <ul style="list-style-type: none"> • Overview payout dates (button) • Overview payout (button) • Not received money (button) 	The chatbot answers with information about payment dates, which is not what this citizen asks about.

This citizen asks an open question about which benefits she may be eligible for in her situation but does neither get a good answer nor receive help to formulate a better request. However, the citizen seems to understand that the answer is irrelevant and quits the chat session, perhaps to make a phone call for a better response.

In the next example, the chatbot has not given a sufficient response, but we cannot tell if the citizen is aware of that. The chat session is long, and only the first three requests from the citizen are shown here.

Example 4.

The citizen	The chatbot	Comments and explanations
	My name is Anna and I am a chatbot. I am best adapted to answering short questions. Remember to include what type of benefit you are asking	The chatbot's opening phrase. Anna is a pseudonym for the

	about. How can I help you?	chatbot, which has a female name.
can a young disabled person married to a foreign single mother receive child benefit and child supplement	<p>If you are a single mother or father, you may be entitled to extended child benefit if you are living alone with children. The extended child benefit is a child benefit for one more child than what you actually are living together with. You have to apply for an extended child benefit, it will not be automatically granted.</p> <ul style="list-style-type: none"> • Who is entitled to extended child benefit? (button) • <list of other options regarding extended benefits> 	The chatbot explains the rules for being a single mother and does not ask back to find out if this mother is single or married.
Who is entitled to extended child benefit?	<p>If you are a single mother or father you can receive extended benefit if you are living alone with the child and:</p> <ul style="list-style-type: none"> • you are separated, divorced or widowed • <continues to list criteria for extended benefit> <p>If you do not have common children with the person you have been living together with, we do only need documentation that you are not living together. It could be:</p> <ul style="list-style-type: none"> • Declaration of breakup • Separation permit • When does the right to extended child benefit cease? (button) • Apply for extended child benefit (button) • Shared child benefit (button) 	The chatbot gives general information about extended benefits for a single mother or father and the requirements for being a single parent.
...	..	
can a foreign single mother receive child benefit and child supplement	<p>If you are a single mother or father, you may be entitled to extended child benefit if you are living alone with children. The extended child benefit is a child benefit for one more child than what you actually are living together with. You have to apply for an extended child benefit, it will not be automatically granted.</p> <ul style="list-style-type: none"> • Who is entitled to extended child benefit? (button) • <list of other options> • Payment (button) 	The chatbot gives general information about benefits for a single mother or father.
(The citizen continues to ask for extended benefits for single mothers)		Four more requests are not included here.

This citizen asks several detailed questions about benefits for a single mother without the chatbot “asking” if the mother in question indeed is single. The citizen seems to focus on the mother being foreign without the chatbot responding

explicitly about that. It does give information about who counts as a single mother but does not focus directly on this particular piece of information in its responses – an issue which will be important for finding out if the single mother mentioned will be eligible at all. This citizen can well believe that s/he will be entitled to extended child benefits without that being the case. This stands in contrast to the call advisor in Example 2 who immediately asks the caller what he will use the tax certificate for and finds out that what the caller needs in this situation is not what he asks for. In Verne et al. (2022) these examples are studied in detail where how the chatbot helps the citizens to formulate better requests is described.

Discussion and open issues

The examples presented above show that a human call advisor shares expertise with the caller about tax rules and regulations applied to the caller's life situation and circumstances - in contrast with the chatbot which presents information to the citizen about the rules on a topic extracted from the user's request. The knowledge repositories of the 1990-ies were developed and used in a workplace internal setting (Ackerman et al., 2013; Ackerman and Halverson, 1998), but the welfare chatbot "shares" knowledge with the general public. Workplace internal users can ask colleagues for help in how to recontextualize what they find in the repository. They will learn to use it and thereby become familiar with the knowledge repository over time. However, the citizens will probably not develop a similarly familiarity with a public chatbot that they use occasionally.

Taxation and welfare categories such as "pensioneer" or "single mother" imply a "spatial, temporal, or spatio-temporal segmentation of the world" (Bowker and Star, 1999). There is work involved in trying to fit into such categories, and at the juncture where people's experience meets category systems, work is often invisible or repressed (Star and Strauss, 1999). For a democracy it is important that citizens receive guidance and help from those who know the rules or categories to apply these to the citizens' life situation and circumstances.

The laws and regulations are written in a general and absolute way and are decontextualized from the law makers' side. The human call advisor helps the citizens to recontextualize and situate the laws and regulations to their life situation and circumstances. The chatbot gives general information which needs to be recontextualised and situated by the citizen – without help from those who know the rules and how they have been interpreted in similar situations previously. The chatbot imitates recontextualizing and situating by presenting buttons indicating alternatives to choose among. We can see that the user does not always find out if and how they fit as in the example about the married single mother.

The welfare chatbot does not operate in a commercial setting. If a commercial chatbot gives erroneous or misleading responses, the company employing it may

for example lose a sale or a customer. If the welfare chatbot gives a misleading response, the error will be experienced by the citizen who will not know and may not learn about benefits for which they are eligible. This difference is important.

Employing a chatbot for giving information to the citizens about welfare benefits set more at stake than for a commercial or social chatbot (Verne et al., 2022). Current-day expectations to chatbots seem to be analogues to the expectations to knowledge repositories in the 1980-ies and early 1990-ies (Ackerman et al., 2013): that if enough data was collected and made retrievable, we will be less dependent on human knowledge. However, an open question is whether the relatively new machine learning technology is different in substantial ways: will the chatbot give good enough responses if the question-answer repository becomes very large and the machine learning gives good matches between new requests and already existing questions in this database? Will machine learning look like the chatbot situates and recontextualises stored knowledge? Will Ackerman's (2013) critique to knowledge repositories no longer apply? Will an objectified understanding of knowledge dominate, and the processual view of knowledge as socially constructed lose terrain? Will there be nobody to talk with?

Chatbots are in rapid development. At the current point in time, it is difficult to see how well they will develop. Will a chatbot for information about citizen's rights and duties be precise enough to include some of the ways a human call advisor helps a caller? Perhaps the chatbot at best can function as an advanced check list for the citizen to help themselves? When conversation repair is necessary in voice chat, a chat robot only indicates a source of the trouble, while a human operator provides a possible solution (Avgustis et al., 2021). A way for the citizens to double check the chatbot's answers will be to show (possibly by clicking a button) the matching question-answer pair and see if this question is what was meant (Verne et al., 2022).

Humans also make mistakes and do not always give good and helpful responses. In the tax call centre, I experienced that some call advisors were more helpful than others. During my fieldwork there, some call advisors gave correct but not helpful responses to a request (Verne, 2015). When it comes to details about complicated taxation laws, they may give incorrect answers. Senior personnel are sometimes listening in to the calls as an approach to quality assurance. Does it make any difference if the chatbot errs and does not give helpful response if human advisors also do?

Many have high hopes that a chatbot will be good enough to give good answers within a limited domain. Chatbots for entertainment on the one hand and for information about civic rights and duties are on the opposite ends of a scale of importance of the answer being correct and relevant to the question. Answers from a social chatbot have a wider range of fault tolerance in that nothing serious will happen if its answer is irrelevant or misleading.

Conclusions

In this exploratory paper, I have given two examples from citizens' conversations with a (human) call advisor in the tax call centre and two examples of citizens' chat sessions with the chatbot of the welfare administration. The examples show that the call advisor provides unasked-for help to the caller by asking for more information to understand the caller's life situation, as well as adapting their responses to how they understand the callers' knowledge about e.g. tax rules, online self-services and tax calculations. In contrast, the chatbot provides text where the rules and checklists are listed. The citizen has to apply them to their own life situation on their own. The advisor shares expertise with the citizens and the chatbot shares knowledge. This difference can be important when the topic is civic rights and duties.

Large amounts of data can simulate the fine distinctions of real-world knowledge and understanding but will always be dependent on and limited by the extent and variety of the stored data. A chatbot will not be able to take new situations and surprising aspects into account, as it is based on data that already is in its repository.

As chatbots implementing knowledge repositories increasingly are used to answer questions from citizens, it will be important to reinvigorate the CSCW discussion about knowledge and information. As the chatbots become better at providing answers, research is needed to investigate occurrences of answers that are misleading or wrong in context and the mechanisms that produce them. It is in this respect better that a chatbot gives an irrelevant answer that the citizen can recognize as such than giving an unsatisfactory answer that is "disguised as correct". This is problematic as citizens will need to have previous knowledge in addition to what the chatbot tells them to find out. Cover-up strategies that conceal that the chatbot could not provide a good and relevant answer can mislead people to believe they can answer more than it can. Empiric and conceptual research on differences between expertise and knowledge will be important to understand the challenges of providing a chatbot first for answering questions from the citizens.

References

- Ackerman, M. S., Dachtera, J., Pipek, V., and Wulf, V. (2013): Sharing Knowledge and Expertise: The CSCW View of Knowledge Management, *Computer Supported Cooperative Work (CSCW)*, 22(4–6), 531–573. <https://doi.org/10.1007/s10606-013-9192-8>

- Ackerman, M. S., and C. Halverson (1998): Considering an organization's memory, *Proceedings of the 1998 ACM Conference on Computer Supported Cooperative Work*, 39–48. <https://doi.org/10.1145/289444.289461>
- Ackerman, M. S., and Halverson, C. (2004): Sharing Expertise: The Next Step for Knowledge Management, In *Social Capital and Information Technology*, ed. Wulf, Volker and Marlene Huysman. MIT Press.
- Adam, M., Wessel, M., and Benlian, A. (2021): AI-based chatbots in customer service and their effects on user compliance, *Electronic Markets*, 31(2), 427–445. <https://doi.org/10.1007/s12525-020-00414-7>
- Avgustis, I., Shirokov, A., and Iivari, N. (2021): “Please Connect Me to a Specialist”: Scrutinising ‘Recipient Design’ in Interaction with an Artificial Conversational Agent, In C. Ardito, R. Lanzilotti, A. Malizia, H. Petrie, A. Piccinno, G. Desolda, and K. Inkpen (Eds.), *Human-Computer Interaction – INTERACT 2021* (pp. 155–176), Springer International Publishing. https://doi.org/10.1007/978-3-030-85610-6_10
- Blomberg, J., and Karasti, H. (2013): Reflections on 25 Years of Ethnography in CSCW, *Computer Supported Cooperative Work (CSCW)*, 22(4–6), 373–423. <https://doi.org/10.1007/s10606-012-9183-1>
- Borchorst, N., McPhail, B., Smith, K. L., Ferenbok, J., and Clement, A. (2012): Bridging Identity Gaps—Supporting Identity Performance in Citizen Service Encounters, *Computer Supported Cooperative Work (CSCW)*, 21(6), 555–590. <https://doi.org/10.1007/s10606-012-9163-5>
- Bowker, G. C., and Star, S. L. (1999): *Sorting Things Out: Classification and Its Consequences*, Massachusetts Institute of Technology.
- Brandtzaeg, P. B., and Følstad, A. (2018): Chatbots: Changing user needs and motivations, *Interactions*, 25(5), 38–43. <https://doi.org/10.1145/3236669>
- Bratteteig, T., and Verne, G. (2012): Conditions for Autonomy in the Information Society: Disentangling as a public service, *Scandinavian Journal of Information Systems*, 24(2)
- Bratteteig, T., and Wagner, I. (2013): Moving healthcare to the home: The work to make homecare work, ECSCW2013). Springer, London
- Caldarini, G., Jaf, S., and McGarry, K. (2022): A Literature Survey of Recent Advances in Chatbots, *Information*, 13(1), <https://doi.org/10.3390/info13010041>
- Ciolfi, L., Gray, B., and Pinatti de Carvalho, A. F. (2020): Making Home Work Places, In: *Proceedings of the 18th European Conference on Computer-Supported Cooperative Work: The International Venue on Practice-centred Computing on the Design of Cooperation Technologies – Exploratory Papers*, Reports of the European Society for Socially Embedded Technologies (ISSN 2510-2591) https://doi.org/10.18420/ECSCW2020_EP10
- Crang, M., and Cook, I. (2007): *Doing Ethnographies*, SAGE Publications Ltd.
- Farshchian, B. A., Vilarinho, T., and Mikalsen, M. (2017): From Episodes to Continuity of Care: A Study of a Call Center for Supporting Independent Living. *Computer Supported Cooperative Work (CSCW)*, 26(3), 309–343. <https://doi.org/10.1007/s10606-017-9262-4>

- Følstad, A., and Brandtzæg, P. B. (2017): Chatbots and the New World of HCI, *Interactions*, 2017 (July-August), 38–42.
- Grudin, J., and Jacques, R. (2019): Chatbots, Humbots, and the Quest for Artificial General Intelligence, *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, 1–11. <https://doi.org/10.1145/3290605.3300439>
- Lipsky, M. (2010): *Street-Level Bureaucracy. Dilemmas of the Individual in Public Service*, Russel Sage.
- Luff, P., Heath, C., and Hindmarsh, J. (Eds.). (2000): *Workplace Studies. Recovering Work Practice and Informing System Design*, Cambridge University Press. <https://doi.org/10.1017/CBO9780511628122.006>
- Maass, S., and Rommes, E. (2007): Uncovering the Invisible: Gender-Sensitive Analysis of Call Center Work and Software, In I. Zorn, S. Maass, and E. Rommes (Eds.), *Gender Designs IT: Construction and Deconstruction of Information Society Technologies*.
- Martin, D., O’neill, J., Randall, D., and Rouncefield, M. (2007): How Can I Help You? Call Centres, Classification Work and Coordination, *Computer Supported Cooperative Work (CSCW)*, 16(3), 231–264. <https://doi.org/10.1007/s10606-007-9045-4>
- Normark, M., and Randall, D. (2005): Local expertise at an emergency call centre, In Gellersen, H., Schmidt, K., Beaudouin-Lafon, M., Mackay, W. (eds) *ECSCW 2005* Springer, London. https://doi.org/10.1007/1-4020-4023-7_18
- Star, S. L., and Strauss, A. (1999): Layers of Silence, Arenas of Voice: The Ecology of Visible and Invisible Work. *Computer Supported Cooperative Work*, 8(1–2), 9–30. <https://doi.org/10.1023/a:1008651105359>
- Suchman, L. (1994a): Do categories have politics?, *Computer Supported Cooperative Work (CSCW)*, 2(3), 177–190, <https://doi.org/10.1007/bf00749015>
- Suchman, L. (1994b): Speech acts and voices: Response to Winograd et al., *Computer Supported Cooperative Work (CSCW)*, 3(1), 85–95. <https://doi.org/10.1007/BF01305852>
- Suchman, L. (2007): *Human-Machine Reconfigurations*, Cambridge University Press.
- Svensson, M. (2012): *Routes, Routines and Emotions in Decision Making of Emergency Call Takers*, Blekinge Institute of Technology.
- Svensson, M. (2012): *Routes, Routines and Emotions in Decision Making of Emergency Call Takers*, PhD dissertation, Blekinge Institute of Technology, Retrieved from <http://urn.kb.se/resolve?urn=urn:nbn:se:bth-00524>
- Verne, G. (2015): *The winners are those who have used the old paper form. On citizens and automated public services*, PhD dissertation, University of Oslo, <http://urn.nb.no/URN:NBN:no-50321>
- Verne, G., and Bratteteig, T. (2016): Do-it-yourself services and work-like chores: On civic duties and digital public services, *Personal and Ubiquitous Computing*, 20(4), 517–532. <https://doi.org/10.1007/s00779-016-0936-6>

- Verne, G., Steinstø, T., Simonsen, L., and Bratteteig, T. (2022): How Can I Help You? A chatbot's answers to citizens' information needs, *Scandinavian Journal of Information Systems*, 34(2). <https://aisel.aisnet.org/sjis/vol34/iss2/7>
- Whalen, J., Whalen, M., and Henderson, K. (2002): Improvisational choreography in teleservice work, *The British Journal of Sociology*, 53(2), 239–258. <https://doi.org/10.1080/00071310220133322>
- Wollny, S., Schneider, J., Di Mitri, D., Weidlich, J., Rittberger, M., and Drachsler, H. (2021): Are We There Yet? - A Systematic Literature Review on Chatbots in Education, *Frontiers in Artificial Intelligence*, 4. <https://doi.org/10.3389/frai.2021.654924>
- Wroldsen, K. O. (2008): Skatteetaten—Femti år med IKT og omstilling, In Arild Jansen and Dag Wiese Schartum (Eds.), *Elektronisk forvaltning på norsk*, Fagbokforlaget.

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Are Team Autonomy and Flexibility Enough for Agile Transformation? A Review of Transformed Practices in a Public Sector Organization

Morteza Moalagh, Marius Mikalsen and Babak A. Farshchian

Norwegian University of Science and Technology (NTNU), Trondheim, Norway

morteza.moalagh@ntnu.no; marius.mikalsen@ntnu.no; babak.farshchian@ntnu.no

Abstract. The public sector is adopting agile transformation to accelerate digitalization, but it often prioritizes internal efficiency over public values. In this ongoing case study of agile transformation in a large public organization in Norway, we apply a practice-theoretic lens to analyze practice changes. By looking at papers published in recent years on this case, The open coding method was used to identify the components of the practices, including competency, meaning, and material. The study revealed that agile transformation led to a shift in software development practices, improved communication, and increased authority, which enhanced ownership, productivity, and organizational learning. Moreover, The role of architects changed to advisors, and teams took full decision-making authority for managing data and architecture. The analysis of transformed practices revealed that the organization made changes to allow development teams to be more autonomous and flexible in their projects. However, the organization's inherent bias towards development teams seems to hamper effective collaboration and undermines democratic participation, a fundamental value of the public sector. Also, the study illustrates the need for boundary work and infrastructures that integrate the users/business side of the organization beyond the development side to address complex socio-technical interdependencies.

Introduction

Agile software engineering is commonly understood as the application of iterative methods in software development as opposed to planning-based methods such as waterfall models (Sommerville, 2016). Due to their increased popularity, agile methods that originated from software engineering are now being applied to other domains such as teaching (Lang, 2017), project management (Augustine et al., 2005), and organizational change (Fuchs & Hess, 2018). This means that many practices that CSCW researchers are interested in are going through a rapid “agile transformation.” Therefore, CSCW researchers must develop a practice-centered understanding of this phenomenon.

Agile methods often lead to increased autonomy and flexibility at the team level while increasing organizational demands for agility and efficiency. This makes the study of these methods relevant for the CSCW community as they produce tensions between teams and organizations (Tendedez et al., 2018). At the same time, we observe that agile transformation literature frequently ignores the practices of those involved in such transformations, whether they are IT developers, employees, or customers and users.

One area where such agile transformation processes are becoming prevalent is the digitalization of public services. There is increasing pressure on public services due to demographic developments in Western societies and a demand to reduce public spending in many countries. Therefore, agile transformation in the public sector has become a mantra among public administration researchers and practitioners (Mergel et al., 2018).

However, adopting agile methods to transform public services can be a double-edged sword. Most agile methods were initially developed by private companies, whose main outcome was efficiency (Sutherland, 2014). E-government research shows a similar interest in internal organizational efficiency at the expense of other values, such as social and democratic (Twizeyimana & Andersson, 2019). In adopting agile methods to the public sector, it is therefore essential to go beyond

internally oriented imperatives and pay attention to the particular characteristics of the public sector. Public services often exist within complex ecosystems, including citizens in various roles such as recipients of services, providers of services, employees in the public sector, politicians, etc. Public administration, therefore, needs to go beyond internal efficiency as the main value and consider the public value in a broader context (Moore, 1995).

This paper reports an ongoing case study of agile transformation in a large public organization in Norway. The Norwegian Labor and Welfare Administration (abbreviated as NAV) is the Norwegian public welfare agency responsible for providing services like unemployment benefits, pensions, child benefits, and more (NAV, 2022). The case organization has had agile transformation as its main strategy since 2015. Digitalization processes are used to follow a planning-based packaged software acquisition strategy. Now, the organization has set up several autonomous product teams in charge of maintaining digital product families that implement various public services related to, e.g., unemployment, sick leave, and parental leave.

This recent move to agile methods has shown positive results –the case organization has achieved a high level of digitalization and has won several prizes for its innovative services. At the same time, the organization has been criticized for its overemphasis on internal organization and its lack of sensitivity toward the needs of the citizens. A recent report for the Norwegian Board of Health Supervision (Helsetilsynet) uncovered a range of challenges meeting citizens who have to deal with the organization –e.g., lack of access to physical offices, long waiting lists in telephone lines, and lack of communication channels for those with a low level of digital competences (Helsetilsynet, 2020). Moreover, the organization’s latest large-scale digitalization project has met several challenges, such as considerable overspending, delays, and prolonged waiting time for citizens.

Our research interest lies in the intersection of practice-centered studies and agile transformation. We apply a practice-theoretic lens (Shove et al., 2012) to agile transformation in public organizations. Through applying the practice lens, we ask

the question: How do agile transformation practices emerge in public organizations, and how do they affect the provision of public value beyond efficiency? Our research addresses a gap in knowledge by observing and analyzing practice changes.

We build on earlier studies of agile practices (Johannessen & Ellingsen, 2009; Tendedez et al., 2018; Bjørn et al., 2019); and extend these through our study of a large public sector organization and how its practices have changed as the results of its extensive agile transformation initiative. Our preliminary findings are based on a meta-analysis of secondary data from 16 published papers about the case organization. We find that practice changes have led to increased team autonomy and flexibility. However, it is not clear how these changes have impacted the organization's ability to deliver public value.

In the rest of this paper, we first provide an overview of relevant earlier research. Then, we present our findings and discuss them in the light of practice and public value.

Background

Agile Transformation

The evolution of work techniques away from the conventional, linear waterfall development model is agile software development. Agile teams produce work in manageable, tiny batches as opposed to relying solely on a "big bang" release. As a result, there is a shorter time to market, quicker customer requirement adaption, and less risk (S. Rubin, 2013). The agile movement in the software development industry began in 2001 with the agile manifesto's publication by several well-known software practitioners and consultants. Four values were introduced: 1) individuals and interactions over processes and tools, 2) working software over comprehensive documentation, 3) customer collaboration over contract negotiation, and finally, responding to change over following a plan (Abrahamsson

et al., 2002). Every software development agile method or framework, like XP, Scrum, and Kanban, is built upon these values with different degrees of flexibility, speed, learning, and responsiveness (Qumer & Henderson-Sellers, 2006). The idea of self-organizing teams, whose members are collocated and operate at a speed that supports their creativity and productivity, lies at the heart of these methods. The principles support approaches that adapt to changing requirements at any step of the development cycle. Customers are deeply engaged in the creation process, providing feedback and reflection that can produce more satisfactory results (Dingsøyr et al., 2012).

Many organizations thought they could replicate their team-level success at the organizational level after using agile methods, particularly in software firms. The idea of agile transformation was brought up here. Agile transformations were initially created for collocated development teams but are now utilized in various settings (Dingsøyr et al., 2019). This approach encompasses more than just software development techniques and technology; it also refers to new ways of thinking and finding immediate solutions to problems (Olteanu, 2018). In the public sector, agile transformation is used as a technique that can improve the efficiency of service digitalization (Mergel & Ganapati, 2020). According to some studies, implementing agile could enhance public sector collaboration, flexibility, customer satisfaction, and operational excellence (Ylinen, 2021).

Autonomy and Flexibility in CSCW

A key concern in computer-supported collaborative work (CSCW) is how people work together to get things done. Since the early days of workplace studies, studies have demonstrated how introducing digital tools in collaborative work can be a form of *standardization* (Suchman, 1983) and that such systems must be aligned with and support collaborative practices. Failure to do so results in workarounds (Bowers et al., 1995), where workers create practices to bypass the system or engage with them in unexpected and often inefficient ways. This has caused an emphasis on a greater degree of flexibility, where the digital system serves as a tool

for coordinating work while also not overly limiting action. (Blomberg & Karasti, 2013). CSCW, from its origins, is about the tension between standardization and flexibility (Schmidt & Bannon, 2013).

Recently, CSCW research has focused on the tension between standardization and flexibility in software development (Tendedez et al., 2018). Research has shown the importance of coordination, using representations and tools, and organizational obstacles and constraints in software development (Procter et al., 2011). While agile methods have shown success in individual teams and smaller projects, scaling agile methods (such as larger projects or expanding beyond the development unit, i.e., large-scale agile transformation) is known to be challenging (Kruchten, 2013; Hoda, 2019). Scaling agile beyond teams is more challenging because it touches upon or transforms more and different dependencies (i.e., the need to work together to get things done), which traditionally have been controlled through standardization, such as plans (e.g., release plans), documents (e.g., requirement specifications and architecture models), hierarchies (e.g., architecture boards) and formal handovers (e.g., between requirement teams, development teams, and test teams) (Barlow et al., 2011). Example dependencies are between agile teams and from agile teams to the rest of the organization (such as the user side) (Mikalsen et al., 2018). As agile transformation scales, it may be problematic to scale the more flexible agile coordination and communication practices from the team level. Such a revolution may require a broader change in organizational structure and processes (Khan et al., 2016). For example, consider how it can be challenging if a development team is granted more flexibility without the user side of the organization being granted the same flexibility in terms of engaging and participating with the development side. Such one-sided transformations, where the development side is flexible, and the user side is standardized, can harm proper collaboration. It is necessary to consider how the balancing act between standardization and flexibility plays out in agile transformations. In so doing, we question existing conceptions of agile transformation and point to a suitable challenge for CSCW.

Practice Theory

Given that agile transformation is a cultural shift closely related to cooperation and communication between various organizational stakeholders, one appropriate method to investigate the effects of this transformation is to examine organizational practices and procedures (Naslund & Kale, 2020). Practice theory examines how practices are carried out, sustained, and changed in various organizational and social settings (Schmidt, 2018). A practice lens is necessary to understand the routines better, activities, and tasks that people perform while working collaboratively, as well as how these practices are influenced by the tools and technologies they employ (Bourdieu, P, 1997; Schatzki et al., 2005).

As we will see later, we have used practice theory to identify and analyze a set of practices in published literature. To understand the practices of agile transformations better, we look to cultural theories of practice. Cultural theories of practice "highlight the significance of shared or collective symbolic structures of knowledge in order to grasp both action and social order" (Reckwitz, 2002, p.246). Shove et al. (2012), based on Reckwitz (2002) cultural orientation, defined *meaning*, *material*, and *competency* as the components of practices. According to Shove et al. (2012), meaning refers to socially accepted theories or notions about a practice that gives it purpose, justifications for doing it, and rationalizations for why. Competency includes knowledge as well as attitudes and behaviors. It also provides insights into what is right, normal, and acceptable. The third element, material, refers to the physical things, innovations, and built environments that people use on a daily basis to enact their practices (Table I). Integrated components make up practices. As connections between their distinguishing elements are made and broken, practices transform, endure, and eventually vanish. Wherever these components are connected, they will be incorporated into one another, and practices will be developed. As Shove et al. put it, each component, or "element," shapes the others. When practices change, the component elements of each practice are either scrapped completely, get it passive and shrouded, or altered to become a part of the new practice or other new practices (Shove et al., 2012).

Table I- Definitions of practice components (Shove et al., 2012)

Practice Component	Definition
Competency	It includes knowledge as well as attitudes and behaviors. Competency also provides insights into what is right, normal, and acceptable.
Meaning	It refers to socially accepted theories or notions about a practice that gives it purpose, justifications for doing it, and rationalizations for why.
Material	It refers to the physical things, innovations, and built environments that people use on a daily basis to enact their practices.

Case Description

NAV manages a third of the Norwegian budget and employs over 19000 people to provide a portfolio of hundreds of services. The administration offers welfare services to the Norwegian population, such as job security, unemployment benefit, family-related benefit, occupational injury, health services, financial advice and debt counseling, and retirement and disability benefit (NAV, 2022). As established in 2006, NAV is a complex organization, or onion, as some scholars refer to it, with multiple layers of line organization structure. Its executives hoped to modernize its services through the use of new technologies. Between 2012 and 2016, several factors, such as the Norwegian government's strategy for digitizing citizen services, the failure of some projects that were put into action, and unfavorable media coverage of the company's performance in creating systems that matched users' needs led the organization's senior managers to hold specialized meetings and come to a conclusion that the organization's strategy in this area needed to be changed (Kohansal & Haki, 2021). By employing 800 people in the IT department, the company could digitalize many services by shifting its strategy to insourcing application development and modernizing architecture. NAV has created a platform that allows different teams to automatically deploy their applications. Agile methodologies began to be implemented at the team level by 2016 due to issues such as a long time to market, low user satisfaction, and a lack of internal understanding of the procedures and systems. In order to organically create new solutions, the company changed its IT ecosystem in 2017. This was a significant

move that impacted the organization, tools, people, and technologies employed by the NAV IT department (Mikalef & Parmiggiani, 2022).

NAV initially consisted of small, agile teams comprising product owners and development team members. The business decided to run fewer projects and concentrate more on improving current products with the help of agile mentors. They can choose their strategy by creating autonomous teams. With approximately 2.8 million people as users, NAV has developed product areas that are funded independently. Since the company switched teams to product areas at the end of 2019, most IT staff members are now working on specialized product teams or teams that offer infrastructure and cross-border services. The organization now has seven cross-functional product teams (CFPT) made up of 2 to 9 teams, four specialized product areas made up of 5 to 14 teams each, and 15 CFPTs that are awaiting status determination. This transition from an antiquated IT department to a product-focused company has been compared to a toddler growing into an adult by some senior executives. Due to the aforementioned modifications, the weekly release volume has increased significantly from 50 to 800, the roles of functional advisers and developer and designer have been switched, and internal IT staff members now feel more ownership of their work (Mohagheghi & Lassenius, 2021).

Method

This paper reports preliminary results from an ongoing case study (Yin, 2013). The phenomenon we study is the changes in practices as a consequence of agile transformation and their potential impact on public value. Our study is interpretative (Walsham, 1995) as we are currently trying to interpret our data in the context of several plausible theories in parallel. Our current status can be called a framing phase, where we are trying to conceptualize the phenomenon and collect and organize initial data (Pan & Tan, 2011).

The findings reported here are based on a meta-analysis of secondary data from research that various researchers have published about agile transformation in

NAV. We are aware that the use of second-hand data may be interpreted in such a way that the article is a systematic literature review. However, this article is presented as an exploratory paper and is part of ongoing research with a case study strategy that will use first-hand data such as observations and interviews in future full versions. Some of the publications used here are by researchers in our network. Others we have obtained by doing systematic searches in various databases (See Table II). After screening, we were left with 16 published papers that constitute the basis for our findings in this paper. We included only qualitative papers that discussed agile transformation in NAV. These articles were mainly written from 2016 onwards, and each described the agile transformation in the NAV from a different point of view.

Table II- Systematic Search Results in Different Scientific Databases

Keyword	Web of Science	Scopus	IEEE Explorer	Science Direct	ProQuest	AIS
TITLE-ABS-KEY (Norwegian OR welfare OR agile)	7	2	1	227	393	15
TITLE-ABS-KEY (NAV OR agile)	67	10	2	123	364	12

We analyzed the papers based on the model of practice from Shove et al. (2012). To do this, we first identified and coded all the practices studied in our sample. We then analyzed these practices to find the competencies, meaning, and material each practice contained and, where possible, the changes in these components. We used open coding. Words and sentences that discussed practices and their component units were extracted, grouped, and then used with quotations to describe the practices, their status, and the constituent parts of each practice. The results are shown in Tables III to V in the Findings section.

We acknowledge the limitations inherent in secondary data analysis, as we base our findings on limited data without ourselves having been exposed to the cases reported in these papers (Small & McCrory Calarco, 2022). We need to rely on the interpretations of other researchers instead of our own. On the other hand, secondary research-based sources as the first source of data for our case study can

also provide advantages. Analysis of secondary data, as we have done here, provides a broad perspective of NAV's agile transformation beyond what is available in internal policy and strategy documents and media coverage. As a first data source, they provide valuable insight into NAV and how other researchers have perceived NAV's agile transformation. We plan to add new data in the form of interviews with NAV employees, additional document analysis –both internal but also external media coverage – and observations of product teams.

Findings

In this section, as seen in Tables III to V, the open coding method was used to identify all of the identified practices' components, including competence, meaning, and material. For each component in these tables, pertinent quotations from the papers that have been reviewed serve as supporting evidence.

Software Development Practices

Following its gradual introduction in the NAV organization in 2016, the agile approach slowly transformed and matured, leading to significant changes in many operational aspects. One of these crucial changes was the shift of the software development practices from a project approach to a product-oriented approach (Table III). The shift from project-focused to product-focused improved communication between the business and information technology departments (Mikalef & Parmiggiani, 2022). From the lens of practice theory, through the competency component, Prior to the agile transformation, the information technology department for software development served primarily as a middleman and project supervisor, but after internalizing production and undergoing the scaled-agile transformation, product areas were gradually established, and specialized teams were formed around each product (Kohansal & Haki, 2021; Mohagheghi & Lassenius, 2021). Before the transformation, The information technology department collected the requirements from different business departments and,

after reviewing and summarizing, sent them to the system development contractors (Dingsøyr et al., 2022). The increase in the authority granted to groups of people in the form of solution development teams was another significant change that took place within the software development practice in NAV. The advantages of increasing authority include lowering organizational stress, raising motivation, enhancing interpersonal relationships, and raising productivity (Stray et al., 2018).

From the lens of practice theory, the meaning of software development in NAV has also undergone a significant change. Before the transformation, every project was carried out using a special methodology established in 2012 and involved numerous steps and handoffs between the IT department, business units, and vendors (Mohagheghi & Lassenius, 2021). The development scope was fixed, and the releases were too large and consisted of too many features (Lundene & Mohagheghi, 2018a). The sense of ownership of the products increased due to the organizational approach being changed to become more product-oriented. Product development proceeded more quickly, and organizational resources were not wasted (Kohansal & Haki, 2021). The NAV organization adopted an agile approach that increased organizational learning and reduced the gap between the business and information technology departments, allowing these two departments to coordinate their efforts and form specialized teams to focus on product development (Lundene & Mohagheghi, 2018a; Dingsøyr et al., 2023).

From the material viewpoint, The NAV software development infrastructure underwent a complete transformation from a material standpoint. Before the transformation, there were more than 50 systems in the company that was created by various contractors using numerous user interfaces and programming languages (Paasivaara & Kruchten, 2020). A product manager was assigned to each project who was responsible for creating the product backlog, gathering the requirements identified during meetings with business users, and managing them using the Jira software (Lundene & Mohagheghi, 2018a). Following the transformation, NAV concentrated on internal infrastructure development to create information systems and then established the NAIS platform. This platform allowed different

software development teams to continuously release software (Mikalef & Parmiggiani, 2022). Other platforms developed by NAV include Night Watch allows teams to independently design, execute, and implement software tests (Lundene & Mohagheghi, 2018a). The organization's goal in designing these platforms is to establish an environment for continuous software production and getting user feedback (Dingsøyr et al., 2023).

Table III – Software Development Practices and their components in NAV

Practice Component	Quotes From Literature
Old Practice: Project-Oriented Development	
Competency	<ul style="list-style-type: none"> • “The requirements were described through epics, which were broken down into user stories and detailed by domain experts. The user stories were then handed over to the development teams”(Dingsøyr et al., 2022, p.2) • “The IT department worked as a middleman between the business departments, from which funding and requirements came, and the vendors who did the actual development. The main roles in the IT department assisting system owners in contact with vendors were functional advisors, who had business domain knowledge and assisted in tasks such as analysis and estimation, and technical advisors”(Mohagheghi & Lassenius, 2021, p.1447)
Meaning	<ul style="list-style-type: none"> • “Up till 2016, nearly all software development and maintenance were conducted as large coordinated releases. These were typically organized in a staged workflow with defined phases and hand-overs. The teams in this process had a limited degree of autonomy: The scope of the iteration was fixed, the teams had to follow common processes, and they delivered to large planned releases and had to coordinate with other teams through the release plans.” (Lundene & Mohagheghi, 2018a, p.2) • “The development process used in all development was defined in 2012 and was a waterfall process with many gates and handovers between the client and vendor” (Mohagheghi & Lassenius, 2021, p.1448)
Material	<ul style="list-style-type: none"> • “Over 50 applications covering a broad range of user interfaces were managed by a group of employees organized in an office in the IT department. The office managed the contract with the vendor, provided support to the business side, and followed testing, deployment, and operations of the applications.” (Paasivaara & Kruchten, 2020, p.247) • “Typically, A project was started for new development or major modifications, and the user stories assigned to the project were organized

Practice Component	Quotes From Literature
	by product owners in a prioritized queue with virtual backlogs for each team using the JIRA software” (Lundene & Mohagheghi, 2018a, p.2)
New Practice: Product-Oriented Development	
Competency	<ul style="list-style-type: none"> • “A new organizational model, known as “Product Area,” was introduced to NAV. The Product Area groups a number of cross-functional teams and is in charge of one or more "user journeys" or "user groups," as well as related products or features. A Product Area encompasses all of the skills required to manage, develop, deliver, and maintain software within its responsibility scope.” (Kohansal & Haki, 2021, p.6) • “Placing both business and development people in cross-functional teams led to fewer handovers, and requirement dependencies, in particular, were managed at a low level.” (Dingsøy et al., 2023, p.39)
Meaning	<ul style="list-style-type: none"> • “From 2017 to 2020, NAV has moved from project development to ongoing product development in interdisciplinary/cross-functional product teams.” (Mikalef & Parmiggiani, 2022, p.128) • “Silo systems are decoupled into modular applications, and the hierarchical organization recoupled into cross-functional teams that perform continuous software development.” (Vestues & Knut, 2019, p.6) • “Teams have taken the responsibility for deployment as well, and most teams release software continuously.” (Mohagheghi & Lassenius, 2021, p.1451)
Material	<ul style="list-style-type: none"> • “By developing its own application platform for deployment/production setting (NAIS), NAV IT gained a modern application platform that allowed teams to automatically deploy to production whenever they wanted.” (Mikalef & Parmiggiani, 2022, p.127) • “The teams use Night Watch, an end-to-end testing tool, to develop and run automated functional tests. As an autonomous cross-functional team, all team members owned and were responsible for the product quality” (Lundene & Mohagheghi, 2018b, p.4) • “A new technical platform enabled continuous delivery, which increased the feedback speed.” (Dingsøy et al., 2023, p.39)

Enterprise Architecture Practices

Another practice that underwent significant modifications due to the agile transformation in the NAV organization was enterprise architecture(EA). As Table IV shows, architects played important roles at all stages before adopting agile

frameworks. From the lens of competency, they were management assignees and so-called technical police who monitored everything, and vendors should get their approval before any roll-out. Architects had significant executive power and controlled the projects' budget, timeline, and execution strategy. Enterprise architects, notwithstanding, refuted this assertion and proclaimed that although architects may have assumed the manager's position, it is likely that they did so under the manager's oversight (Kohansal & Haki, 2021). At that time, the administration established a specific section for EA to guarantee that all projects adhere to architectural procedures and practices. This section created and disseminated governance frameworks and architectural decisions, such as integration architecture or security standards, which all projects must follow (Sortehaug Ajer & Olsen, 2018). However, after the agile transformation, the role of architects changed to advisors, and the teams took full decision-making authority on the choice of architecture. Some architects joined agile product development teams, reducing the size of the central team and shifting its role from supervisory to advisory (Kohansal & Haki, 2021).

The enterprise architecture's meaning component significantly changed after the agile transformation. Previously, architecture focused more on project budget, cost, and timeline control, as well as ensuring that each project adhered to the organization's standards. EA, however, has shifted its attention more toward product areas since going agile. Teams choose the development frameworks and infrastructures to be used; there is no longer a predetermined architectural framework for creating systems (Kohansal & Haki, 2021). From the lens of material components, EA practices have evolved from controlling integration to modular architecture (Vestues & Knut, 2019) to give teams more freedom in creating their applications.

Table IV – Enterprise Architecture Practices and their Components in NAV

Practice Component	Quotes From Literature
Old Practice: Top-Down Enterprise Architecture	
Competency	<ul style="list-style-type: none"> • “In the NAV, external EA consultants had made plans not aligned with the NAV business. However, an architect from the NAV explained that the management had realized that ‘we need our own employees to be the ones who ensure continuity and, for example, ensure proper documentation.’” (Ajer & Olsen, 2019, p.88) • “The NAV has established an EA section to align the programs and the projects with the NAV’s long-term goals. NAV have established separate functions for architecture and design that work in an interdisciplinary manner across programs and projects to help in complicated situations and ensure that architectural practices are followed.” (Sortehaug Ajer & Olsen, 2018, p.5)
Meaning	<ul style="list-style-type: none"> • “The departments worked independently in the NAV, without much interaction. An enterprise architect noted, ‘NAV is a strong line-driven organization, [with] very little matrix focus. A [horizontal perspective] has very little authority and power in practice, and the hierarchy in government organizations reinforces this.’” (Sortehaug Ajer & Olsen, 2018, p.7) • “The IT projects were primarily governed by function, costs, and deadlines, necessitating close monitoring of these factors. In this governance model, architects, at all levels, had strong roles. Some believed that architects had taken the manager's role. Thus, the command and control were their approaches, and their role was assumed as the technology police, which the vendor companies only tried to get their approval.” (Kohansal & Haki, 2021, p.6)
Material	<ul style="list-style-type: none"> • “The IT department was responsible for a number of tasks, including the creation of high-level constraints such as integration architecture and security specifications, contract management, operational and technical assistance to business units, owning the system for integration and release, providing first customer support, and ensuring the service's full functionality.” (Kohansal & Haki, 2021, p.5)
New Practice: Federated (Decentralized) Enterprise Architecture	
Competency	<ul style="list-style-type: none"> • “Architects' contribution to the agile teams by bringing holistic view and organizational knowledge.” (Kohansal & Haki, 2021, p.12) • “As a result, a new experience of collaboration between architects and teams was shaped by the collaboration of architects within the agile teams. Thus, agile teams recognized that the architect's experiences and skills could be a required resource. However, the architects chose not to use the

Practice Component	Quotes From Literature
	title "architect" in their collaboration. They anticipated that this title would create some difficulties. Through this collaboration, several architects confirm that they previously lacked sufficient flexibility in their jobs. They also agreed that in order to create value in this new way of working, they must reform their working style.” (Kohansal & Haki, 2021, p.11)
Meaning	<ul style="list-style-type: none"> • “Agile teams are more accepting of the importance of EA practices. 40 designers were hired to complement the necessary team skills, and decentralized architectural work was introduced. Enterprise architects also proposed a new organizational structure called Product Area at this time. It was an effective way of establishing agile teams that was well-received by individuals.” (Kohansal & Haki, 2021, p.10)
Material	<ul style="list-style-type: none"> • “The modular architecture of the application platform was a precondition for the ongoing change. By decoupling applications, development teams could develop and release applications frequently, ensuring continuous feedback from systems and users.” (Vestues & Knut, 2019, p.10)

Data Management Practices

Data management practices are the next domain that has changed dramatically after the agile transformation. As shown in Table V, From the competency perspective, the knowledge management department was responsible for creating data storage models and analytical reports before internalization and agile transformation. However, with the swift development of software, the rapid modification of data models, and the fact that changes are unknown, the responsibility has become decentralized. Each team was in charge of managing the data. In the past, data management practices revolved around gathering data from various systems and transforming it into a data warehouse. However, the concept of "data product"—which refers to managing data by users' needs and creating a strategy for its upkeep and management—emerged as a result of agile transformation. From the lens of material, the business also created a platform that teams could use on their own to share data and create the knowledge products the business required, like dashboards (Vestues et al., 2022). The ongoing updating of data necessitates the replacement of outdated plans, which is impossible with centralized data management and

maintenance models. Traditional data management models, which gather analytical data in data silos and analyse it centrally, are incompatible with the ongoing deployment approach of agile software development (Stray et al., 2022).

Table V – Data Management Practices and their components in NAV

Practice Component	Quotes From Literature
Old Practice: Centralized Data Management	
Competency	<ul style="list-style-type: none"> “Within NAV, Analytical data has traditionally been managed by a single unit, the Knowledge department. As the name implies, the Knowledge department has been responsible for producing analytical insight about NAV, ranging from public statistics to internal steering information.” (Stray et al., 2022, p.226)
Meaning	<ul style="list-style-type: none"> “The Knowledge department has traditionally been responsible for gathering analytical data across NAV. These data have been extracted from source systems, transformed, and loaded into a data warehouse.” (Stray et al., 2022, p.226)
Material	<ul style="list-style-type: none"> “The data warehouse team has been responsible for transforming and compiling data into a coherent data model. This requires extensive knowledge of both source systems and business domains” (Stray et al., 2022, p.226)
New Practice: Distributed Data Management	
Competency	<ul style="list-style-type: none"> “For NAV, a shift from centralized to decentralized ownership implies that application development teams assume responsibility for their own data. With the distributed data ownership, interpretations and decisions relating to the data are done by the people closest to the data.” (Stray et al., 2022, p.227)
Meaning	<ul style="list-style-type: none"> “As a means of implementing data ownership, teams will develop so called “data products.” A data product is defined as a dataset and the documentation it. Data products require deliberate design and management, satisfying the needs of prospective users” (Stray et al., 2022, p.227)
Material	<ul style="list-style-type: none"> “By offering the data as reusable services, the data could then be reused by other applications and services – thereby increasing the accuracy and efficiency of transactions.” (Vestues & Knut, 2019, p.11) “To enable distributed data ownership, the organization has introduced a self-serve data platform called NADA. While data in the data warehouse is collected and curated by a single team, the new data platform offers functionality which allows all teams to share their data. The NADA platform is thus a multisided platform where the entire organization can produce and consume data” (Stray et al., 2022, p.228)

Discussion

Agile Transformation has become the belle of the ball in project and product management techniques in the past decade, gaining immense popularity in organizations worldwide. It has been the go-to approach for many, and now, the public sector is also trying to jump on the bandwagon. The goal is to accelerate and enhance the digitalization of their services, hoping to catch up with the rest of the world. However, the central query here is how agile methodologies can be applied in public organizations and what impact, beyond efficiency, they have on public values. As a cultural shift that inevitably impacts how people interact, communicate, and collaborate within an organization, it requires a deep dive into practices to understand its effects fully. Our study is about understanding how the agile approach shapes public values.

This article documents our initial analysis of the changes made within the NAV organization, using a case study approach to reveal critical findings. Through an investigation of various practices outlined in the findings, it becomes clear that software development has undergone a significant transformation. Internal agile teams have emerged, with the increased authority to design, develop, and maintain their products. In turn, platforms have been established to facilitate continuous software development, allowing teams to adopt the most suitable architectural options. As a result, the role of the organizational architecture department has shifted from hands-on development to that of a consultant and advisor. Service-oriented and modular architectures have been employed to further empower the development teams by providing more freedom and control over creating digital services. This autonomy extends to knowledge mining, business intelligence development, and data management. The development teams completely own data products, from designing and implementing reporting structures to creating analytical frameworks. All of these changes serve to enhance the agility of the organization, ultimately leading to more efficient and effective software development.

The analysis of NAV-transformed practices revealed two key elements: *authority* and *flexibility*. The organization changed to allow development teams to be more autonomous and flexible in their projects. However, the organization's inherent bias towards development teams and internal efficiency seems to hamper effective collaboration and undermine democratic participation, a fundamental value of the public sector. According to Saldivar et al. (2019), Democratic participation involves including all stakeholders in the decision-making process and building consensus rather than relying solely on the power and authority of a select few. In the realm of CSCW, a commitment to democratic participation and collaboration is crucial to creating an inclusive and innovative environment that fosters sustained growth and progress. With the expansion of agile approaches to scale in the organization and the creation of different teams for multiple product areas, this gap will gradually deepen. Introducing flexibility into a vast and intricate organization that has grown accustomed to relying on documents, plans, and hierarchies can pose a significant challenge to the organization's ability to regulate and oversee development. This conundrum can also be quite bothersome for development teams (Barlow et al., 2011; Hanseth et al., 1996).

The review of papers found that the NAV agile transformation is an internal/administrative development. The organization is undergoing a large-scale agile transformation, which poses significant challenges to conventional notions of large-scale agile implementation. This transformation requires the development of boundary and address the “*boundary work and boundary infrastructures that are required for working across contexts resolving and coordinating complex socio-technical interdependencies*” (Rolland et al., 2016, p.2). This discussion points to how we must expand notions of large-scale agile transformation to move beyond internal/admin concerns like internal efficiency and address public value. A key issue here is to broaden from a focus on only the dev side and a sole focus on autonomy and flexibility and embrace more complexity to address the boundary work involving the users/business side of the organization.

Conclusion

In pursuing digital transformation, public organizations are increasingly turning to agile methodologies to enhance their efficiency and catch up with the rest of the world. While agile transformation has proven successful in many organizations, applying it to the public sector requires a deeper understanding of its impact on public values, including democratic participation and collaboration. Through a case study approach, we revealed the significant transformation of software development within the NAV organization. The emergence of internal agile teams with increased authority over the choice of architecture, design, development, and maintain complex systems enhanced the agility of the organization, leading to more efficient and effective software development. This approach is a critical factor for public organizations to provide excellent services.

The case study of NAV reveals that although agile transformation has enabled development teams to become more autonomous and flexible, it has also highlighted inherent biases towards development teams, which may undermine democratic participation. To address this issue, there is a need to broaden the focus of agile transformation beyond internal/administrative concerns. A more nuanced and complex understanding of agile transformation is required, one that considers public organizations' unique challenges and opportunities. As we delve deeper into agile transformation, it becomes apparent that the key to success lies in more than just studying and interviewing the development teams. It is imperative that we also engage with employees from other departments within the organization, end users, and even citizens who have utilized the services provided. These valuable insights and perspectives can be integrated into the agile transformation design process. We will undoubtedly explore this further in the subsequent phases of our research.

The NAV case study also illustrates the need for boundary work and infrastructures that integrate the users/business side of the organization beyond the development side to address complex socio-technical interdependencies. Embracing complexity and developing a more holistic approach to agile transformation can facilitate

sustained growth and progress, creating an inclusive and innovative environment that fosters public values and enhances the digitalization of public services. As we look to the future, it seems essential that agile transformation studies shift their emphasis toward closely examining how public institutions change in relation to how they align with public values. This type of research will be of great value to organizations as they work to comply with government regulations regarding the wise distribution of public funds in line with democratic principles.

References

- Abrahamsson, P., Salo, O., & Ronkainen, J. (2002). *Agile Software Development Methods: Review and Analysis*. 112.
- Ajer, A. K. S., & Olsen, D. H. (2019). Enterprise Architecture Implementation Is a Bumpy Ride: A Case Study in the Norwegian Public Sector. *Electronic Journal of E-Government*, 17(2). <https://doi.org/10.34190/EJEG.17.2.002>
- Augustine, S., Payne, B., Sencindiver, F., & Woodcock, S. (2005). *Agile project management*.
- Barlow, J. B., Giboney, J. S., Keith, M. J., Wilson, D. W., Schuetzler, R. M., Lowry, P. B., & Vance, A. (2011). Overview and Guidance on Agile Development in Large Organizations. *Communications of the Association for Information Systems*, 29, 25–44.
- Bjørn, P., Søderberg, A.-M., & Krishna, S. (2019). Translocality in Global Software Development: The Dark Side of Global Agile. *Human-Computer Interaction*, 34(2), 174–203. <https://doi.org/10.1080/07370024.2017.1398092>
- Blomberg, J., & Karasti, H. (2013). Reflections on 25 Years of Ethnography in CSCW. *Computer Supported Cooperative Work (CSCW)*, 22(4–6), 373–423. <https://doi.org/10.1007/s10606-012-9183-1>
- Bourdieu, P. (1997). *Outline of a Theory of Practice*. Cambridge University Press.
- Bowers, J., Button, G., & Sharrock, W. (1995). Workflow From Within and Without: Technology and Cooperative Work on the Print Industry Shopfloor. In H. Marmolin, Y. Sundblad, & K. Schmidt (Eds.), *Proceedings of the Fourth European Conference on Computer-Supported Cooperative Work ECSCW '95* (pp. 51–66). Springer Netherlands. https://doi.org/10.1007/978-94-011-0349-7_4
- Dingsøyr, T., Falessi, D., & Power, K. (2019). Agile Development at Scale: The Next Frontier. *IEEE Software*, 36(2), 30–38. <https://doi.org/10.1109/MS.2018.2884884>
- Dingsøyr, T., Bjørnson, F. O., Schrof, J., & Sporse, T. (2023). A longitudinal explanatory case study of coordination in a very large development programme: The impact of

- transitioning from a first- to a second-generation large-scale agile development method. *Empirical Software Engineering*, 28(1), 1. <https://doi.org/10.1007/s10664-022-10230-6>
- Dingsoyr, T., Jorgensen, M., Carlsen, F. O., Carlstrom, L., Engelsrud, J., Hansvold, K., Heibo-Bagheri, M., Roe, K., & Sorensen, K. O. V. (2022). Enabling Autonomous Teams and Continuous Deployment at Scale. *IT Professional*, 24(6), 47–53. <https://doi.org/10.1109/MITP.2022.3209871>
- Dingsøy, T., Nerur, S., Balijepally, V., & Moe, N. B. (2012). A decade of agile methodologies: Towards explaining agile software development. *Journal of Systems and Software*, 85(6), 1213–1221. <https://doi.org/10.1016/j.jss.2012.02.033>
- Fuchs, C., & Hess, T. (2018). *Becoming Agile in the Digital Transformation: The Process of a Large-Scale Agile Transformation*. 18.
- Hanseth, O., Monteiro, E., & Hatling, M. (1996). Developing Information Infrastructure: The Tension Between Standardization and Flexibility. *Science, Technology, & Human Values*, 21(4), 407–426. <https://doi.org/10.1177/016224399602100402>
- Helsetilsynet. (2020). *Veileder for landsomfattende undersøkelse 2020-2021 om tilgjengelighet til sosiale tjenester i Nav. Internserien 2/2020*.
- Hoda, R. (Ed.). (2019). *Agile Processes in Software Engineering and Extreme Programming – Workshops: XP 2019 Workshops, Montréal, QC, Canada, May 21–25, 2019, Proceedings (Vol. 364)*. Springer International Publishing. <https://doi.org/10.1007/978-3-030-30126-2>
- Johannessen, L. K., & Ellingsen, G. (2009). Integration and Generification—Agile Software Development in the Healthcare Market. *Computer Supported Cooperative Work (CSCW)*, 18(5–6), 607–634. <https://doi.org/10.1007/s10606-009-9097-8>
- Khan, M. R., Fernández, W. D., & Jiang, J. J. (2016). Is there such a thing as agile IT program management?
- Kohansal, M. A., & Haki, K. (2021). *Enterprise Architecture’s Ups and Downs Over Time: A Case of De- and Re- Institutionalization*.
- Kruchten, P. (2013). Contextualizing agile software development: CONTEXTUALIZING AGILE SOFTWARE DEVELOPMENT. *Journal of Software: Evolution and Process*, 25(4), 351–361. <https://doi.org/10.1002/smr.572>
- Lang, G. (2017). Agile Learning: Sprinting Through the Semester. *Information Systems Education Journal*, 15(3), 14–21.
- Lundene, K., & Mohagheghi, P. (2018a). How autonomy emerges as agile cross-functional teams mature. *Proceedings of the 19th International Conference on Agile Software Development: Companion*, 1–5. <https://doi.org/10.1145/3234152.3234184>
- Lundene, K., & Mohagheghi, P. (2018b). How autonomy emerges as agile cross-functional teams mature. *Proceedings of the 19th International Conference on Agile Software Development: Companion*, 1–5. <https://doi.org/10.1145/3234152.3234184>

- Mergel, I., & Ganapati, S. (2020). Agile: A New Way of Governing. *Public Administration Review*, 81(1), 161–165.
- Mergel, I., Gong, Y., & Bertot, J. (2018). Agile government: Systematic literature review and future research. *Government Information Quarterly*, 35(2), 291–298. <https://doi.org/10.1016/j.giq.2018.04.003>
- Mikalef, P., & Parmiggiani, E. (Eds.). (2022). *Digital Transformation in Norwegian Enterprises*. Springer International Publishing. <https://doi.org/10.1007/978-3-031-05276-7>
- Mikalsen, M., Moe, N. B., Stray, V., & Nyrud, H. (2018). Agile Digital Transformation: A Case Study of Interdependencies. 9.
- Mohagheghi, P., & Lassenius, C. (2021). Organizational implications of agile adoption: A case study from the public sector. *Proceedings of the 29th ACM Joint Meeting on European Software Engineering Conference and Symposium on the Foundations of Software Engineering*, 1444–1454. <https://doi.org/10.1145/3468264.3473937>
- Moore, M. H. (1995). *Creating public value: Strategic management in government*. Harvard university press.
- Naslund, D., & Kale, R. (2020). Is agile the latest management fad? A review of success factors of agile transformations. *International Journal of Quality and Service Sciences*, 12(4), 489–504. <https://doi.org/10.1108/IJQSS-12-2019-0142>
- NAV. (2022). What is NAV? <https://www.nav.no/en/home/about-nav/what-is-nav>
- Olteanu, C. G. (2018). IT Agile Transformation. *Academy of Economic Studies. Economy Informatics*, 18(1), 23–31.
- Paasivaara, M., & Kruchten, P. (Eds.). (2020). *Agile Processes in Software Engineering and Extreme Programming – Workshops: XP 2020 Workshops*, Copenhagen, Denmark, June 8–12, 2020, Revised Selected Papers (Vol. 396). Springer International Publishing. <https://doi.org/10.1007/978-3-030-58858-8>
- Pan, S. L., & Tan, B. (2011). Demystifying case research: A structured–pragmatic–situational (SPS) approach to conducting case studies. *Information and Organization*, 21(3), 161–176. <https://doi.org/10.1016/j.infoandorg.2011.07.001>
- Procter, R., Rouncefield, M., Poschen, M., Lin, Y., & Voss, A. (2011). Agile Project Management: A Case Study of a Virtual Research Environment Development Project. *Computer Supported Cooperative Work (CSCW)*, 20(3), 197–225. <https://doi.org/10.1007/s10606-011-9137-z>
- Qumer, A., & Henderson-Sellers, B. (2006). COMPARATIVE EVALUATION OF XP AND SCRUM USING THE 4D ANALYTICAL TOOL (4-DAT). 9.
- Reckwitz, A. (2002). Toward a Theory of Social Practices: A Development in Culturalist Theorizing. *European Journal of Social Theory*, 5(2), 243–263. <https://doi.org/10.1177/13684310222225432>

- Rolland, K. H., Dingsøy, T., & Fitzgerald, B. (2016). Large-Scale Agile Development. Thirty Seventh International Conference on Information Systems, Dublin.
- S. Rubin, K. (2013). ESSENTIAL SCRUMA PRACTICAL GUIDE TO THE MOST POPULARAGILE PROCESS. Pearson Education.
- Saldivar, J., Parra, C., Alcaraz, M., Arteta, R., & Cernuzzi, L. (2019). Civic Technology for Social Innovation: A Systematic Literature Review. *Computer Supported Cooperative Work (CSCW)*, 28(1–2), 169–207. <https://doi.org/10.1007/s10606-018-9311-7>
- Schatzki, T. R., Savigny, E. von, & Knorr-Cetina, K. (2005). *The Practice Turn in Contemporary Theory*. Taylor and Francis.
- Schmidt, K. (2018). Practice and Technology: On the Conceptual Foundations of Practice-Centered Computing. In *Socio-Informatics* (pp. 47–104). Oxford University Press.
- Schmidt, K., & Bannon, L. (2013). Constructing CSCW: The First Quarter Century. *Computer Supported Cooperative Work (CSCW)*, 22(4–6), 345–372. <https://doi.org/10.1007/s10606-013-9193-7>
- Shove, E., Pantzar, M., & Watson, M. (2012). *The dynamics of social practice: Everyday life and how it changes*. SAGE.
- Small, M. L., & McCrory Calarco, J. (2022). *Qualitative literacy: A guide to evaluating ethnographic and interview research*. University of California Press.
- Sommerville, I. (2016). *Software engineering* (10. ed., global ed). Pearson.
- Sortehaug Ajer, A. K., & Olsen, D. H. (2018). ENTERPRISE ARCHITECTURE CHALLENGES: A CASE STUDY OF THREE NORWEGIAN PUBLIC SECTORS. 17.
- Stray, V., Moe, N. B., & Hoda, R. (2018). Autonomous agile teams: Challenges and future directions for research. *Proceedings of the 19th International Conference on Agile Software Development: Companion*, 1–5. <https://doi.org/10.1145/3234152.3234182>
- Stray, V., Stol, K.-J., Paasivaara, M., & Kruchten, P. (Eds.). (2022). *Agile Processes in Software Engineering and Extreme Programming: 23rd International Conference on Agile Software Development, XP 2022, Copenhagen, Denmark, June 13–17, 2022, Proceedings* (Vol. 445). Springer International Publishing. <https://doi.org/10.1007/978-3-031-08169-9>
- Suchman, L. A. (1983). Office procedure as practical action: Models of work and system design. *ACM Transactions on Information Systems*, 1(4), 320–328. <https://doi.org/10.1145/357442.357445>
- Sutherland, J. V. (2014). *Scrum: The art of doing twice the work in half the time* (First Edition). Crown Business.
- Tendedez, H., Ferrario, M. A. M. A. F., & Whittle, J. (2018). Software Development and CSCW: Standardization and Flexibility in Large-Scale Agile Development. *Proceedings of the ACM on Human-Computer Interaction*, 2(CSCW), 1–23. <https://doi.org/10.1145/3274440>

- Twizeyimana, J. D., & Andersson, A. (2019). The public value of E-Government – A literature review. *Government Information Quarterly*, 36(2), 167–178. <https://doi.org/10.1016/j.giq.2019.01.001>
- Vestues, K., Hanssen, G. K., Mikalsen, M., & Buan, T. A. (Eds.). (2022). A Case Study. In *Agile Processes in Software Engineering and Extreme Programming*. In *Agile Processes in Software Engineering and Extreme Programming* (Vol. 445, pp. 220–235). Springer International Publishing. <https://doi.org/10.1007/978-3-031-08169-9>
- Vestues, K., & Knut, R. (2019). Making Digital Infrastructures More Generative Through Platformization and Platform- driven Software Development: An Explorative Case Study.
- Walsham, G. (1995). Interpretive case studies in IS research: Nature and method.
- Yin, R. K. (2013). Validity and generalization in future case study evaluations. *Sage Publication*, 19, 321–332.
- Ylinen, M. (2021). Incorporating agile practices in public sector IT management: A nudge toward adaptive governance. *Information Polity*, 26(3), 251–271. <https://doi.org/10.3233/IP-200269>

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The workers strike back- A literature survey of digital circumvention tools used by online gig workers

Runar Sæther and Babak A. Farshchian

Norwegian University of Science and Technology (NTNU), Trondheim, Norway
runarsae@stud.ntnu.no; babak.farshchian@ntnu.no

Abstract. Most studies of digital labor platforms –also known as gig platforms –investigate how workers are affected by platforms through algorithmic control and governance models implemented by platform owners. We draw on the platform boundary resource model to review an emerging body of literature that looks at how platform workers cope with this platform-enforced governance through an array of digital circumvention tools. We find that workers make use of several types of such tools including social media, chat groups, and various forms of specialized software. We show what this type of digital circumvention tools are used for and discuss their challenges and potential impact on labor platform ecosystems.

Introduction

Labor platforms are a specific type of multi-sided digital platform that facilitate a market for buying and selling of labor. They are also called gig platforms as they often support gig work. These platforms are popular in many countries because they provide an additional source of income for many, and because they help freelance workers get access to often large pools of potential customers. Labor platforms are used to trade anything from the so-called micro-tasks –e.g. filling in a form in Amazon Mechanical Turk (AMT) –to standardized errands such as delivering food

to more interactive and creative freelance work such as photography gigs or designing a web site. International Labour Organization (ILO) distinguishes between platforms that facilitate online location-independent work –e.g. AMT –and platforms that facilitate physical work in specific locations –e.g. Uber (International Labour Organization 2021). Surveys in Europe and North America between 2015 and 2019 suggests that 0.3 to 22 percent of the adult population has performed platform work. These figures have probably increased after pandemic (International Labour Organization 2021).

Research involving gig workers and in particular labor platform workers often uncovers a wide set of challenges faced by the workers (Kittur et al. 2013; Martin et al. 2014). Gig workers can struggle to remain viable, organize themselves, develop and maintain professional identities, cope emotionally, and build networks (Ashford et al. 2018). These challenges are different from those faced by long-term employees in permanent employment relationships (Caza et al. 2022). Regulatory bodies, labor unions, and workers’ interest organizations continuously monitor and propose or implement new regulations (International Labour Organization 2021; Alsos and Dølvik 2021).

At the same time, there is a growing body of research that shows platform workers themselves develop tools that allow them to overcome platform-related challenges. Such approaches are interesting because they can be seen as worker-initiated attempts to improve platform ecosystem well-being. We therefore present in this paper the initial results of an ongoing systematic literature review to better understand this emerging phenomenon that we call *digital circumvention* by workers in labor and gig platforms. By digital circumvention we mean any individual or collective use of digital tools by platform workers to cope with what the workers perceive as labor-related restrictions implemented by digital platforms.

Our systematic literature review tries to answer the following research question: What do we know about digital circumvention among digital labor platform workers based on existing research literature? We did a systematic search in Scopus for related concepts. This resulted in 41 relevant papers that we then analyzed qualitatively.

In our analysis, we perceive digital circumvention tools as platform boundary resources (Ghazawneh and Henfridsson 2013). Platform boundary resources include application programmer’s interfaces (APIs), contracts, apps and other digital or non-digital tools that support interaction and data exchange between a platform core and its periphery. While such resources are often developed and offered by platform owners, earlier research has shown that platform boundary resources are often developed in various forms of collaboration between platform owners/designers and end-users (Eaton et al. 2015; Farshchian and Thomassen 2019; Islind et al. 2019). Our study shows a range of platform boundary resources that are mainly developed and owned by the end-users themselves, through what Ghazawneh and Henfridsson (2013) call self-resourcing.

Our results show three major types of digital circumvention: 1) online communities, 2) layered-on software, and 3) external software. Online communities seem to be the most prevalent among the three types. Conventional social media such as Facebook are often used to bring together –often local –communities of platform workers. However, we also see examples of private chat rooms and even independent portals and social media specifically developed for the purpose. Layered software is specialized software developed to collect and disseminate data from the platform that otherwise are not easily available for the workers. Examples are browser plugins that distill and present data from Amazon Mechanical Turk. External software is decoupled software that is used individually or collectively by workers to do specific tasks, such as video conferencing tools to cooperate with other workers or with customers in freelance work.

Our data also show that these tools are used for different purposes such as moral and emotional support, task-specific collaboration, and support for collective action. We also see variations among the types of workers, e.g. those who primarily work with micro-tasks and those who work on larger and creative tasks. Our data also show different degrees of collaboration between platform workers and owners in developing digital circumvention tools.

Our paper is an important initial contribution to the fertile topic of digital circumvention in online labor and gig platforms. Often, the discussion about labor platforms and worker conditions happens in a top-down manner, involving legal and regulatory issues. Our study looks at existing empirical evidence of how the workers themselves find practical means of circumventing what they consider as unreasonable restrictions imposed on their work practices. This evidence can be an important input to various policy and regulatory discussion but can also be an important input to sustainable labor platform design.

In the rest of this paper, we first provide a brief background from extant literature. We then present our method and our findings, before we conclude with a discussion of the findings.

Background

In this background section we provide a short introduction to digital multi-sided platforms, online labor platforms, some emerging challenges for platform workers, and what digital circumvention tools can achieve.

Multi-sided platforms and platform labor

Digital platforms are defined in various ways. From a technological perspective, a digital platform can be regarded as a “software-based product or service that serves as a foundation on which outside parties can build complementary products or services” (Tiwana 2014 p. 5). This definition implies that a platform consists of a

foundation –often called the *core* of the platform –and a set of complementary building blocks –the *periphery* –developed by third-party complementors (Rodon Modol and Eaton 2021).

The platform boundary resource model developed by Ghazawneh and Henfridsson (2013) explains how the core and the boundary are connected and communicate through resources such as APIs and other non-technical tools such as end-user license agreements. Platform boundary resources are often used by platform owners to secure –i.e., gaining control of the platform by restricting the space in which complementors can operate –or to resource –i.e., increase the scope and diversity of a platform for the third-party complementors. Not all platform boundary resources are owned by the platform owners. For instance, the digital circumvention tools that we review in this paper are all developed by others that platform owners, i.e., workers and complementors. This is called self-resourcing, which is the act of third-party developers building their own boundary resources as an answer to the restrictiveness of digital platforms imposed by securing (Ghazawneh and Henfridsson 2013).

Besides this technical view of digital platforms, platforms are also often regarded as marketplaces. The core of a platform facilitates the connection between producers and consumers situated in the periphery. From this perspective, platforms are regarded as multi-sided markets that sit between platform owners, producers, and consumers (McIntyre et al. 2021). Sutherland and Jarrahi (2018) have identified several affordances for multi-sided sharing platforms, including match-making, trust-building, extended reach, and transaction management. Digital labor platforms can be regarded as multi-sided platforms that create a marketplace for trading labor.

This review will use the categorization suggested by the International Labour Organization (ILO) to distinguish the different types of digital labor platforms and the type of work they mediate (International Labour Organization 2021). ILO differentiates labor platforms by how the work is conducted, either online or physically.

Online web-based labor platforms facilitate work that is done entirely remotely, making it possible for workers and clients to connect globally with ease. Different types of online platforms are freelance- and contest-based ones for more demanding tasks like accounting, programming, and design (e.g., Upwork, Fiverr and 99designs) and microtask platforms for small, simple tasks given to a crowd, such as image categorization, survey completion, and text translation (e.g., Amazon Mechanical Turk and Clickworker). The latter type is often referred to as crowdwork platforms. ILO also mentions competitive programming platforms and medical consultation platforms as types of online web-based labor platforms.

Location-based labor platforms mediate tasks that are to be carried out in the physical world. Examples are found in sectors such as accommodation (e.g., Airbnb), transport (e.g., Uber and Lyft), delivery (e.g., Foodora and Deliveroo) and household services (e.g., Taskrabbit and Helpling). Workers on these platforms

usually must provide their own equipment to be able to do the work, such as mobile phones, transportation methods, tools, etc.

Platform labor and its challenges

Platform labor is supported differently by different platforms. Some platforms may use a competition-based strategy to select workers, while others may choose the first person to sign up. There are also differences in worker-client communication; some platforms opens up for a more direct, closer relationship between the two, often seen on freelancer platforms, while others restrict the communication to predefined steps mediated by the platform (Gray et al. 2016). Platforms can be general purpose or specialize in services such as driving.

Platforms do more than enabling labor. In addition to their support for the task itself –e.g. ride hailing –platforms implement several mechanisms to enable the marketplace where the labor is traded. Choudary (2018) has identified several incentives, punishments, and subsidization mechanisms in labor platforms, including multihoming costs, reputation systems, network effects, reduction in transaction costs, and various risk reduction systems for the platform owner.

A crucial aspect of the operation of most digital labor platforms, which makes standardization and scalability possible, is their algorithmic management of workers (Jarrahi et al. 2020). This encompasses several ways in which algorithms are used for decision making in organizing and controlling workers and managing transactions on platforms through search, matching, prioritization, and scheduling (Raval and Dourish 2016).

The algorithmic nature of digital labor platforms creates a complex work environment for gig workers (Jarrahi and Sutherland 2019). As identified by Caza et al. (2022) in a thorough literature review, the way work is structured imposes several challenges on workers related to viability, organization, identity, emotional, relational and career-path uncertainty. For instance, viability refers to workers' concerns about whether work is going to provide them with the income they need and help them to reach their goals. Organizational challenges are related to the atomization of workers, who are left on their own to navigate the platforms, make themselves available on the market, and be attractive to clients (Yao et al. 2021). Atomization also creates power asymmetries, making it difficult for workers to collectively organize and collaborate (Kinder et al. 2019).

Digital circumvention among platform workers

Despite atomized work arrangements by digital labor platforms, and the absence of a traditional physical workplace, research has shown that these restrictions do not stop workers from collaborating and collectively coordinating (Gray et al. 2016; Yin et al. 2016). With little or no support from platform owners and policy makers, gig workers turn to their own solutions to solve their challenges, often through

digital means. These digital tools, what we call *digital circumvention tools*, have been sporadically documented in the literature in form of online groups, individual task support tools, tools specialized for specific platforms, platforms for collective action etc. Our objective in this paper is to provide a systematic overview of these tools, which is provided below in the Findings section.

Method

In this paper we report on the first iteration of a systematic literature review of digital circumvention tools. This is a first step because we aim to follow a hermeneutic approach in our work with literature (Boell and Cecez-Kecmanovic 2014). Digital circumvention is an emerging concept, and a common conceptual model or a vocabulary is still missing. It is therefore difficult to find all relevant literature by merely searching for keywords. By documenting and presenting preliminary results we hope to get focused feedback on our research questions and what to search for in a new round (Tynan and Bishop 2022), but also to develop our conceptual framework for the study (Leidner and Tona 2021).

We followed a standard staged model for our initial review, suggested by, among others, Oates et al. (2022). These stages are searching, obtaining, assessing, reading, evaluating, recording, and writing. The process resulted in a total of $n = 41$ relevant publications that are included in the review, illustrated in Figure 1.

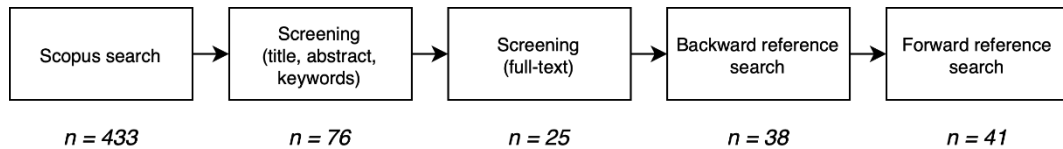


Figure 1: Literature review process followed in this study and the number of primary sources in each step.

At this first step in our study, we searched only in Scopus. Our search phrase (shown in Table 1 below) emerged from our background study (see previous section), our formulation of the research question, but also from the interactive search functionality offered by Scopus. The two concepts seek to grasp how labor platform workers, reflected in concept 1, may use IT solutions to address their challenges, reflected in concept 2. The search query is generated using the Boolean operator OR between the keywords within each concept, and then using the Boolean operator AND between the two concepts. This ensures that the resulting documents include at least one keyword for each concept. The search is performed on the title, abstract and Scopus-provided keywords.

Table 1: Our search phrase.

Concept 1: Target group	Concept 2: Purpose	
“Digital labor platform”	Mobilization	“Peer support”
“Gig economy”	Resistance	Network
“Gig work”	Organization	Collective
“Gig worker”	Union	Collaborate
Crowdwork	Community	Share
Crowdworker	Group	Learn

We included only papers that were in English, peer reviewed, and that were focusing on digital circumvention among platform workers. We excluded papers that were about worker challenges in general without studying digital circumvention. Screening of the search results based on inclusion and exclusion criteria resulted in 25 papers. We then did one round of backward and forward snowball search that resulted in additional 13 papers, bringing the total number of included papers to 41. These papers were then imported to a qualitative analysis tool (MAXQDA) and coded. Through a thematic analysis (Braun and Clarke 2006) a range of themes emerged related to types of tools, types of supported activities, and challenges. These themes are presented in our Findings section.

Findings

Types of digital circumvention tools

Our data show three classes of digital circumvention tools in use. These are online groups and communities, layered-on tools, and independent tools (see Table 2 at the end of this section). In the following sections we shortly introduce these and summarize our findings related to each.

Online communities and groups

Online communities are used to create a sense of identity, provide emotional support among workers, and provide information that is otherwise not available through digital labor platforms (Cropanzano et al. 2023). These efforts can help workers increase their productivity and efficiency, but also satisfy their social interaction needs (Kost et al. 2020). The communities are built on social media platforms, in chat and messaging groups, and on independent forums and websites (Gray et al. 2016).

Most of the literature discusses how gig workers utilize the collaboration support features of popular platforms to complement their work life. Examples include

social media platforms such as Facebook (Raval and Dourish 2016; Yin et al. 2016; Holikatti et al. 2019; Williams et al. 2019; Maffie 2020; Soriano and Cabañes 2020; Shalini et al. 2021; Yao et al. 2021; Posada 2022), social news sites such as Reddit (Schmidt and Jettinghoff 2016; Yin et al. 2016; Williams et al. 2019; Kinder et al. 2019; Waldkirch et al. 2021; Yao et al. 2021), and online video platforms such as YouTube (Chan 2019; Kinder et al. 2019). Although the literature shows that most types of gig workers have used these means of community building, it is also shown that freelancers are more likely to organize in social media groups compared to crowdworkers (Wood et al. 2018). Crowdworkers usually make use of independent community websites, discussed below.

Chat and messaging groups share many of the same functionalities and benefits as social media groups but tend to be smaller and more specialized for a specific geographic location (Seetharaman et al. 2021; Shalini et al. 2021). Compared to other online communities, gig workers prefer messaging groups with people they know (Woodside et al. 2021; Posada 2022). Chat and messaging groups offer instant and synchronous communication among participants. Examples found in the literature are instant messaging and voice over IP (VoIP) services such as WhatsApp (Tassinari and Maccarrone 2020; Popan 2021; Seetharaman et al. 2021; Shalini et al. 2021; Posada 2022), Discord (Williams et al. 2019; Posada 2022), Messenger (Williams et al. 2019), Telegram (Williams et al. 2019; Posada 2022) and WeChat (Zhou and Pun 2022).

There is a subcategory of online communities that has emerged, especially within crowdwork. These communities are independent websites and forums without any connection to any third-party organization, such as social media platforms or messaging providers (Lehdonvirta 2018). From the perspective of the platforms, they are third-party websites (Schmidt and Van Dellen 2022). These communities often function similarly to social media groups but are specifically tailored for their users and may have different sections for different topics (Ihl et al. 2020). Crowdworkers turn to these communities, as they are independent of the platform and the requesters on the platform (Gray et al. 2016; Ihl et al. 2020).

Independent community websites have facilitated collaboration between workers in several ways. These efforts cover up information asymmetries, often targeting more inexperienced workers. For example, they help each other with account creation and how to find reliable and well-paying tasks and requesters (Gray et al. 2016; Ihl et al. 2020). They also collaborate to solve tasks through the websites (Gray et al. 2016).

Layered on software tools

The category of layered-on software includes digital tools that use data from labor platforms and in some way provide additional information to the user interfaces of the platforms. In this way, they mitigate some of the information asymmetries enforced by the platforms, which, as we will see, further affects precariousness and

power asymmetries. Examples found in the literature are browser extensions (Irani and Silberman 2013; Callison-Burch 2014; Hanrahan et al. 2015; Williams et al. 2019; Savage et al. 2020; Cini 2023), apps (Woodside et al. 2021) and messaging bots (Pentland et al. 2022; Calacci and Pentland 2022).

Many of the layered-on software solutions target crowdwork platforms like Amazon Mechanical Turk. These are often browser extensions, ranging from simple interface enhancements, such as blocking out content that is not in use, to more sophisticated enhancements to display earnings and statistics, and automatic alerting when new tasks are created (Lehdonvirta 2018).

Layered-on solutions are based on data collection and data presentation as a response to information asymmetries. The data collection is initiated by workers and is done manually or automatically. Manual data collection is found in Shipt, where workers take screenshots and send them, and in Turkopticon, where workers write reviews of tasks and fill in their pay. Other software solutions collect data from the platforms automatically as they are being used, as seen in the CrowdWorkers, TurkBench and TurkerView plugins, and in Driver's Seat and Mystro. The presentation of data is often inserted into the platform user interfaces, like in most of the browser extensions, or presented through an external interface, like its own application or website, such as in TurkBench, Driver's Seat and Mystro.

External software tools

External software can be categorized as tools that do not have a direct connection to digital labor platforms, but otherwise help workers in their work situation. Research shows that external software is used to bypass the limitations of the tools provided by the platforms (Williams et al. 2019; Kinder et al. 2019). Freelance workers have been found to use external communication tools such as Skype and Google Hangouts to stay in touch with their clients (Kinder et al. 2019). They also use external tools for file sharing, due to the reduction in image and video quality, and the limitations on file size enforced by the platform (Kinder et al. 2019). Tools such as Google Sheets, Google Docs, Word and Paint are also used by crowdworkers in an administrative way to log and document their tasks (Williams et al. 2019). Drivers on location-based platforms use Excel to calculate the true costs of driving, covering gas money, waiting times and car repairs (Cameron 2022).

Table 2: Types of digital circumvention tools reported in the included literature.

Article	IT solution				
	Online community			Layered-on software	External software
	Social media	Chat	Independent		
Callison-Burch (2014)				x	
Calacci and Pentland (2022)				x	
Cameron (2022)					x
Chan (2019)	x				
Chesta et al. (2019)	x	x			
Cini (2022)	x		x	x	
Cropanzano et al. (2022)	x	x	x		
Graham et al. (2020)					x
Gray et al. (2016)	x	x	x		
Hanrahan et al. (2015)				x	
Harmon and Silberman (2018)					x
Holikatti et al. (2019)	x				
Ihl et al. (2020)			x		
Irani and Silberman (2013)				x	
Kaine and Josserand (2019)	x				
Kinder et al. (2019)	x				x
Kost et al. (2020)	x	x	x		
Lehdonvirta (2018)	x	x	x	x	
Lettieri et al. (2019)					x
Li et al. (2022)				x	
Maffie (2020)	x				
Popan (2021)		x			
Posada (2022)	x	x			
Raval and Dourish (2016)	x				
Salehi et al. (2015)			x		
Savage et al. (2020)				x	
G. Schmidt and Jettinghoff (2016)	x		x		
G. Schmidt and Van Dellen (2022)			x		
Seetharaman et al. (2021)		x			
Shalini et al. (2021)	x	x			
Soriano and Cabañes (2020)	x				
Tassinari and Maccarrone (2020)		x			
Waldkirch et al. (2021)	x				
Walker (2021)			x		
Watkins (2022)			x		
Williams et al. (2019)	x	x	x	x	x
Wood et al. (2018)	x	x	x		
Woodside et al. (2021)	x	x	x	x	
Yao et al. (2021)	x				
Yin et al. (2016)	x		x		
Zhou and Pun (2022)		x			

Types of activity supported by the tools

In this section we provide a categorization of the types of activities that digital circumvention tools are used for.

Access to additional information

Evidence shows that the most prominent benefit of social media groups for gig workers is the information sharing capabilities they facilitate, helping to compensate for platform-imposed information asymmetries (Raval and Dourish 2016; Kaine and Josserand 2019; Kinder et al. 2019; Maffie 2020; Yao et al. 2021). Workers use these groups to share experiences to better understand digital labor platforms and their algorithms, and how to bypass them (Posada 2022), creating entrepreneurial solidarity (Soriano and Cabañes 2020). Facebook groups for location-based work are found to contain four types of information sharing behavior. Workers seek solutions to the problems they face, seek experiences from other workers, share experiences in their work, and share external resources such as official information (Yao et al. 2021).

While online communities can facilitate information sharing among workers, many layered-on software tools focus on providing individual workers with information that is difficult to share or see in the platforms interface. An example is Turkopticon, a browser extension that augments the Amazon Mechanical Turk website with the ability for workers to review employers (Irani and Silberman 2013). These reviews are aggregated so that other workers can easily see whether an employer is reliable and pays well. Turkopticon reverses the roles of evaluation and information asymmetry, allowing workers to avoid employers with a bad reputation (Cini 2023). Another example is the CrowdWorkers plugin that tracks when a worker accepts and delivers tasks and aggregates the pay of all users of the plugin, so they get a quantitative overview of well-paid tasks (Callison-Burch 2014). A similar software is TurkBench, a browser plugin and website that crawls the Amazon Mechanical Turk website for tasks, tracks worker usage, and enhances the interface so that workers can easily locate lucrative tasks and requesters based on their qualifications (Hanrahan et al. 2015). Another example is TurkerView, which functions similarly to the CrowdWorkers plugin, by crawling the website and showing the expected hourly wage for a given requester (Williams et al. 2019; Savage et al. 2020). The goal of these software tools is to “minimize unpaid work and increase earnings” (Hanrahan et al. 2015), which directly helps mitigate the challenges related to precarity.

Education and training

Workers who rely on digital labor platforms for their primary income and career development often participate in communities of practice and create resources for learning, increasing their competencies, and possibly creating “boundaryless careers” (Kost et al. 2020). For instance, on social media such as YouTube, there are numerous Uber drivers who create video content, acting as bloggers, to increase the knowledge and skills of other drivers (Chan 2019). These resources are often targeted towards the algorithmic aspect of the platform, to get an understanding of its functioning for drivers to maximize their profit.

As they learn more about their work, workers also tend to be more active in social media groups, moving from a peripheral role, often just observing the group, to being integrated into the community (Holikatti et al. 2019). These bottom-up learning and training strategies have shown to be important for workers in the gig economy (Waldkirch et al. 2021).

Emotional support

Gig work is often perceived as low status by friends, family and society, due to its precariousness (Seetharaman et al. 2021). Although informational support is dominant in social media groups, there are also cases of emotional support (Yao et al. 2021). Members are often in the same situation, which makes it easier to ask for and provide emotional support, as there is less fear of being stigmatized. Emotional support often takes the form of humor related to the work, rant or complaint about the work situation and experiences, and compassion for others (Yao et al. 2021).

The use of chat and messaging groups fosters the building of relationships with other workers to create an environment for emotional support. The groups are often smaller than in online communities and may have members with pre-existing relationships. They facilitate the acceptance and understanding of similar-minded workers, providing emotional support and solidarity, mitigating labor atomization (Seetharaman et al. 2021). For physical gig workers, they offer a digital free space from both platform control and the society (Shalini et al. 2021; Zhou and Pun 2022). Workers also often use them to plan real-world meetings (Tassinari and Maccarrone 2020; Shalini et al. 2021).

Like social media groups and messaging groups, independent communities also provide emotional support among workers (Ihl et al. 2020). On one hand, they share negative emotions and work incidents, and receive support from their peers. On the other hand, they share positive aspects, such as the achievement of goals to be recognized by their peers and to receive appreciation. Through these cases of support, workers feel that their work is more meaningful and that they develop a sense of shared identity with others (Ihl et al. 2020; Schmidt and Van Dellen 2022).

Practical support

While online media is mostly used for informal sharing and emotional support, practical support related to specific types of task is done through chat groups and specialized layered-on or independent tools. Groups that target location-based work are used as a safety net in the absence of instrumental support from platforms and society (Tassinari and Maccarrone 2020; Popan 2021; Seetharaman et al. 2021). When entering the gig economy, many are unaware of the risks they might face. As a consequence, workers turn to their peer networks in messaging groups to minimize some of the risks (Seetharaman et al. 2021). The groups are used to contact other workers for support in emergencies, for example, in cases of theft, violence, vehicle problems, and accidents. They are also used to mitigate risks in advance. For

example, they provide information about dangerous locations and whether workers should accept tasks they are offered.

Several tools are used to share salary-related data among workers. The layered-on Shipt calculator is a tool that grocery delivery workers on the Shipt platform use to increase wage transparency (Calacci and Pentland 2022). The tool works by having workers take screenshots of their pay history from the labor platform app and send them using SMS, and then having them send different commands so that they can learn more about their pay in aggregation and in relation to other workers. Otherwise, this type of information is not accessible through the platform. For transport platforms such as Uber and Lyft, Driver's Seat and Mystro are used (Woodside et al. 2021). Driver's Seat uses your data from multiple platforms to let you understand your performance compared to others, including pay, productiveness, driving strategy, etc. Mystro lets you filter incoming requests on several platforms by setting your own criteria on for example distance, bonuses and rating.

Collective action

The literature is split on how social media groups may facilitate collective action among gig workers, as an answer to the power asymmetries and precarity they face. On one hand, evidence shows that social media groups have been used successfully to organize workers to collectively resist platform organizations and facilitate strikes (Chesta et al. 2019; Kaine and Josserrand 2019). As workers join social media groups, they discover the possibilities of collective action and turn them into “a kind of political site for collectively voicing their collective outrage” (Cini 2023).

On the other hand, research has found that the outcomes of social media organization and resistance are weak and that there are not many real-world cases of success (Soriano and Cabañes 2020). Successful cases are often related to specific geographical locations and groups of workers (Woodside et al. 2021). More experienced workers, with more social and cultural capital compared to others, are more likely to participate in collective action through social media (Chesta et al. 2019). However, these workers have the highest risk of doing so, as their primary income depends on the work offered by the platform.

Although social media groups have managed to facilitate collective action, it is argued that these actions are only small-scale and have short-term effects. This is because workers have different goals, they do it solely for money, they are afraid to risk their reputation, and because there are several crowdwork platforms to choose from (Salehi et al. 2015). The same has been found for independent community websites; peer-to-peer discussions can unintentionally encourage small-scale collective action (Walker 2021). A counterexample is drawn by Salehi et al. (2015), who showed how a forum specifically designed for Amazon Mechanical Turk workers, called Dynamo, could foster collective action to a greater degree and relieve some of the more severe power asymmetries. Through this forum, workers

could submit issues and suggest steps to collectively solve them. Examples of successful outcomes are the development of ethical guidelines for academic research requests regarding crowdwork, including the scope of tasks and their fairness of payment, and the creation of an open letter campaign aimed at platform owners with the goal of humanizing workers (Salehi et al. 2015; Cini 2023).

Chat and messaging groups facilitate collective action to a greater extent compared to social media and independent community websites, as they foster stronger bonds between participants and communication is carried out in a closed space without platform representatives (Tassinari and Maccarrone 2020; Zhou and Pun 2022). Through affordances for association, discourse and mobilization, chat and messaging groups are argued to promote solidarity (Zhou and Pun 2022). Association refers to how chats help overcome the atomization of workers by facilitating connection. Discourse is how chats function as a channel to share grievances and form a collective consensus on worker experiences. The affordance of mobilization is generated as messages are used to coordinate and plan collective action, both online and offline. Consequently, discourse and mobilization are preventive mechanisms of power asymmetries imposed by platforms.

Challenges

The literature outlined several challenges related to digital circumvention tools and their use, which will be covered in this section.

Finding each other

Most gig workers are unaware of the communities in which they can participate and assume that their work is forced to be atomized (Yao et al. 2021). A catalyst for joining communities is often the conflicts they encounter that make them unsure of their responsibilities and how they should act (Maffie 2020). When the digital platforms themselves do not have a clear answer or provide sufficient support, workers seek to online communities, providing “concrete, personalized and experiential information” (Yao et al. 2021).

Social media groups are often used to target specific groups of workers. In location-based work, geographical location is used to restrict the scope, as both city-based, state-based, nation-wide and international groups have been found (Yao et al. 2021). The more local groups have been shown to foster a higher degree of engagement between members, as they provide more relevant information, while national and international groups tend to have more general content (Holikatti et al. 2019). In online-based work, groups are of varying sizes (Lehdonvirta 2018). Larger groups are often more open with few restrictions, overlooked by a group of moderators (Posada 2022).

Lack of the personal touch

Several factors have been identified that contribute to less emotional support compared to informational support in online communities (Yao et al. 2021). These include the competitive environment in which gig work is performed, the use of offline relationships for emotional support, and the structure of social media groups. Some groups have several thousand members, and communication is happening in an asynchronous manner, making it difficult to establish close relationships.

Competition

A drawback noticed by several workers is how the competitive nature of the gig economy prevents them from sharing specific strategic information (Kost et al. 2020; Yao et al. 2021). This information is usually regarded as valuable because few people are aware of it, giving the information holder a competitive advantage. On digital labor platforms where workers bid for gigs or where some actions lead to higher profit, the sharing of strategic information with other workers may not be very tempting, as the competition will increase. In location-based work, this phenomenon may be even stronger, as there can be a skewed worker-client balance in the geographical area, which in turn leads to a limited set of gigs to choose from or get assigned to. There are also many “lurkers” in online groups, staying in a peripheral role, only reading content, and rarely participating. Due to them, more part-taking workers are unwilling to share competitive information (Yao et al. 2021).

Due to the sharing of well-paying tasks and requesters, Yin et al. (2016) argue that workers who do not use circumvention tools may have a disadvantage, as lucrative tasks may have been completed long before they ever get to see them. Through this division, it is argued that e.g., online communities themselves contribute to a higher degree of precarity for isolated workers who are not aware of such communities. The same is seen in the prevention of payment scams or requesters that do not approve solved tasks. If a worker warns about a scam on a forum and this scam has already been identified in another post, the worker is perceived as a non-legitimate member of the community (Watkins 2022). Therefore, workers should be aware of the communities and what they may offer to have an advantage in the market.

Decentralization

The reasons for the weakness of social media resistance are argued to be related to the numerous challenges that gig workers face. A key concept here is decentralization. Workers feel that collective action would be ineffective due to their employment status (Soriano and Cabañes 2020; Yao et al. 2021). Gig workers are regarded as independent contractors with no formal organizational foundation that supports them. This notion of employment stops many from organizing collectively, as they can choose not to take a gig and can easily leave the platform

and find other work. Furthermore, it is difficult for workers to assess the sentiments and activities of other workers, as they are atomized and have a high variance of participation in labor platforms (Yao et al. 2021). The use of a digital intermediary for communication, such as social media, makes this even harder. Social media groups and online communities, in general, are aligned with labor platforms in terms of their decentralized infrastructure (Yao et al. 2021).

Williams et al. (2019) suggest that there are not only positive effects of using external and layered-on software. They argue that the tooling used in crowdwork contributes to fragmentation of the work through the ease of switching between tasks and doing multiple tasks at once. Furthermore, they argue that tool usage creates an environment in which work can be done anywhere and anytime, promoting unstable working hours. They also suggest that social bonds between workers in communities are becoming more fragmented, as workers use different tools, and not all tools are available or known to everyone.

Cooperating with the platforms

As noted by several researchers, mobile operating systems for app-based platforms and the platforms themselves make it difficult to read data directly from platform applications, due to security and the protection of their business models (Woodside et al. 2021; Li et al. 2022; Calacci and Pentland 2022). Layered-on software must bypass these restrictions if automatic data collection is to be possible. The literature refers to backdoor approaches, such as crawling websites through installed browser extensions and software (Callison-Burch 2014; Hanrahan et al. 2015; Williams et al. 2019) or exploiting screen reading accessibility features on phones (Woodside et al. 2021; Li et al. 2022). Because layered-on software that uses automatic data collection is not directly attached to the software of the platforms, but depends on data from them, it becomes unreliable if the platform software changes (Woodside et al. 2021).

There is also external software specifically made to rate labor platforms, targeting workers across platforms and individuals entering the gig economy (Lettieri et al. 2019; Harmon and Silberman 2019; Graham et al. 2020). Graham et al. (2020) present the Fairwork foundation, an initiative created to make the society aware of the working conditions on digital labor platforms. The foundation displays ratings for both online-based and location-based platforms on the Fairwork website. The ratings are based on five principles co-developed with platform economy stakeholders, including workers, unions, platform owners, lawyers, academics and government. The principles cover payment, working conditions, contracts, management and worker representation, and are evaluated per platform on a yearly basis. The initiative has proven to impact the gig economy, as platforms have agreed to change their way of operating to get higher ratings (Graham et al. 2020).

Similar to Fairwork is the Fair Crowd Work website, discussed by Harmon and Silberman (2019). They show how the Fair Crowd Work website also reviews labor

platforms, and more specifically crowdwork platforms. A platform review covers platform details, worker reviews and a terms of service check. The schema for worker reviews is based on a 95-question survey answered by workers on the specific platform, covering topics such as experiences, tasks, pay, communication, ratings and evaluations on the platform and platform technology. The reviews are shown as star ratings, but with qualitative information from the survey responses to back up the ratings. The terms of service check assesses the fairness of platforms and the working conditions based on official information from the platform. The website is found to attract not only workers but also unions, policy makers, journalists and researchers.

Discussion

Our research has mapped an array of different digital circumvention tools that are developed in the periphery of digital labor platforms to help workers in one or the other way. We grouped these tools into three classes: online communities and groups, layered on software tools, and external software tools. We also reviewed what the tools are used for, ranging from sharing information among workers, to emotional and practical support, and collective action.

These tools show that labor platforms lack some aspects that the workers find useful. In some cases, platform owners do not want to make this information available because of strategic decisions e.g., creating algorithmic control (Jarrahi et al. 2020). In other cases, platform owners might deliberately –as a means to reduce own costs and risk –leave it to the workers to develop and maintain with their own tools, in the same way that Uber drivers have to use their own cars to drive customers around.

The existence of these digital circumvention tools is most plausibly a testament to the strong securing mechanisms used by platform owners. All the reviewed tools, except for some of the layered-on software, have weak attachment to the core of the digital labor platforms. They are often made by workers with no support from the platform owners. Our study is one of the few that shows how self-resourcing (Ghazawneh and Henfridsson 2013) can function in practice. Our work shows that even if we deal with a purely transactional platform, innovation in the edges happens to a large extent but is often precarious because platforms can choose to change without notice –which will invalidate these tools.

The layered-on software found demonstrates a form for bypassing the securing of platforms, by reading data and interacting with the platform applications and websites with backdoor approaches. These approaches can be seen as self-resourcing (Ghazawneh and Henfridsson 2013), as the solutions make use of their own boundary resources used by their applications. Other solutions that rely on manual data collection are still applications in the ecosystem, but not attached to the core, just like online communities. The data they use do not come directly from the

platforms, but usually through the workers. Layered-on software, as seen in the results, is primarily used to mitigate the information asymmetries workers face, through the aggregation of data from the platforms or worker-generated data.

Worker voice and collective action through external software, such as the Fair Work website and the Fair Crowd Work website, together with online community building and self-resourcing through layered-on software, show that the tuning of boundary resources, discussed by Eaton et al. (2015), also occurs on digital labor platforms. Through these IT solutions, workers can influence the evolution of labor platforms, even though they have reduced power and resources compared to platform owners. For example, the Fair Work website has made platform owners change their way of operation, resourcing their platform and increasing openness, further making stakeholders, including workers, more satisfied with the platform (Graham et al. 2020). Online communities have been shown to occasionally be able to foster collective action against their platforms (Salehi et al. 2015; Walker 2021; Cini 2023) and layered-on software illustrates a worker-led initiative to make platforms more transparent.

While much of the research on labor platform focuses on the precarity of platform labor, our study has summarized research that shows how platform workers circumvent precarious working conditions by devising practical means. The research reported here can be used to empirically investigate the needs of the workers and can be a source of knowledge not only for policymakers but also for the designers of more sustainable labor platforms.

Conclusions

Our study of the concept of digital circumvention, including the search for literature and our analysis and theoretical framing, is in a preliminary phase. Our future work includes a more extensive search, a more in-depth analysis, and investigation of alternative theoretical framework. We also have started interview studies with platform workers and labor union representatives. We hope to present our results in future ECSCW conferences.

This work is part of the project SustainDiT (Sustainable Digital Transformations). SustainDiT investigates the affordances of digital platforms from a social and economic sustainability perspective.

The authors declare no conflicts of interests.

References

Alsos, Kristin; and Jon Erik Dølvik (2021). *The Future of Work in the Nordic countries: Opportunities and Challenges for the Nordic Working Life Models*. Oslo, Norway: Nordic Council of Ministers.

- Ashford, Susan J; Brianna Barker Caza; and Erin M Reid (2018). From surviving to thriving in the gig economy: A research agenda for individuals in the new world of work. *Research in Organizational Behavior*, vol. 38, no. 1, pp. 23–41.
- Boell, Sebastian; and Dubravka Cecez-Kecmanovic (2014). A Hermeneutic Approach for Conducting Literature Reviews and Literature Searches. *Communications of the Association for Information Systems*, vol. 34, no. 1, pp. 257–286.
- Braun, Virginia; and Victoria Clarke (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, vol. 3, no. 2, pp. 77–101.
- Calacci, Dan; and Alex Pentland (2022). Bargaining with the Black-Box: Designing and Deploying Worker-Centric Tools to Audit Algorithmic Management. *Proceedings of the ACM on Human-Computer Interaction*, vol. 6, no. CSCW2, pp. 428:1–428:24.
- Callison-Burch, Chris (2014). Crowd-Workers: Aggregating Information Across Turkers to Help Them Find Higher Paying Work. In *Proceedings of the AAAI Conference on Human Computation and Crowdsourcing*. pp. 8–9.
- Cameron, LD (2022). “Making Out” While Driving: Relational and Efficiency Games in the Gig Economy. *Organization Science*, vol. 33, no. 1, pp. 231–252.
- Caza, Brianna B; Erin M Reid; Susan J Ashford; and Steve Granger (2022). Working on my own: Measuring the challenges of gig work. *Human Relations*, vol. 75, no. 11, pp. 2122–2159.
- Chan, NK (2019). “Becoming an expert in driving for Uber”: Uber driver/bloggers’ performance of expertise and self-presentation on YouTube. *New Media and Society*, vol. 21, no. 9, pp. 2048–2067.
- Chesta, RE; L Zamponi; and C Caciagli (2019). Labour activism and social movement unionism in the gig economy. Food delivery workers’ struggles in Italy. *Partecipazione e Conflitto*, vol. 12, no. 3, pp. 819–844.
- Choudary, Sangeet Paul (2018). *The architecture of digital labour platforms: Policy recommendations on platform design for worker well-being*. Geneva: International Labour Organization, ILO.
- Cini, Lorenzo (2023). Resisting algorithmic control: Understanding the rise and variety of platform worker mobilisations. *New Technology, Work and Employment*, vol. 38, no. 1, pp. 125–144.
- Eaton, Ben; Silvia Elaluf-Calderwood; Carsten Sørensen; and Youngjin Yoo (2015). Distributed Tuning of Boundary Resources: The Case of Apple’s iOS Service System. *MIS Quarterly*, vol. 39, no. 1, pp. 217–244.
- Farshchian, Babak A; and Hanne Ekran Thomassen (2019). Co-Creating Platform Governance Models Using Boundary Resources: a Case Study from Dementia Care Services. *Computer Supported Cooperative Work (CSCW)*, vol. 28, no. 3, pp. 549–589.

- Ghazawneh, Ahmad; and Ola Henfridsson (2013). Balancing platform control and external contribution in third-party development: the boundary resources model. *Information Systems Journal*, vol. 23, no. 2, pp. 173–192.
- Graham, M; J Woodcock; R Heeks; P Mungai; J-P Van Belle; D du Toit; S Fredman; A Osiki; A van der Spuy; and SM Silberman (2020). The Fairwork Foundation: Strategies for improving platform work in a global context. *Geoforum*, vol. 112, no. 1, pp. 100–103.
- Gray, Mary L; Siddharth Suri; Syed Shoaib Ali; and Deepti Kulkarni (2016). The Crowd is a Collaborative Network. In *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing*. New York, NY, USA: Association for Computing Machinery, pp. 134–147.
- Hanrahan, BV; JK Willamowski; S Swaminathan; and DB Martin (2015). Turk bench: Rendering the market for turkers. In *CHI '15: Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. pp. 1613–1616.
- Harmon, Ellie; and MSix Silberman (2019). Rating Working Conditions on Digital Labor Platforms. *Computer Supported Cooperative Work (CSCW)*, vol. 28, no. 5, pp. 911–960.
- Holikatti, M; S Jhaver; and N Kumar (2019). Learning to airbnb by engaging in online communities of practice. *Proceedings of the ACM on Human-Computer Interaction*, vol. 3, no. CSCW, pp. 1–19.
- Ihl, A; KS Strunk; and M Fiedler (2020). The mediated effects of social support in professional online communities on crowdworker engagement in micro-task crowdworking. *Computers in Human Behavior*, vol. 113, no. 1, pp. 106482.
- International Labour Organization (2021). *The role of digital labour platforms in transforming the world of work*. Geneva: International Labour Organization, ILO.
- Irani, LC; and MS Silberman (2013). Turkopecticon: Interrupting worker invisibility in Amazon Mechanical Turk. In *CHI '13: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. pp. 611–620.
- Islind, Anna Sigrður; Tomas Lindroth; Johan Lundin; and Gunnar Steineck (2019). Co-designing a digital platform with boundary objects: bringing together heterogeneous users in healthcare. *Health and Technology*, vol. 9, no. 4, pp. 425–438.
- Jarrahi, Mohammad Hossein; and Will Sutherland (2019). Algorithmic Management and Algorithmic Competencies: Understanding and Appropriating Algorithms in Gig Work. In Taylor NG; C Christian-Lamb; MH Martin; and B Nardi (eds): *Information in Contemporary Society*. Cham: Springer International Publishing, pp. 578–589.
- Jarrahi, Mohammad Hossein; Will Sutherland; Sarah Beth Nelson; and Steve Sawyer (2020). Platformic Management, Boundary Resources for Gig Work, and

- Worker Autonomy. *Computer Supported Cooperative Work (CSCW)*, vol. 29, no. 1, pp. 153–189.
- Kaine, S; and E Josserand (2019). The organisation and experience of work in the gig economy. *Journal of Industrial Relations*, vol. 61, no. 4, pp. 479–501.
- Kinder, Eliscia; Mohammad Hossein Jarrahi; and Will Sutherland (2019). Gig Platforms, Tensions, Alliances and Ecosystems: An Actor-Network Perspective. *Proceedings of the ACM on Human-Computer Interaction*, vol. 3, no. CSCW, pp. 212:1–212:26.
- Kittur, Aniket; Jeffrey V Nickerson; Michael Bernstein; Elizabeth Gerber; Aaron Shaw; John Zimmerman; Matt Lease; and John Horton (2013). The future of crowd work. In *CSCW'13: Proceedings of the 2013 conference on Computer supported cooperative work*. New York, NY, USA: Association for Computing Machinery, pp. 1301–1318.
- Kost, D; C Fieseler; and SI Wong (2020). Boundaryless careers in the gig economy: An oxymoron? *Human Resource Management Journal*, vol. 30, no. 1, pp. 100–113.
- Lehdonvirta, V (2018). Flexibility in the gig economy: managing time on three online piecework platforms. *New Technology, Work and Employment*, vol. 33, no. 1, pp. 13–29.
- Leidner, Dorothy; and Olgerta Tona (2021). A Thought-Gear Model of Theorizing from Literature. *Journal of the Association for Information Systems*, vol. 22, no. 4, pp. 874–892.
- Lettieri, N; A Guarino; D Malandrino; and R Zaccagnino (2019). Platform economy and techno-regulation-Experimenting with reputation and nudge. *Future Internet*, vol. 11, no. 7, pp. 163.
- Li, TJ-J; Y Lu; J Clark; M Chen; V Cox; M Jiang; Y Yang; T Kay; D Wood; and J Brockman (2022). A Bottom-Up End-User Intelligent Assistant Approach to Empower Gig Workers against AI Inequality. In *CHIWORK 2022: 2022 Symposium on Human-Computer Interaction for Work*. pp. 1–10.
- Maffie, MD (2020). The Role of Digital Communities in Organizing Gig Workers. *Industrial Relations*, vol. 59, no. 1, pp. 123–149.
- Martin, David; Benjamin V Hanrahan; Jacki O'Neill; and Neha Gupta (2014). Being a turker. In *CSCW '14: Proceedings of the 17th ACM conference on Computer supported cooperative work & social computing*. New York, NY, USA: Association for Computing Machinery, pp. 224–235.
- McIntyre, David; Arati Srinivasan; Allan Afuah; Annabelle Gawer; and Tobias Kretschmer (2021). Multisided Platforms as New Organizational Forms. *Academy of Management Perspectives*, vol. 35, no. 4, pp. 566–583.
- Oates, Briony J; Marie Griffiths; and Rachel McLean (2022). *Researching information systems and computing*, Second edition. Thousand Oaks, CA: SAGE.

- Pentland, Brian T; Youngjin Yoo; Jan Recker; and Inkyu Kim (2022). From Lock-In to Transformation: A Path-Centric Theory of Emerging Technology and Organizing. *Organization Science*, vol. 33, no. 1, pp. 194–211.
- Popan, C (2021). Embodied Precariat and Digital Control in the “Gig Economy”: The Mobile Labor of Food Delivery Workers. *Journal of Urban Technology*, vol. 0, no. 0, pp. 1–20.
- Posada, J (2022). Embedded reproduction in platform data work. *Information Communication and Society*, vol. 25, no. 6, pp. 816–834.
- Raval, Noopur; and Paul Dourish (2016). Standing Out from the Crowd: Emotional Labor, Body Labor, and Temporal Labor in Ridesharing. In *CSCW '16: Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing*. New York, NY, USA: Association for Computing Machinery, pp. 97–107.
- Rodon Modol, Joan; and Ben Eaton (2021). Digital infrastructure evolution as generative entrenchment: The formation of a core–periphery structure. *Journal of Information Technology*, vol. 36, no. 4, pp. 342–364.
- Salehi, N; LC Irani; MS Bernstein; A Alkhatib; E Ogbe; K Milland; and Clickhappier (2015). We are dynamo: Overcoming stalling and friction in collective action for crowd workers. In *CHI '15: Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. pp. 1621–1630.
- Savage, S; CW Chiang; S Saito; C Toxtli; and J Bigham (2020). Becoming the Super Turker: Increasing Wages via a Strategy from High Earning Workers. In *WWW '20: Proceedings of The Web Conference 2020*. pp. 1241–1252.
- Schmidt, GB; and WM Jettinghoff (2016). Using Amazon Mechanical Turk and other compensated crowdsourcing sites. *Business Horizons*, vol. 59, no. 4, pp. 391–400.
- Schmidt, GB; and SA Van Dellen (2022). Leadership of place in virtual environments. *Leadership*, vol. 18, no. 1, pp. 186–202.
- Seetharaman, B; J Pal; and J Hui (2021). Delivery Work and the Experience of Social Isolation. *Proceedings of the ACM on Human-Computer Interaction*, vol. 5, no. CSCW1, pp. 1–17.
- Shalini; DR Bathini; and G Kandathil (2021). Actions in phygital space: Work solidarity and collective action among app-based cab drivers in India. *New Technology, Work and Employment*, vol. 0, no. 0, pp. 1–24.
- Soriano, CRR; and JVA Cabañes (2020). Entrepreneurial Solidarities: Social Media Collectives and Filipino Digital Platform Workers. *Social Media and Society*, vol. 6, no. 2, pp. 1–11.
- Sutherland, Will; and Mohammad Hossein Jarrahi (2018). The sharing economy and digital platforms: A review and research agenda. *International Journal of Information Management*, vol. 43, pp. 328–341.

- Tassinari, Arianna; and Vincenzo Maccarrone (2020). Riders on the Storm: Workplace Solidarity among Gig Economy Couriers in Italy and the UK. *Work, Employment and Society*, vol. 34, no. 1, pp. 35–54.
- Tiwana, Amrit (2014). *Platform ecosystems: Aligning architecture, governance, and strategy*. Amsterdam: Morgan Kaufmann.
- Tynan, Lauren; and Michelle Bishop (2022). Decolonizing the Literature Review: A Relational Approach. *Qualitative Inquiry*, vol. 29, no. 3-4, pp. 498–508.
- Waldkirch, M; E Bucher; PK Schou; and E Grünwald (2021). Controlled by the algorithm, coached by the crowd—how HRM activities take shape on digital work platforms in the gig economy. *International Journal of Human Resource Management*, vol. 32, no. 12, pp. 2643–2682.
- Walker, M (2021). Peer-to-peer online voice as emergent collective action. *Journal of Industrial Relations*, vol. 63, no. 5, pp. 777–797.
- Watkins, EA (2022). “Have you learned your lesson?” Communities of practice under algorithmic competition. *New Media and Society*, vol. 24, no. 7, pp. 1567–1590.
- Williams, AC; G Mark; K Milland; E Lank; and E Law (2019). The perpetual work life of crowdworkers: How tooling practices increase fragmentation in crowdwork. *Proceedings of the ACM on Human-Computer Interaction*, vol. 3, no. CSCW, pp. 1–28.
- Wood, Alex J; Vili Lehdonvirta; and Mark Graham (2018). Workers of the Internet unite? Online freelancer organisation among remote gig economy workers in six Asian and African countries. *New Technology, Work and Employment*, vol. 33, no. 2, pp. 95–112.
- Woodside, J; M Moos; and T Vinodrai (2021). Bottom-up strategies, platform worker power and local action: Learning from ridehailing drivers. *Local Economy*, vol. 36, no. 4, pp. 325–343.
- Yao, Zheng; Silas Weden; Lea Emerlyn; Haiyi Zhu; and Robert E Kraut (2021). Together But Alone: Atomization and Peer Support among Gig Workers. *Proceedings of the ACM on Human-Computer Interaction*, vol. 5, no. CSCW2, pp. 391:1–391:29.
- Yin, Ming; Mary L Gray; Siddharth Suri; and Jennifer Wortman Vaughan (2016). The Communication Network Within the Crowd. In *WWW '16: Proceedings of the 25th International Conference on World Wide Web*. Republic and Canton of Geneva, CHE: International World Wide Web Conferences Steering Committee, pp. 1293–1303.
- Zhou, Y; and N Pun (2022). Affording worker solidarity in motion: Theorising the intersection between social media and agential practices in the platform economy. *New Media and Society*, vol. 0, no. 0, pp. 1–19.

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Designing with Awareness: Building an Agenda for Worker and Patient Well-being

Tina Westergaard Milbak, Jakob Grue Simonsen, Marco Bo Hansen, Naja Holten Møller

University of Copenhagen, Denmark

twm@di.ku.dk; simonsen@di.ku.dk; mh@saninudge.com; naja@di.ku.dk

Abstract. Awareness technologies are a core interest for CSCW: when people pay attention to each other's actions, they have less need to communicate with each other to accomplish hospitals' complex, cooperative work. In Denmark, healthcare workers (HCWs) and patients face challenges with the architectural design of new super hospitals, which are designed to optimise the care and efficiency of healthcare services. A concrete challenge is how the new design of single-patient rooms, as opposed to traditional multi-patient rooms, will change the workflows and affect the patients and HCWs. HCWs' well-being is at risk when they have to attend to more rooms and the risk of adverse events increases. Similarly, the patient's well-being is at risk when they feel lonely or neglected in a single-patient room. In this paper, we propose an agenda for awareness technologies designed around both worker and patient well-being. We examine through prototyping an awareness technology, iAware. The solution draws together insights from a long-term ethnographic study on how to responsibly design sensed environments. We identified 4 openings for supporting patients' and HCWs' mutual awareness of workflows: 1) progress of HCWs 'ward rounds'; 2) patient 'visits' by HCWs; 3) patient 'calls' and 4) patient 'mobility'. We end with concluding remarks on how sensed environments can be designed to support HCWs' and patients' well-being.

Introduction

Sensed environments are increasingly explored to support awareness at a low cost. In hospitals, sensed environments typically involve the usage of sensors for creating awareness of patient vitals (i.e., physical health). Several studies, e.g. Andersen et al. (2020), explore how sensor data (e.g., patient activity data) can support clinical decision-making by providing an alarm for heart attack risk before its occurrence. Sensors have been used to assess patients' well-being as measured by their heart rate, blood pressure, and other vital metrics. Another perspective on well-being is patients' feeling of safety. Research in this area has primarily focused on patient well-being measured as the occurrence of adverse events (patient falls, pressure ulcers, and deep vein thrombosis) (Søndergaard, 2021). Other ways to measure patients' well-being are, for example, if they feel lonely or neglected by the HCWs (ibid).

HCWs' experience of sensor tracking as 'surveillance' is also a risk and relevant consideration. Recent studies of workplace tracking show that reliable data requires workers to accept, and not actively resist or subvert, tracking (Harper et al., 1992; Gorm and Shklovski, 2016). Another study of sensor tracking in healthcare reported that sensor tracking was acceptable to HCWs only if: (1) they could influence what is tracked; (2) they knew the intentions for data tracking; and (3) they could contest and correct tracking results (Holten Møller et al., 2017). This research demonstrates that tracking in the healthcare workplace is widespread. Increasingly the questions put before researchers and designers are not whether or not such data are acceptable but rather how to help stakeholders with different interests understand their roles, rights, and responsibilities in sensed environments (Kristiansen et al., 2018).

In this paper, we propose a CSCW agenda for HCW- and patient *well-being* through the design of sensed environments. The concept of well-being is defined in many ways but overall refers to the emotional and affective aspects of care (Andersen and Fritsch, 2018). We draw on insights from a long-term ethnographic study (+5y) of how to responsibly design sensed environments (Holten Møller et al., 2017). We present empirical findings from a recent study (March 2022) identifying that: (a) there is a risk of missing or losing critical information on patients due to a practice of storing information physically in the patient room; (b) Physical documents support an overview of working tasks and patient matters, resulting in sensitive knowledge being lost or forgotten and the risk of adverse events occurring; (c) Complexity of diversity: Patients are cognitively and socially at very different stages, which must be considered in communication systems to include all patients; (d) Physical interaction between patients and HCWs is prioritised as a form of care in order to foster safety and well-being. (e) HCWs express concern about the increasing level of documentation demand and systems

to handle at the expense of physical care and face-to-face contact with patients.

Currently, in hospitals in Denmark as well as the UK and other countries, the well-being of HCWs and patients is a growing concern for researchers (Ooms et al., 2022). The British state-run National Health Service is in crisis as thousands of nurses are leaving their jobs (Ravikumarand, 2023). Poor wages during the last decade have contributed to thousands of nurses fleeing from their profession, impacting patient care and working conditions for the remaining HCWs. Millions of patients are left waiting for treatment and are unable to receive prompt emergency care (Ravikumarand, 2023). HCWs face working conditions they describe as "unsafe and unworthy" (Jensen, 2023). The situation calls for technologies designed for the well-being of HCWs and patients.

Related work

In CSCW, there is an increasing interest in how work tracking can contribute to HCWs- and patients' well-being, especially how data can support the communication and interaction between HCWs and patients, with concern for the relational complexities of the healthcare domain (Kaziunas et al., 2017; Karusala et al., 2021; Devito et al., 2019). Many have studied sensor data tracking, gathering wearable tracking data from HCWs (Neff et al., 2017; Chung et al., 2017; Holten Møller et al., 2017, 2021; Iversen et al., 2020; Stangerup et al., 2021; From-Hansen et al.). The understanding of how sensor data and architectural designs are interlinked, specifically concerning workflows and HCW acceptance of sensor technology is well documented, e.g. by Holten Møller et al. (2017).

Despite the research focus on HCW and patient interaction, in practice sensed environments largely focus on data about patient vitals as one-way information (Andersen et al., 2020). Relatively few studies in CSCW sensor data tracking studies focus on the holistic role of data to support HCWs and patients' well-being, awareness, and emotions (Tang et al., 2015). An aspect of sensor data that explores the understanding and development of data output, focusing on qualitative 'care' data, and data that address (patient and HCW) emotional aspects. Andersen et al. (2020) and Lomborg et al. (2020) report a study of patient's well-being during a self-tracking of data related to their heart condition. Patient's well-being in CSCW is typically addressed in relation to personal tracking (Devito et al., 2019), people's capacity to deal with their health (Light et al., 2015), and politics of care (Boone et al., 2023; Lomborg et al., 2020).

Sensor data provides insights into the flow of work of HCWs (Holten Møller et al., 2021) and it has the advantage that it does not require any human interaction such as 'clicks' to produce data. Hockenhuil and Cohn (2021) explore the role of dashboards in designing alternative data visions to better understand and support cooperative work. They suggest "changing dashboards from devices that focus on

matters of fact to things which can help in articulating matters of concern" (Hockenhull and Cohn, 2021). Mutual awareness between HCWs and patients is a well-known design strategy; however, more research is needed on how sensor tracking impacts work and well-being from both an HCW and patient perspective.

Mutual awareness is tricky to design and not without issues as a theoretical concept (Schmidt, 2002). The concept of awareness as introduced by Gutwin and Greenberg (2002) describes how tasks are brought to others' attention in an organisation. Awareness supports cooperation in contexts where people share a workplace or space (Dourish and Bellotti, 1992). Workspace awareness is defined as: "up-to-the-moment understanding of another person's interaction with the shared workspace." (Gutwin and Greenberg, 2002). When designing for mutual awareness, the participation of HCWs and patients is important for testing the shift of workflows in natural settings (Bossen and Foss, 2016). According to Schmidt (2002), the challenge with awareness in cooperative work is to understand how actors effortlessly detect what is going on around them and make sense of it. Awareness in cooperative work emphasises the potentially unconscious attention towards the work of others. In successful awareness, the collaborating parties support a larger goal and integrate their activities based on a deep knowledge of the environment in which they act. Successful awareness includes a key understanding of how activities are connected as well as the likeliness and potential consequence of a given situation. Hence, a situation can effortlessly make sense.

Designing for awareness is fundamentally about finding ways to convey the sense of HCW work as it unfolds (Paul and Reddy, 2010) and patients' well-being, impacting the ongoing prioritisation (Andersen et al., 2020).

Case and Method

Our research was conducted as part of a long-term ethnographic study on the architectural design of Danish super hospitals between 2015-2021, following principles of contemporary data studies research (Blomberg et al., 1993; Blomberg and Karasti, 2013). The empirical setting is primarily sensor data tracking studies of gathering wearable tracking data from HCWs (Holten Møller et al., 2017; Stangerup et al., 2021; From-Hansen et al.) The research took place at an existing hospital - to be a new acute care hospital as part of a process of modernising and building hospitals in Denmark. The hospital is a fully functional hospital of historical and architectural importance, inspired by English Pavilions with recreative gardens. The existing hospital is fully functional but to be a 'new' acute hospital in Denmark, the building will develop with integrated new buildings.

Our team was part of a project to inform hospital designers and management about workflows and the design of physical workspaces, and to study the processes around planning a future super hospital (Holten Møller et al., 2017, 2021). This

paper also draws on a recent field study - an observation and participatory workshop conducted in March 2022. This field study took place at the same hospital as our long-term ethnographic study. This hospital is an interesting case for data tracking because people are currently working there while the new super hospital is under construction. The new super hospital will transition from having multi-patient rooms to having only single-patient rooms, entailing significant change in HCW workflows (Møller and Bjørn, 2016; Møller et al., 2017). With single-patient rooms, the HCWs oversee the same number of patients but over a greater distance, which is expected to result in fewer HCW-patient interactions and an increased risk of adverse events for patients, such as falls while not being observed and feeling lonely or even forgotten.

The participation and engagement of HCWs and patients in this study is critical. That is for an ethical approach to learning how relevant stakeholders with differential power perceive intentions when capturing data on care as a basis for our research. We apply participatory design methods for "collective sensemaking" (Holten Møller et al., 2021), a type of worker contestation of datasets with the subjects of that data, for use with the results of our sensor data analysis.

We developed a concrete prototype of scenarios for supporting awareness and well-being through sensor data. The scenarios that we prototyped were informed by and identified based on a long-term ethnographic study of the mentioned future super hospital (Holten Møller et al., 2021; Møller and Bansler, 2017). Following this, a two-day observational study was conducted in March 2022, including a participatory workshop with nursing HCWs in a hospital department with experience with sensor tracking and relevant knowledge of the layout of the future single-patient rooms. We identified mutual awareness of workflows and the well-being of patients and HCWs as critical issues for the future super hospital where single-patient rooms will be the norm. We discussed this focus and the prototype with the design team of the super hospital as well as the innovation officer.

The research prototype was developed to accommodate learning from the ethnographic studies related to mutual awareness. We aimed to apply a qualitative research method that could explore the HCWs' understanding of awareness of the workflow in multi-patient rooms versus a single-patient room. We developed a research design for a participatory card sorting workshop (Nawaz, 2012) in which HCWs were invited to debate and actively reflect on their work practices. The field study in March 2022 consisted of following and observing the HCWs during their daily work activities. The HCWs were invited for an unstructured discussion over the initial sketches of iAware.

The card sorting workshop was held in the HCWs' lunchroom (March 2022), as a constant flow of HCWs would stop by for a coffee break. The workshop

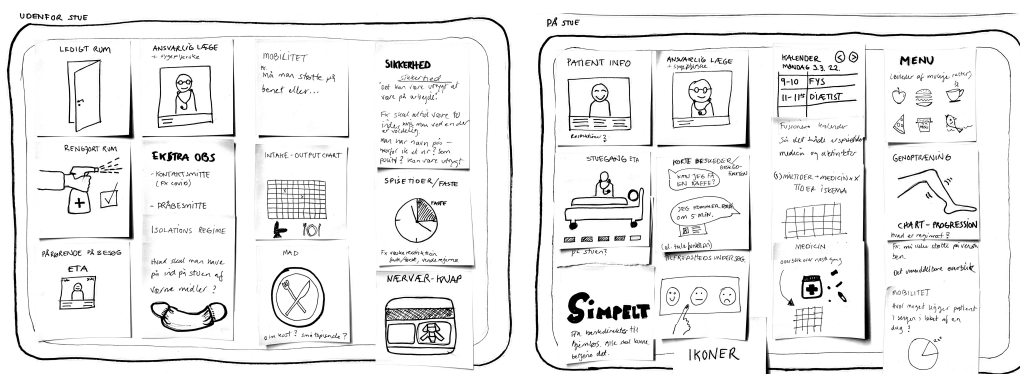


Figure 1. Designing with awareness through a participatory workshop with nursing HCWs. Cardboard sheets illustrated as a tablet dashboard - together with post-its, blank as well as predefined post-its with icons and sketches illustrating themes and situations in a hospital ward. The left-side prototype displays nursing HCWs' input for important components and topics on a dashboard outside the patient room. The right-side prototype displays the nursing HCWs' input for a dashboard inside the patient room.

consisted of two A3-sized cardboard sheets illustrated as a tablet dashboard, along with post-its both blank as well as predefined with icons and sketches illustrating themes and situations in a hospital ward (See Fig. 1). This analogue dashboard acted as an empathy probe (Mattelmäki, 2005) to engage more deeply and support conceptualisation for the HCWs. Moreover, as an exercise to invite HCWs to interact with thematic content from the previous study. When HCWs entered the room, they were all curious about the cardboard sheets and sketches on the table, which quickly enabled a dialogue between HCWs' sharing experiences and opinions about work practices and care for patients. The familiar visualisation space (Hockenhuil and Cohn, 2021) of the analogue tablet dashboard led to debate amongst the HCWs. More themes were added during the ongoing discussion as HCWs entered the lunchroom during the day.

Fifteen HCWs, mainly nurses and a few physiotherapists, participated in the workshop during the two days, with some HCWs participating more than once. A broader spectrum of HCWs would have been preferable, however, in this field study, this was our resource. The next step in our research would be to engage with HCWs across professions. Drawing from Andersen et al. (2019), we propose a patient-centred approach where both patients (and their relatives) together with HCWs explore, experiment with, and evaluate (Andersen et al., 2019) divergent needs and concerns with the aim to support both HCWs and patients well-being.

Our workshops were conducted by posing unstructured questions to HCWs in relation to the material. Themes and questions, i.e., "how do you orient yourself before entering a patient room?" During the workshop, the HCWs' reflections were documented by taking ethnographic notes, sketching and illustrating post-its according to the input from HCWs, and collecting physical template papers that supported nurses during their work. The process was also captured in photographs.

Findings were thematically analysed (Bryman, 2016) to inform conceptualisation and operationalisation in future work.

Findings: Awareness of Care Workflows

Data-driven solutions for coordination and collaboration are a long-standing interest in support of hospital workers amongst researchers. In current Danish hospitals, coordination rooms located centrally in a ward support staff coordination of work across patient rooms. However, single-patient rooms in the new super hospitals will impact the workflow, in particular with regard to HCW infrastructure, coordination, and orientation. Moreover, it will also affect the awareness and overview of the hospitalised patients as well as the well-being of the patients.

In our study of the transitory process of becoming a new super hospital, we found some topics addressed by the HCWs as critical aspects of care and awareness. Namely the risk of missing critical information on patients due to the practice of keeping information artefacts in a physical way in and outside specific patient rooms. Patients with regimes such as isolation have a physical file holder containing documents next to the patient room entrance, as well as a wooden block inside the room to indicate their specific regime. These artefacts are at risk of being lost or overlooked by HCWs as well as relatives. Another topic concerns the general overview of working tasks and specific patient matters. Physical documents with handwritten notes regarding patient issues support HCWs' in keeping an overview of patients during their workday. The overview is limited and knowledge is devalued. Yet another topic surfaces from the HCWs' experience of the cognitive and social diversity of patients. The HCWs emphasise the need to include patients that are cognitively impaired and patients that can not read or understand the local language. All communication systems for patients must be intuitive and as simple as a button with a recognisable icon to support the inclusion of a diverse spectrum of individuals. HCWs point out that "contact fosters comfort and dignity," making (physical) interaction between patients and HCWs an essential aspect of care and acknowledging the patient as a holistic human being. HCWs also raise the concern of an increasingly comprehensive level of documentation demand and systems to handle at the expense of physical care and face-to-face contact with patients.

The Super Hospital as a Basis for Redesigning the Workplace

Super hospitals are designed to optimise the care and efficiency of healthcare services. New forms of data support HCWs in decision-making to ensure patients' needs are met, and to spend resources efficiently while coordinating their work across patients. In this context, sensor tracking of HCWs is considered. A concrete challenge is how the new design feature of single-patient rooms (as opposed to

traditional multi-patient rooms) will affect patients and HCWs (Møller et al., 2017). The awareness required by single-patient rooms (Søndergaard, 2021) has been shown to increase the risk of adverse events for patients, decrease patient satisfaction and mental well-being, and contribute to HCW burnout. Experiences from the first super hospitals in Denmark have shown that patients in single-patient bedrooms feel more isolated and disconnected from the staff. Given the increased distances between patients in the newly built hospitals, HCWs make fewer patient visits (ibid).

Sensed environments enable care for a broad group of patients with varying capabilities. Not all are capable of patient self-services (Nunes et al., 2015) or navigating waiting times for scheduled services (Lorenzetti and Noseworthy, 2011). In a hospital setting, HCWs shuffle and re-shuffle queues of patients in the day-to-day activities of their workflow. Both from a patient and HCW perspective, there is a need for actively exchanging information. Once a patient is admitted, the prioritisation of resources only appears to patients and their relatives when communicated explicitly (typically verbally) by the HCWs in person. For example, an HCW might explain how long the patient should expect to wait for doctors as they do their ward rounds. This implicit negotiation of patients queuing for ward rounds, cleaning, etc., is a crucial part of making the context and the provision of hospital services (Holten Møller and Bjørn, 2011; Møller and Bjørn, 2016).

Designing dashboards to support awareness and well-being

To establish an overview of workflows for coordination amongst HCWs, data can enable and support the decision-making to ensure patients' needs are met. Moreover, it can be helpful in assisting HCWs to spend resources efficiently while coordinating their work across patients. However, it is a matter of concern (Bødker et al., 2017) in sensitive settings such as healthcare.

Our ongoing study informed an iterative process of designing and prototyping data to support HCW workflows and HCW and patient well-being. The research team started working on how to operationalise the sensor data of movement, location, and interaction in a way that accommodates both the HCWs and patients according to the overall research project goal of exploring how data can be used with concern for the relational complexities that are characteristic of the healthcare domain. Sensor data could in this context be used to answer questions like: "Where is my patient?" or "When is the doctor coming to see me?"

Based on the insights from our card-sorting workshop, the analogy of a window between the patient room and the ward was discussed as a metaphor for creating mutual awareness. In order to do so, and to relate the conceptualisation to a familiar setting, we applied the identified topics and relevant features to a visual board. The board depicted an interface for the HCWs - to be in the ward, and the

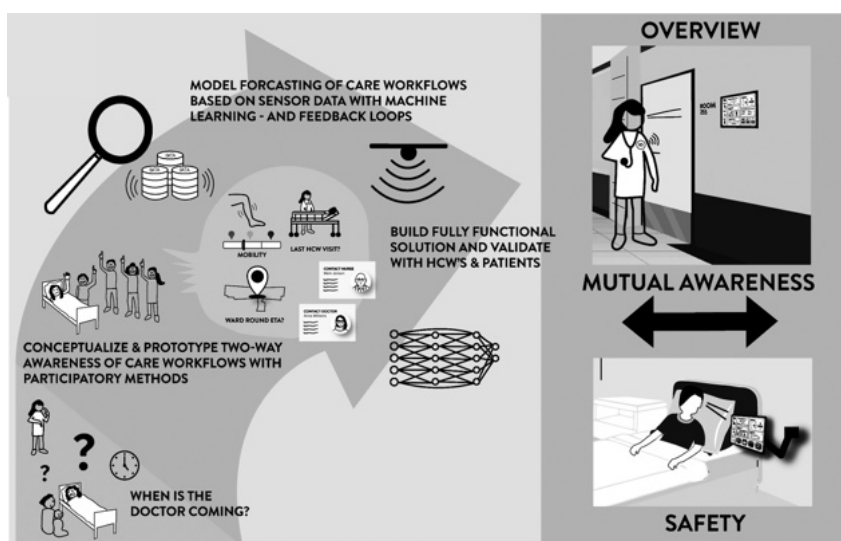


Figure 2. Designing for awareness: The figure depicts our identified topics aiming to support both patients' and HCWs' mutual awareness of workflows in the hospital ward. The concept is based on sensor data with machine learning and feedback loops..

patients - to be in the patient room.

Employing dashboards to support mutual awareness among HCWs and patients is based on the idea of using a recognisable space that the HCWs already refer to in their everyday work. iAware is not assuming the centralised information boards that are now located in coordination rooms. The familiar visualisation space (Hockenull and Cohn, 2021) of the analogue tablet dashboard facilitates a shared understanding. While displaying relevant information on a single screen to be studied "at a glance" (Few, 2006), it draws attention to shared as well as diverging topics in what sorts of data to support team activity and coordination among HCWs. Using integrated interactive dashboards placed along the work paths of the HCWs and inside patient rooms can benefit both HCWs and patients and acknowledge the objectives as two-fold: 1) to optimise the workflow of the HCWs; and 2) to improve information exchange through mutual awareness and well-being of patients and HCWs (See Figure 2).

Movement tracking using sensor data may be used to explore complex and highly context-dependent workflows to produce new understandings of, for example, patients' needs for awareness (Kumar et al., 2020), and to redesign future workflows (Holten Møller et al., 2021). It is only recently that machine learning with sensor data has been applied in healthcare settings, and often only for specific monitoring tasks, rather than for the complex workflow that we aim to do with our concept, iAware. Sensor data have become available with the widespread use of mobile phones and wearable sensors for detecting human-building interaction in addition to the interaction between people. Prior work on machine learning in

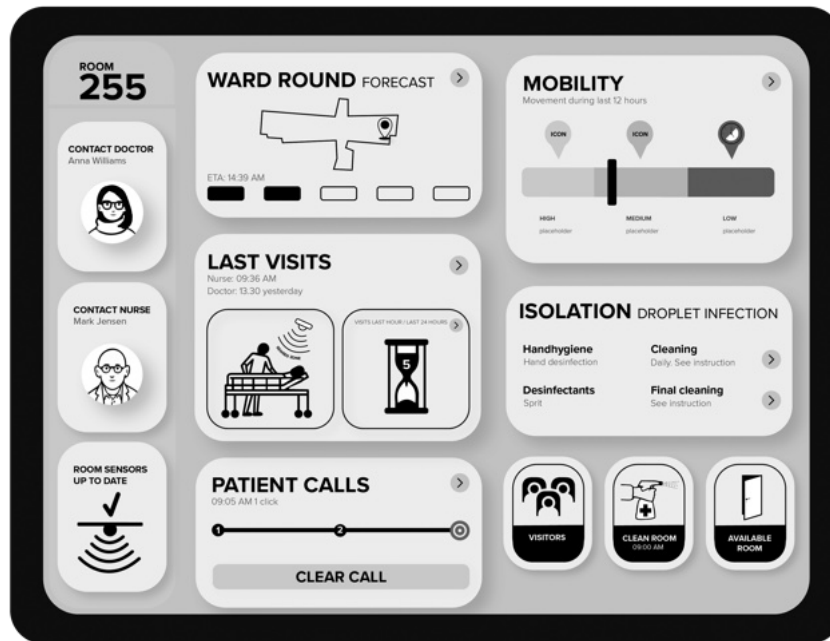


Figure 3. The figure shows awareness dashboards for HCW overview installed in the hospital ward at each patient room entrance. Data is collected from a wearable HCW beacon and sensor zones in the patient room. The dashboards replace centralised information boards in the coordination rooms and provide the HCWs with relevant GDPR-safe information they can see "at a glance" during their workflows.

hospital settings has almost solely focused on electronic patient records or vital data (Andersen et al., 2020), with scarce work on sensor data (Yu et al., 2021). In contrast, iAware will use time series analysis of sensor data to: (i) dynamically forecast and display estimated times for ward rounds in single-room wards; and (ii) gently nudge patient movement patterns based on prior data to facilitate well-being and recovery. While not necessary for iAware, both (i) and (ii) may be enriched and improved by data extracted from electronic health records (EHR), strictly keeping data in the local ward.

To facilitate knowledge management as well as support coordination of work and team awareness, dashboards as artefacts of displaying and organising data are relevant in CSCW. Following Hockenull and Cohn (2021), studies of dashboards within CSCW have mainly focused on them as devices to investigate particular measurable goals. However, we expand to a broader holistic study of how dashboards can affect other practices in a hospital ward work setting, including both patient and HCW awareness and well-being.

Our solution iAware ensures that HCWs workflows are optimised by implementing dashboards along their work paths, i.e., they do not have to walk back to the centralised coordination room to switch off alarms or find information

about their patients. The HCWs will receive relevant information when they need it during their workflows. To address the probability that the nearest HCW may be occupied with other duties, we point out that this study is exploratory and still in the early phase. We look to Bossen and Foss (2016) suggestion for work tracking; this solution enables the porters to view and assign themselves tasks via a smartphone. The display of worker status and assignment of tasks, where the worker can influence their tasks seems relevant to study further in our context.

iAware, includes: 1. predictive ward round forecasts to inform HCWs in their workflow on ward round progression and to minimise patient calls; 2. patient movement analyses (timely mobility and fall prevention); 3. smart nurse rounding registrations (timely patient visits); 4. automated registrations of cleaned and available rooms. (See Figure 3)

Finally, to capture both movement, location and interaction activity, we note every combination of room number and contact with a specific employee category. Sensor data will be automatically analysed by state-of-the-art machine learning (ML) (Berthold et al., 2009; Bishop and Nasrabadi, 2006) algorithms that will be adapted and refactored to provide two distinct, actionable outcomes: (1) Real-time(RT) categorisation of current workflow situations (e.g., the concentration of HCW for communication such as a caregiver relaying information to a head nurse); and (2) forecasting and prediction of caregiving and clinical events (e.g., patients needing urgent care due to activity patterns of HCWs in prior hours), which HCWs can use for resource planning or medical intervention.

Concluding remarks

In our study of the transitory process of becoming a new super hospital, we find that the shift from multi-patient rooms to single-patient rooms will affect and change the workflows of HCWs significantly. The HCWs have to oversee the same number of patients placed in several rooms over a greater distance. This results in fewer HCW-patient interactions and an increased risk of adverse events, such as falls while not being observed and feeling lonely or even forgotten. The transition will affect both patients and HCWs.

We designed a concept for mutual awareness between HCWs and patients of care workflows and a research prototype for engaging sensor data with the initial perspective of the nursing HCWs in a natural setting. The resulting sensor data will contain time, location, movement, and interaction information about proximity between beacons and sensors.

This paper makes two primary contributions. First, it uses empirical data based on 5+ years of ethnographic studies to provide an understanding of how to responsibly design sensed environments, building an agenda for worker and patient

well-being. Moreover, we present empirical findings from a recent study (March 2022) identifying that: (a) there is a risk of missing or losing critical information on patients due to a practice of storing information physically in the patient room; (b) Physical documents support an overview of working tasks and patient matters, resulting in sensitive knowledge being lost or forgotten and the risk of adverse events occurring; (c) Complexity of diversity: Patients are cognitively and socially at very different stages, which must be considered in communication systems to include all patients; (d) Physical interaction between patients and HCWs is prioritised as a form of care in order to foster safety and well-being. (e) HCWs express concern about the increasing level of documentation demand and systems to handle at the expense of physical care and face-to-face contact with patients.

Second, we propose a concept for mutual awareness of care workflows and a research prototype for engaging sensor data with the perspectives of the HCWs, patients, and their relatives in a natural setting. We identify four opportunities for supporting patients' and HCWs' mutual awareness of workflows: (1) progress of 'ward rounds'; (2) patient 'visits'; (3) patient 'calls'; and (4) patient 'mobility'. The concept optimises the workflow of the HCWs by implementing dashboards along their work paths, i.e., they do not have to walk back to the centralised coordination room to switch off alarms or find information about their patients. The HCWs will receive relevant information when they need it during their workflows, and the HCW closest to the patient will get notified instead of interrupting all HCWs with generic patient alarms/calls in the entire ward. The suggested solution includes: 1. Predictive ward round forecasts, 2. Patient movement analyses (timely mobility and fall prevention), 3. Smart nurse rounding registrations (timely patient visits), 4. Automated registrations of cleaned and available rooms.

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References

- Andersen, T. O., J. P. Bansler, F. Kensing, J. Moll, T. Mønsted, K. D. Nielsen, O. W. Nielsen, H. H. Petersen, and J. H. Svendsen (2019): 'Aligning concerns in telecare: three concepts to guide the design of patient-centred E-health'. *Computer Supported Cooperative Work (CSCW)*, vol. 28, pp. 1039–1072.
- Andersen, T. O. and J. Fritsch (2018): 'Affect and Emotions in Patient Data Work'.

- Andersen, T. O., H. Langstrup, and S. Lomborg (2020): 'Experiences with wearable activity data during self-care by chronic heart patients: qualitative study'. *Journal of Medical Internet Research*, vol. 22, no. 7, pp. e15873.
- Berthold, M. R., N. Cebon, F. Dill, T. R. Gabriel, T. Kötter, T. Meinl, P. Ohl, K. Thiel, and B. Wiswedel (2009): 'KNIME-the Konstanz information miner: version 2.0 and beyond'. *AcM SIGKDD explorations Newsletter*, vol. 11, no. 1, pp. 26–31.
- Bishop, C. M. and N. M. Nasrabadi (2006): *Pattern recognition and machine learning*, Vol. 4. Springer.
- Blomberg, J., J. Giacomi, A. Mosher, and P. Swenton-Wall (1993): 'Ethnographic field methods and their relation to design'. *Participatory design: Principles and practices*, vol. 7, pp. 123–155.
- Blomberg, J. and H. Karasti (2013): 'Reflections on 25 years of ethnography in CSCW'. *Computer supported cooperative work (CSCW)*, vol. 22, no. 4, pp. 373–423.
- Bødker, S., C. Dindler, and O. S. Iversen (2017): 'Tying knots: Participatory infrastructuring at work'. *Computer Supported Cooperative Work (CSCW)*, vol. 26, no. 1, pp. 245–273.
- Boone, A., C. Disalvo, and C. A. Le Dantec (2023): 'Data Practice for a Politics of Care: Food Assistance as a Site of Careful Data Work'. In: *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*. pp. 1–13.
- Bossen, C. and M. Foss (2016): 'The collaborative work of hospital porters: Accountability, visibility and configurations of work'. In: *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing*. pp. 965–979.
- Bryman, A. (2016): *Social research methods*. Oxford university press.
- Chung, C.-F., N. Gorm, I. A. Shklovski, and S. Munson (2017): 'Finding the right fit: understanding health tracking in workplace wellness programs'. In: *Proceedings of the 2017 CHI conference on human factors in computing systems*. pp. 4875–4886.
- Devito, M. A., A. M. Walker, J. Birnholtz, K. Ringland, K. Macapagal, A. Kraus, S. Munson, C. Liang, and H. Saksono (2019): 'Social technologies for digital wellbeing among marginalized communities'. In: *Conference Companion Publication of the 2019 on Computer Supported Cooperative Work and Social Computing*. pp. 449–454.
- Dourish, P. and V. Bellotti (1992): 'Awareness and coordination in shared workspaces'. In: *Proceedings of the 1992 ACM conference on Computer-supported cooperative work*. pp. 107–114.
- Few, S. (2006): *Information dashboard design: The effective visual communication of data*, Vol. 2. O'reilly Sebastopol, CA.
- From-Hansen, M., R. Rosa Hansen, L. P. Sode, M. Krassimir Kostadinov, M. B. Hansen, and M. Henrik Calum. 'Light-guided nudging and data-driven performance feedback improve hand hygiene compliance among nurses and doctors'.
- Gorm, N. and I. Shklovski (2016): 'Steps, choices and moral accounting: Observations from a step-counting campaign in the workplace'. In: *Proceedings of the 19th ACM conference on computer-supported cooperative work & social computing*. pp. 148–159.
- Gutwin, C. and S. Greenberg (2002): 'A descriptive framework of workspace awareness for real-time groupware'. *Computer Supported Cooperative Work (CSCW)*, vol. 11, pp. 411–446.

- Harper, R. H. R., M. G. Lamming, and W. M. Newman (1992): 'Locating systems at work: Implications for the development of active badge applications'. *Interacting with Computers*, vol. 4, no. 3, pp. 343–363.
- Hockenhull, M. and M. L. Cohn (2021): 'Speculative Data Work & Dashboards: Designing Alternative Data Visions'. *Proceedings of the ACM on Human-Computer Interaction*, vol. 4, no. CSCW3, pp. 1–31.
- Holten Møller, N. and P. Bjørn (2011): 'Layers in sorting practices: Sorting out patients with potential cancer'. *Computer Supported Cooperative Work (CSCW)*, vol. 20, pp. 123–153.
- Holten Møller, N., G. Neff, J. G. Simonsen, J. C. Villumsen, and P. Bjørn (2021): 'Can Workplace Tracking Ever Empower? Collective Sensemaking for the Responsible Use of Sensor Data at Work'. *Proceedings of the ACM on Human-Computer Interaction*, vol. 5, no. GROUP, pp. 1–21.
- Holten Møller, N. L., P. Bjørn, J. C. Villumsen, T. C. H. Hancock, T. Aritake, and S. Tani (2017): 'Data tracking in search of workflows'. In: *Proceedings of the 2017 ACM conference on computer supported cooperative work and social computing*. pp. 2153–2165.
- Iversen, A.-M., C. P. Kavaliris, R. Hansen, M. B. Hansen, R. Alexander, K. Kostadinov, J. Holt, B. Kristensen, J. D. Knudsen, J. K. Møller, et al. (2020): 'Clinical experiences with a new system for automated hand hygiene monitoring: a prospective observational study'. *American Journal of Infection Control*, vol. 48, no. 5, pp. 527–533.
- Jensen, C. N. (2023): 'Matt og Mel kæmper for bedre vilkår i det britiske sundhedsvæsen'.
- Karusala, N., A. Ismail, K. S. Bhat, A. Gautam, S. R. Pendse, N. Kumar, R. Anderson, M. Balaam, S. Bardzell, N. J. Bidwell, et al. (2021): 'The future of care work: towards a radical politics of care in CSCW research and practice'. In: *Companion Publication of the 2021 Conference on Computer Supported Cooperative Work and Social Computing*. pp. 338–342.
- Kaziunas, E., M. S. Ackerman, S. Lindtner, and J. M. Lee (2017): 'Caring through data: Attending to the social and emotional experiences of health datafication'. In: *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing*. pp. 2260–2272.
- Kristiansen, K. H., M. A. Valeur-Meller, L. Dombrowski, and N. L. Holten Møller (2018): 'Accountability in the blue-collar data-driven workplace'. In: *Proceedings of the 2018 CHI conference on human factors in computing systems*. pp. 1–12.
- Kumar, D., S. Jeuris, J. E. Bardram, and N. Dragoni (2020): 'Mobile and wearable sensing frameworks for mhealth studies and applications: a systematic review'. *ACM Transactions on Computing for Healthcare*, vol. 2, no. 1, pp. 1–28.
- Light, A., T. W. Leong, and T. Robertson (2015): 'Ageing well with CSCW'. In: *ECSCW 2015: Proceedings of the 14th European Conference on Computer Supported Cooperative Work, 19-23 September 2015, Oslo, Norway*. pp. 295–304.
- Lomborg, S., H. Langstrup, and T. O. Andersen (2020): 'Interpretation as luxury: Heart patients living with data doubt, hope, and anxiety'. *Big Data & Society*, vol. 7, no. 1, pp. 2053951720924436.
- Lorenzetti, D. L. and T. Noseworthy (2011): 'Patient choice systems and waiting times for scheduled services'. In: *Healthcare Management Forum*, Vol. 24. pp. 57–62.
- Mattelmäki, T. (2005): 'Applying probes—from inspirational notes to collaborative insights'. *CoDesign*, vol. 1, no. 2, pp. 83–102.

- Møller, N. L. H. and J. P. Bansler (2017): 'Building Information Modeling: The dream of perfect information'. In: *Proceedings of 15th European Conference on Computer-Supported Cooperative Work-Exploratory Papers*.
- Møller, N. L. H. and P. Bjørn (2016): 'In Due Time: Decision-Making in Architectural Design of Hospitals'. In: *COOP 2016: Proceedings of the 12th International Conference on the Design of Cooperative Systems, 23-27 May 2016, Trento, Italy*. pp. 191–206.
- Møller, N. L. H., I. Shklovski, M. Silberman, L. Dombrowski, and A. Lampinen (2017): 'A constructive-critical approach to the changing workplace and its technologies'. In: *Proceedings of 15th European Conference on Computer-Supported Cooperative Work-Panels, Posters and Demos*.
- Nawaz, A. (2012): 'A comparison of card-sorting analysis methods'. In: *10th Asia Pacific Conference on Computer Human Interaction (Apchi 2012). Matsue-city, Shimane, Japan*. pp. 28–31.
- Neff, G., A. Tanweer, B. Fiore-Gartland, and L. Osburn (2017): 'Critique and contribute: A practice-based framework for improving critical data studies and data science'. *Big data*, vol. 5, no. 2, pp. 85–97.
- Nunes, F., N. Verdezoto, G. Fitzpatrick, M. Kyng, E. Grönvall, and C. Storni (2015): 'Self-care technologies in HCI: Trends, tensions, and opportunities'. *ACM Transactions on Computer-Human Interaction (TOCHI)*, vol. 22, no. 6, pp. 1–45.
- Ooms, A., C. Heaton-Shrestha, S. Connor, S. McCawley, J. McShannon, G. Music, and K. Trainor (2022): 'Enhancing the well-being of front-line healthcare professionals in high pressure clinical environments: A mixed-methods evaluative research project'. *International Journal of Nursing Studies*, vol. 132, pp. 104257.
- Paul, S. A. and M. C. Reddy (2010): 'Understanding together: sensemaking in collaborative information seeking'. In: *Proceedings of the 2010 ACM conference on Computer supported cooperative work*. pp. 321–330.
- Ravikumarand, Sachin; Thomas, N. (2023): 'Workers stage largest strike in history of Britain's health service'.
- Schmidt, K. (2002): 'The Problem with Awareness Introductory Remarks on Awareness in CSCW Journal 11 (3 4), 285_298'.
- Stangerup, M., M. B. Hansen, R. Hansen, L. P. Sode, B. Hesselbo, K. Kostadinov, B. S. Olesen, and H. Calum (2021): 'Hand hygiene compliance of healthcare workers before and during the COVID-19 pandemic: a long-term follow-up study'. *American Journal of Infection Control*, vol. 49, no. 9, pp. 1118–1122.
- Søndergaard, S. F. (2021): 'Erfaringer med de nye sygehuse: Enestuer på Sygehus Lillebælt i Kolding'.
- Tang, C., Y. Xiao, Y. Chen, and P. N. Gorman (2015): 'Design for supporting healthcare teams'. *Cognitive Informatics for Biomedicine: Human Computer Interaction in Healthcare*, pp. 215–239.
- Yu, C., J. Liu, S. Nemati, and G. Yin (2021): 'Reinforcement learning in healthcare: A survey'. *ACM Computing Surveys (CSUR)*, vol. 55, no. 1, pp. 1–36.

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Open Forest: Walking-with Feral Stories, Creatures, Data

Markéta Dolejšová

Department of Design, Aalto University, Espoo, Finland
marketa.dolejsova@aalto.fi

Andrea Botero

Department of Design, Aalto University, Espoo, Finland
andrea.botero@aalto.fi

Jaz Hee-jeong Choi

School of Design, Royal Melbourne Institute of Technology (RMIT), Melbourne, Australia
jaz.hee-jeong.choi@rmit.edu.au

Chewie

Křivoklátsko protected landscape area, Czech Republic

Abstract. Open Forest is an experimental, practice-based inquiry into forests and forest data that facilitates imaginative co-creation of feral forest datasets. The project involves a series of experimental walks with various forests around the world, inviting participants

to explore local ecologies and share their experiences in the form of forest stories. To enable sharing of such personally situated stories, we experiment with various speculative material practices and devices, including the online Feral Map – a collaborative dataset of more-than-human forest experiences and knowledge. Through the experimental forest walks and stories, we explore what can constitute a forest dataset, how it can be produced, and by whom to raise questions about power, values, and structural inequalities that shape forests and their futures. We propose that caring for the futures of forests must be collaborative work. Finding ways to do this labour requires imaginative articulations of technologies, practices and data, an agenda to which CSCW is well positioned to contribute.

Introduction

As complex ecosystems, forests provide a living environment for many species. They are places of refuge, myths, folktales, and sensorial excitement but also sites for control and industrial extraction of natural materials, especially since the introduction of scientific forestry. Dominant western traditions of forest management and environmental policies tend to see forests as a resource to be used to improve human lives – for example, through timber yields and stocks or carbon sink cultivation (González and Kröger 2020). In the times of ongoing climate breakdown, forests are also leveraged to protect – not all, but some – humans from the perils of ecological disasters such as high temperature, ozone, and other health-related consequences (Knight et al. 2021).

In recent years, a variety of ‘smart’ forest management initiatives have sprouted around the world, promising to address climate crises via universalising, data-driven interventions (Gabrys 2020, Mattern 2021, Fleischman et al. 2020, Coleman et al. 2021). These initiatives, such as mass tree planting campaigns and related processes of forest monitoring and automation, often amplify instrumental understandings of a forest as a mere sum of trees that can be mapped, datafied and turned into easy solutions to avert climate catastrophe. This “techno-vegetal solutionism” (Mattern 2021) offers only a limited acknowledgement for the diverse, situated forest epistemologies defining what a forest might be and to whom. As such, these initiatives and their efforts often become ineffective and even harmful, fueling further land depletion and displacement of local communities; amplifying environmental crises rather than enabling more sustainable futures (Fleischman et al. 2020, Coleman et al. 2021).

Forest dwellers, custodians, activists, as well as researchers across disciplines, including CSCW (e.g., Gabrys 2020, González and Kröger 2020, Ohja et al. 2019, Vitos et al. 2017) have called for different approaches to understanding and living with forests that move away from techno-positivist generalisations (‘forests as sum of data’) towards more nuanced engagements with forests as complex,

relational sites for sustenance of multi-species life, cultural narratives, and Indigenous cosmologies. In accordance with these calls for change, the Open Forest project investigates how various human and other-than-human stakeholders make sense of forests and what forest stories they can share (Botero et al. 2022, Dolejšová et al. 2022).

The project was initiated in 2020 by the Open Forest Collective, a multi-disciplinary and multi-species group of creative practitioners and researchers experimenting with co-creative approaches to engaging with forests and forest data. As a collective, we have been interested in how forest data can be approached and understood *otherwise* (Escobar 2018): in situated, relational and collaborative ways that consider perspectives of diverse forest creatures challenging the techno-solutionist, extractivist renderings of forests as resources to serve colonialist, neo-liberal agendas. Our experimental, practice-based inquiry brings together diverse more-than-human forest stakeholders – including scientists, artists, citizens, policymakers, Indigenous forest guardians, as well as dogs and trees – into a co-creative exchange of their forest knowledge and experiences.

Central to the project is a series of experimental walks organised in various forests around the world, where participants come together to *walk-with* and observe the forests around them, both in-situ and online. Their observations become inspiration for forest stories, which are shared via various engagement occasions and formats including in-person workshops, sharing circles, interactive installations and a paper-based catalogue, and online via the Feral Map (<https://feral.more-than-human-derive.net/>). The Map serves as a growing public archive of forest stories and a co-created forest dataset gathering more-than-human forest knowledge contributed by diverse walkers. Through the experimental walks and sharing of stories, the project aims to entangle the currently available (mostly quantitative) forests datasets and extractivist understandings of forests with more messy and eclectic inputs, or what we call “feral data”. We follow an understanding of feral as a quality to appraise open-ended, spontaneous, unexpected, more-than-human encounters that unfold beyond human control, embracing uncertainty and surprise as generative elements (Ampatzidou et al 2021, Bell 2018, Tsing et al 2020). We use feralness as a lens for understanding and experimenting with the complexity of forest epistemologies, as a metaphor for denoting the kind of data we are assembling, and a methodological approach guiding the collaborative project activities.

Acknowledging the constitutive role of data in creating everyday worlds (Gitelman 2013, Lupton 2016, Ruppert, Isin and Bigo 2017) our feral forest experiments question what or who can constitute a forest dataset, in a hope to contribute to the growing critical accounts of human-forest data relationships. Our aim with this exploratory work is to offer a collaborative and co-creative space for expression of diverse forest knowledge and, by extension, to make better

sense of what new forest data and relationships might be needed to support eco-social flourishing and transformational futures based on justice and care. CSCW, along with other related fields such as Human-Computer Interaction and informatics, has a long tradition in investigating and re-imagining human-data entanglements (e.g., Muller et al. 2020, Tolmie et al. 2016, Hilviu and Rapp 2015, Choi, Forlano and Kera 2020) and experimenting with alternative, care-full and collaborative modes of data production (e.g., Chancellor et al 2019, Dolejšová & Kera, 2017, Heitlinger et al 2023, Kaziunas et al 2017, Kloppenborg 2022, Le Dantec et al 2015, Puussaar et al 2022) as well as an interest in environmental issues and sustainable eco-social transformations (e.g., Costanza-Chock 2020, Dolejšová et al. 2021, Gaikwad 2020, Ganglbauer et al 2014, Light 2022, Prost et al 2015, Parmiggiani et al. 2015).

We first introduce the Open Forest collaborative activities and devices, including the walking-with forests and sharing of stories via the Feral Map. Using a few selected examples of stories gathered through our walks, we discuss how these forest stories – or feral forest data – might help expand existing understandings of human-forest data relationships. We pay attention to various challenges and concerns encountered throughout our exploratory inquiry and offer them as provocations for further debate in CSCW and beyond.

Open Forest

Experimental walking-with

In the Open Forest, walking is embraced as a way of becoming responsive to a place: a bodily practice that can activate modes of situated, relational participation and facilitate imaginative knowledge production (Kanstrup et al. 2014, Springgay and Truman 2018). The experimental walks are centred around the elements of surprise and curiosity, inviting participants to walk with one another as well as with the surrounding local forest. We walk both physically and remotely, sometimes with actual forests and other times through data-based representations of them (figure 1). Remote participants join the walks using proprietary video conferencing systems such as Zoom and we bring them along using our laptops and mobile phones.

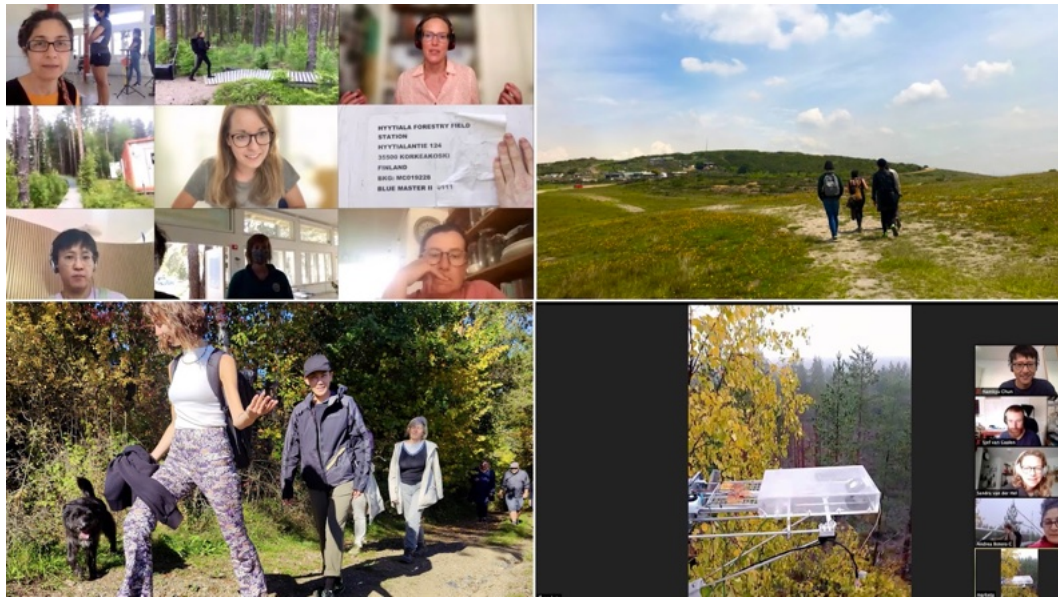


Figure 1: The Open Forest walks take place both physically and remotely via videoconferencing.

The walks are guided by various human and other-than-human navigators with good knowledge or sense of local landscapes (figure 2). Our walking guides have so far included Indigenous forest guardians and healers, forest scientists and data managers, a dog and a river, as well as artistic strategies of *Dérive*, which invite walkers for spontaneous psychogeographic explorations of a local ambiance challenging the capitalistic production of urban space (Debord, 1958).



Figure 2: The Open Forest walks are guided by various human and other-than-human navigators.

Local trees and other forest creatures are considered participants, in both the walking experiences and the larger eco-social phenomena happening in and around forests, such as biodiversity loss and climate change. This relational walking-with follows various approaches: some walking guides share narrated trivia about the local forest area, such as its culture, species and history, which then serve as the key points of the walking route. Other guides, including Chewie – an Open Forest Collective member of canine origin – use their own sensory instincts and invite participants to follow without any predefined route.

At the end of each walk, we articulate our experiences in the form of forest stories, which are shared either in collective sharing circles organised after some of the walks, or by each participant individually. Stories shared on a paper are first compiled into the Open Forest Catalogue, a colourful clip-binder notebook that allows for an easy adding of new pages, and later digitised and uploaded into the online Feral Map, which is our main story archive with over 150 forest stories at the time of writing this paper. In addition to the walks and sharing circles, we have also designed and showcased Open Forest installation (figure 3) which offers another entry for people to engage with the project and share forest stories (Open Forest Collective, 2022).



Figure 3: The interactive Open Forest installation is regularly showcased at public exhibitions and festivals.

Feral Map

The Feral Map makes the collected forest stories available for further reflection and asynchronous engagement outside of the walks' scope, which helps to enable iterative interactions and reach broader audiences. Each forest area where we organise the walks is added to the map as a new location (or 'patch') to collect local stories (figure 4). However, map contributions are not limited to the forest patches we have directly engaged, and a story can also be added anywhere outside of these locations. Anyone, including those who did not participate in the walks, can share their stories in any forest locations they like, thereby contributing to an evolving dataset of diversely situated forest experiences and observations.

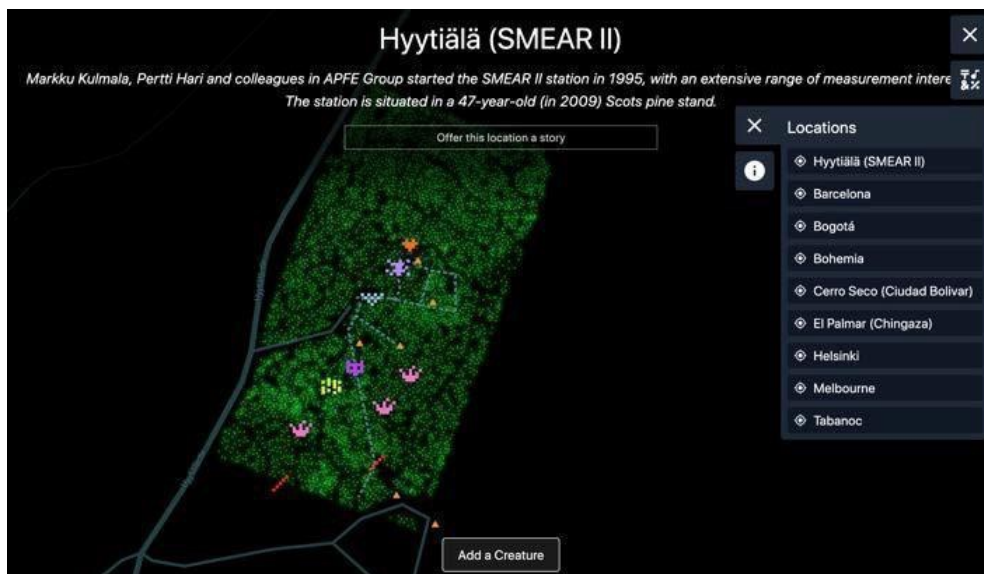


Figure 4: Feral Map and a forest patch in the Hyttiälä station, Finland.

On the map, stories can have various formats and contain text as well as images, audio, and links to external pages: some stories include personal accounts of human-forest relationships expressed in words and pictures, while others document local forest traditions and mythologies. Apart from adding stories to the existing forest places and data points, participants can also add new points of interest, or new 'creatures' as we call them. Offering these creatures to the map is left deliberately open: participants can add creatures of various kinds, such as an animal or plant, but also more abstract ones, such as an ambiance or a glitch (figure 5). By adding these new creatures, they can share their personally situated views on what makes the local forest, thereby drawing attention to what might not be visible otherwise.

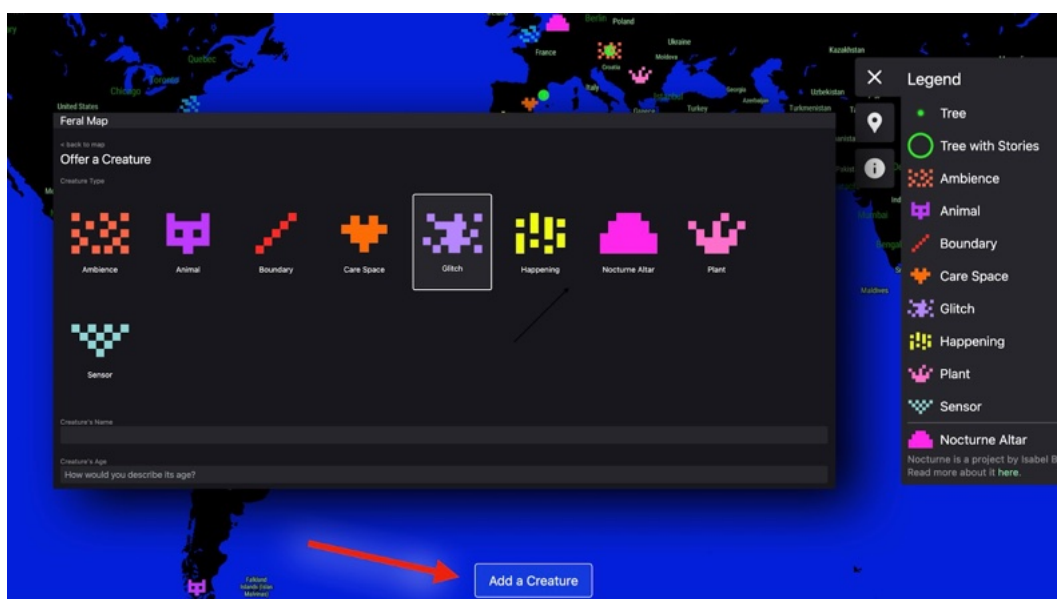


Figure 5: Various new forest ‘creatures’ can be added to the Feral Map dataset.

Besides the content added by participants, the map has been seeded with data points generated automatically using various existing, open and publicly available forest datasets. For instance, we have used urban forest datasets maintained by the city of Melbourne and the city of Helsinki, which allowed us to include all trees that exist in these locations and are monitored by the local municipalities.

We have used the Feral Map as our main portal to collect forest stories during and after our walks in various parts of the world, including (what is known today as) Finland, Australia, the Czech Republic, Colombia, and the United Kingdom. In the following sections, we discuss our walking experiences and stories gathered from four selected forest patches: the Hyttiälä forestry field station (FI), the ancestral territory of the Kamëntša people Bëngbe Uáman Tabanoc (COL), the Melbourne urban forest (AUS), and the protected landscape area Křivoklátsko (CZ).

Forest patches and stories

Hyttiälä

In Finland, our walks have been situated in the SMEAR II – Station for Measuring Ecosystem-Atmosphere Relations in the historical Hyttiälä forestry field station. The walks have been performed in a hybrid format and followed the guidance of two Collective members who previously interviewed several forestry researchers working in Hyttiälä to learn about the station’s history and research. SMEAR II provides a peculiar location for our inquiry: this highly

instrumentalized forest is full of sensors and other monitoring devices that provide comprehensive measurements of fluxes, storages, and concentrations of important substances in the land-ecosystem-atmosphere continuum (figure 6). These sensors and the data they collect present key points of the guided walks.



Figure 6: Snapshots from our walk with the SMEAR II forestry station.

At a recent Hyytiälä walk that was followed by a sharing circle titled *What did the cloud whisper to the forest canopy?* we shared stories to re-imagine SMEAR's data collection practices. One participant offered a story to the local Carbon Tree, a medium-sized Scots pine strapped with sensors that monitor its carbon sequestration activity in real time (<http://www.carbontree.fi/>). The story wonders about the quality of life of this particular tree that was turned into a quantitative data monitoring device, asking: Do people even notice that it is a pine species? Do they notice how beautiful its bark is? Do they care? Or has the tree become a mere sum of numeric data? (figure 7). The story poetically captures what might get lost in numeric datasets representing forests, and what might become difficult to capture about forests and how to care for them, when we rely only on quantitative measures such as carbon sink metrics.

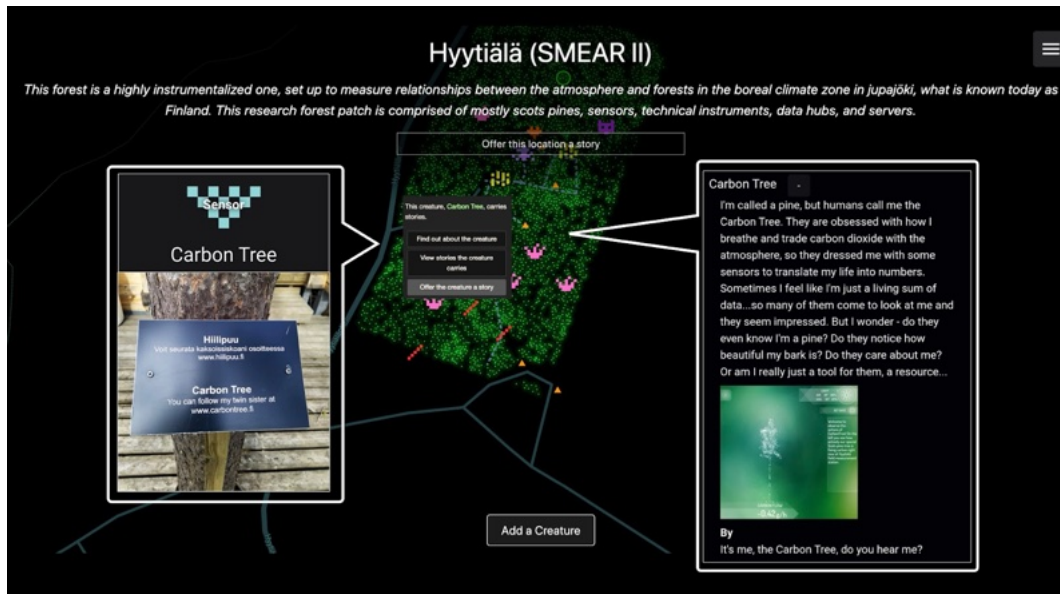


Figure 7: Carbon Tree story speculating about the life of a tree-turned-sensor.

Another story titled *Zooming into the Forest* was shared by a remote walk participant who wanted to reflect on their hybrid walking experience. The story highlights some unexpected moments brought about by the technological mediation of the walk: the low frame rate video connection provided a somewhat distorted image of the forest on their screen; the ambient noise cancelling algorithm of the video conferencing system suppressed the forest sounds experienced by those walking there physically (e.g., the experience of constant eerie humming produced by the sensing instruments mentioned many times by local walkers was not available to those walking remotely). This story (figure 8) illustrates the situatedness of forest experiences and the diverse ways how a forest can be sensed by different creatures – in this case human creatures wandering through the forest in-situ and those experiencing the same forest as a representation displayed in real time, yet across different time zones, on a screen.

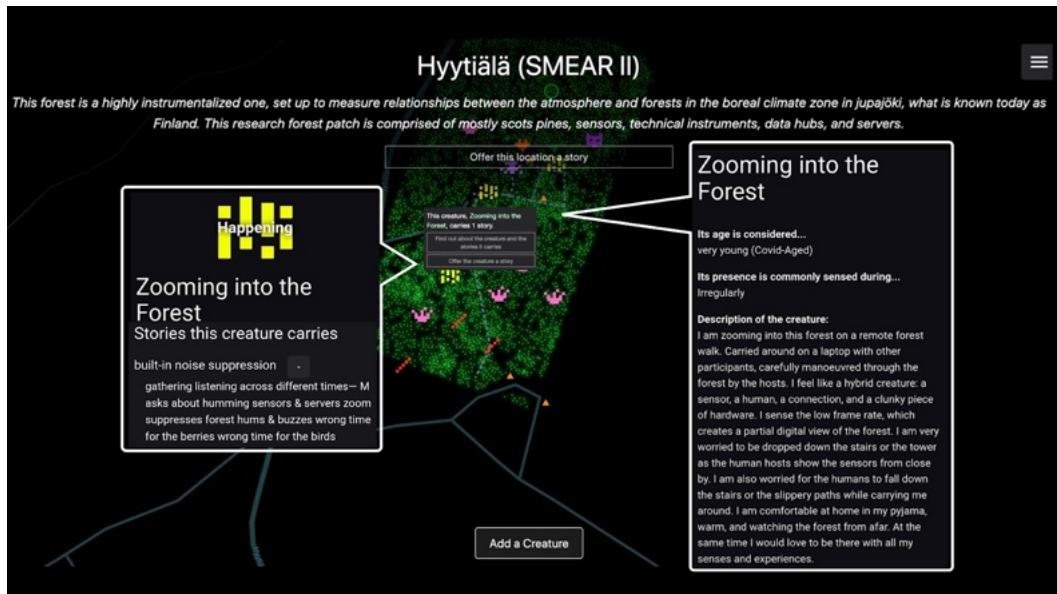


Figure 8: Zooming into the forest – a story shared by a remote participant during one of the walks.

Bëngbe Uáman Tabanoc

In Colombia, we walked in Tabanoc, an ancestral territory of the Kamëntša people located in southern Colombian Andes. The walks were situated in two forest gardens – *jajañs* as they are named in Kamëntša or *chagras*, which is the more commonly used Quechua word. These gardens present complex Indigenous ecosystems where trees, medicinal and edible plants, flowers, and other species intermingle under human stewardship and care (Cabildo Kamëntša 2013). Our walks were guided by the gardeners themselves, in this case two Kamëntša women (figure 9).



Figure 9: Maria Victoria guides the walk through her forest garden in Bëngbe Uáman Tabanoc.

In the past decades, the growth of monocultural agriculture, modern forest management practices and capitalist demands resulted in a steady decline of this forest stewardship practice. Remaining forest gardens that are still maintained according to traditional Kamëntša ecological knowledge and specific preferences of each gardener are maintained more as acts of sociopolitical resistance rather than as daily sustenance. In contrast to our walks with the instrumentalized SMEAR II forest, where we carefully avoid stepping on or touching the sensing devices installed on site, the walks with chagras involve touching, tasting, smelling and loads of references to the larger cosmopolitics of the place. Seasonality and what grew there at the time of our walks defined the key points of the walking routes. This focus on situated details creates an intimate atmosphere, with the gardeners sharing stories of their personal relationships to some of the species growing in their *jajañ*.

Besides gardening, Kamëntša women are renowned for weaving colourful patterned sachets called *tšombiachs* that are used both in everyday life and on special occasions (Cuarán et al 2021). *Tšombiachs* have been woven for centuries through a series of intricate pictograms that hold much of what being Kamëntša means. In many instances, the belts document – in complex ways – environmental knowledge of the territory and stories that codified Kamëntša relationship with their forest gardens past and present. During one of our walks, our guide shared stories about the spectacled bear – once a prominent inhabitant of this territory that is often featured in Kamëntša myths. Spectacled bear is the only bear species left in South America, and is now facing extinction because of habitat loss caused by deforestation. The Spectacled bear story shared on the Feral Map offers some data about this species juxtaposed with its representation in a *tšombiach* that was woven by one of our guides (figure 10). The *tšombiachs*, as particular data representations of the local ecosystem, offer a culturally and locally specific illustration of large-scale eco-social issues such as deforestation and colonialism. Our hope is that the Feral Map can help make these issues visible through the personally situated forest stories shared by local forest stakeholders – such as the one mentioned here.

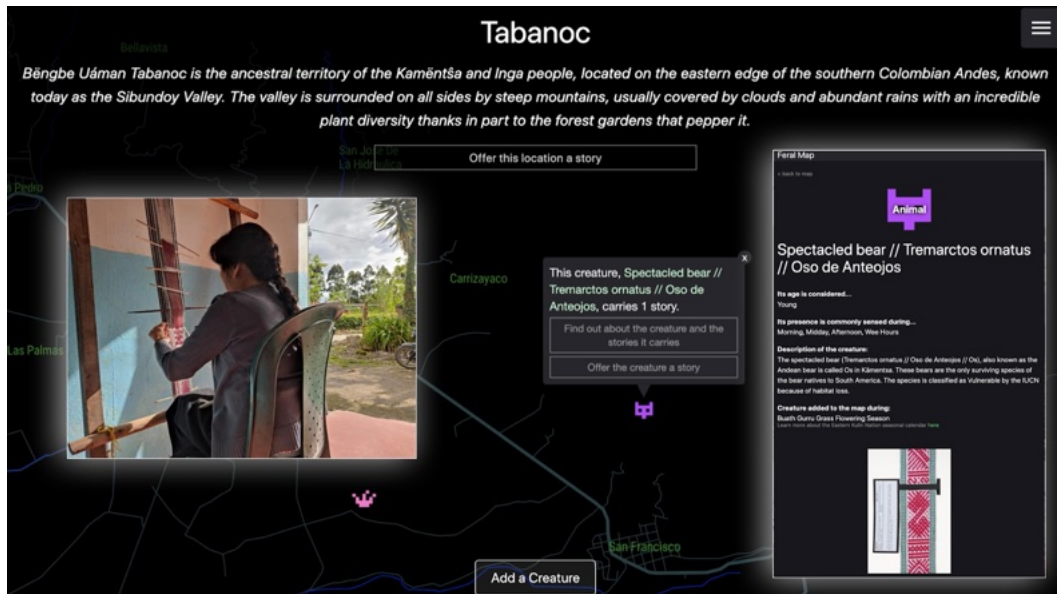


Figure 10: The tšombiach depicted in the story shows one of the pictograms that in Kamëntša mythology refers to the spectacled bear.

Melbourne Urban Forest

The walks with the Melbourne urban forest, a complex ecosystem of more than 70,000 trees each with unique IDs, were guided by a set of More-than-Human (MtH) Dérives (<https://more-than-human-derive.net/about/>), or drifts. Inspired by the Letterist and Situationists International's artistic strategy with the same name, the Dérives invite walkers to take an unplanned journey through local landscapes, drop their everyday relations and let themselves be drawn by chance encounters (Debord, 1958). Dérives were intended to challenge restrictive spaces created by the social and architectural conditioning in urban environments and aimed at creating new spaces for movement and action through creative, playful interactions with abstract intentions. The MtH Dérive, as an online portal with a set of drifting prompts, was developed in parallel with the Feral Map through three co-creative workshops with scientists, designers, artists, researchers and policy actors from Melbourne. Over 200 prompts for drifting through the local landscape were created and categorised into ten themes, including, for example: *Becoming* (To listen and attune to those less visible or heard), *Space-time* (To understand space and time differently), *Decentering the Human* (To not assume anthropocentrism and human exceptionalism), and *Sensemaking* (To feel, think, and know differently) (figure 11).

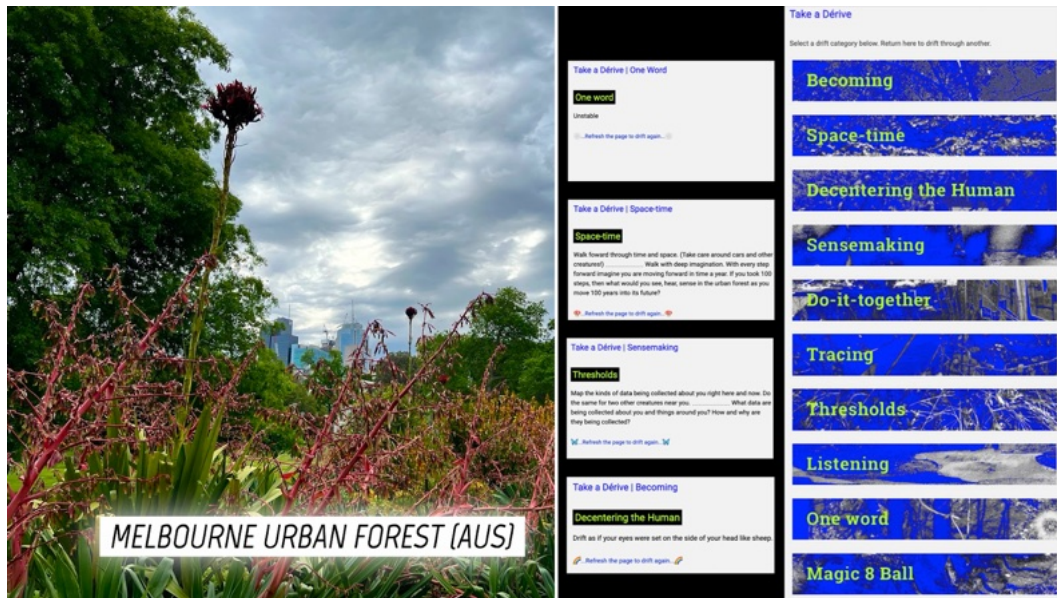


Figure 11: Melbourne urban forest and the More-than-Human Dérive prompts.

The design and engagement with the MtH Dérive were also inspired by the existing website run by the city of Melbourne named Urban Forest Visual. Drawing on the Melbourne Urban Forest dataset, which assigns 70,000 trees in inner city Melbourne with unique IDs, the website allows people to send an email to any of these mapped trees. Although reportedly meant to provide a platform for local citizens to report to the city council various issues concerning the trees, the site has been used by people around the world for an unintended purpose: to write letters *to* the trees rather than *about* them. Many of the letters express people’s affection for and personal memories involving the trees; telling important stories that capture complex (more-than)human-tree relationships that constitute the urban forest. As such, the letters should serve as critical data informing future decisions about the urban forest and, more broadly, the city itself. Yet these remain essentially invisible to most people and illegible to algorithmic systems that only feed specific sets of official, scientific data into their operation. With the MtH Dérive and the Feral Map, we hope to explore how to enrich, complicate and expand ways for these kinds of messy – yet critical – data to become a more visible and meaningful part of the past-present-future forest imaginings.

In a Feral Map story placed in the Melbourne patch titled Dewy Aura, the author shares what they sensed while drifting through the urban forest on an early morning. The story captures various sensory details, such as the fresh smell of the morning air and the soft light coming through the clouds – possibly the kind of ambient forest details, or forest data, that might go unnoticed otherwise, during a morning rush hour in the city (figure 12).

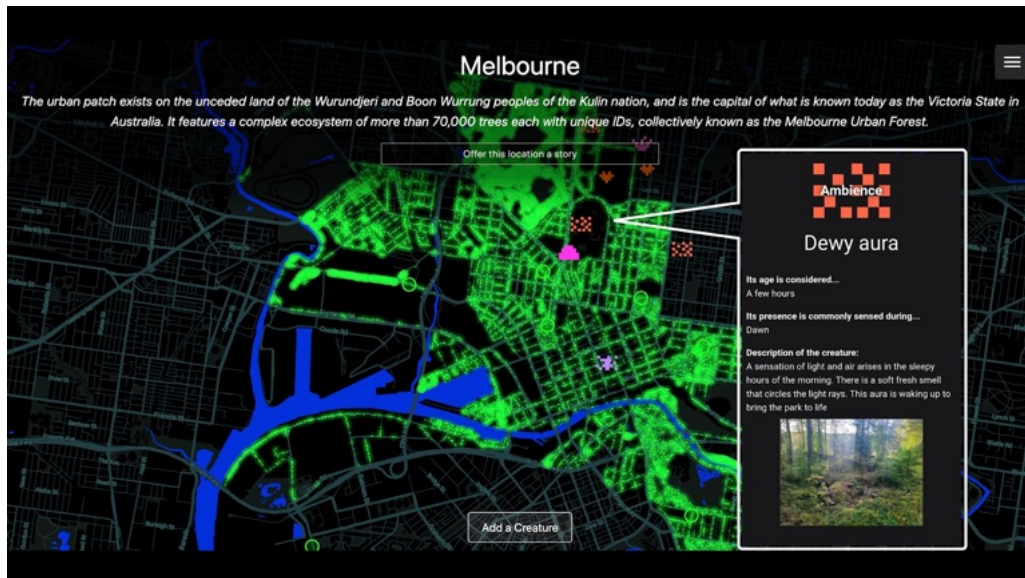


Figure 12: The Dewy Aura story capturing intimate, sensory-rich experiences of forest drifting.

Křivoklátsko

In the Czech Republic, an ongoing series of walks takes place in Central Bohemia, in the protected landscape area Křivoklátsko, which presents a unique ecosystem with a mosaic of species-rich habitats. The Bohemian walks are guided by the Collective's member Chewie – a dog with extensive sensorial knowledge of the local forest landscape. We follow Chewie, his sense of orientation and points of interests in the local forest, letting him choose which direction to take and what is worth exploring. Chewie's sensory capacities – especially the smell that canine species use to orient themselves in the world – become key in these guided trips. Our human sensory capacities are present but their usual connection to rational decision-making is put on hold to some extent, as we walk-with and wait for what will come our way.



Figure 13: Serendipitous more-than-human encounters during the feral Bohemian walks guided by Chewie.

Often, we walk into forest spaces and situations that we might have never encountered otherwise, as captured in some of the forest stories (figure 13). Guided by Chewie, we engaged in new (to us) forest rituals such as plunging our faces into a moss to explore the forest from different perspectives (figure 14).



Figure 14: Face moss spa practised by the Bohemian walking guide and participants.

We learned about lives of various local forest creatures spending many hours watching squirrels jumping through the canopy and otters building and guarding

their houses near the river. These experiences have been enthralling as well as exhausting and sometimes even frightening, expanding our embodied knowledge of the forest and the different temporalities of forest lives. Along with this more-than-human guidance, we explore what we can learn as humans if we reduce our control over our usual movements through time and space and instead try to attune to the different rhythms and interests of a local non-human creature.

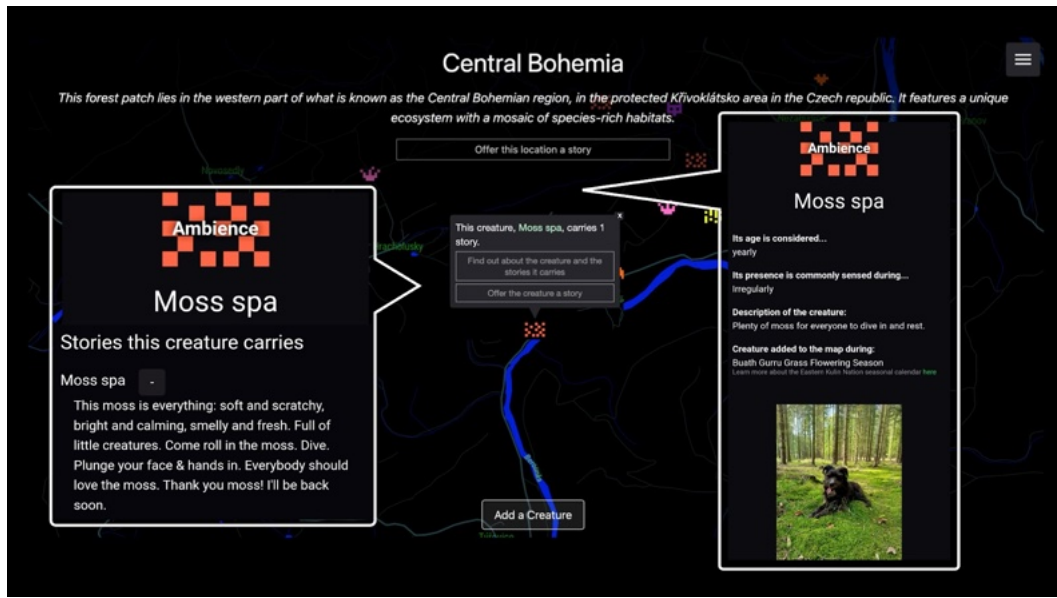


Figure 15: Moss Spa story shared by 'Chewie'.

We note that the stories resulting from the Bohemian walks, such as the Moss Spa story (figure 15), are written from the perspective of Chewie for whom typing on a keyboard does not make sense (this is similar to the case of the Carbon Tree story mentioned earlier). While aiming to playfully capture what they assumed might have been Chewie's experience, the human author of the story started 'speaking' on the dog's behalf, conveying a rather biased, human-driven interpretation of his other-than-human experience. In the context of the Feral Map, the Moss Spa story opens questions about the possibilities and limitations of embracing more-than-human perspectives in human-made datasets. Some of the questions we continue to explore include: How can we involve other-than-humans as collaborators on such datasets and capture their experiences while avoiding falling for mere representations? How can we learn from each other in a mutualistic way beyond the unidirectional mode of humans observing and learning from other creatures?

Feral collaborative practices, feral data, feral futures

The forest stories we have collected from our walks offer alternative, diversely situated perspectives on what forests might mean and to whom, beyond extractivist understandings of forests as resources to be used for human survival and wellbeing. Along with these stories, the evolving Feral Map aims to obscure the currently available numeric data about forests, to include more nuanced or alternative data in various formats, including forest data woven into belts, generated through drifting, and inspired by a dog's forest interests and movements (figure 16). These stories offer a peculiar kind of forest data that is messy, eclectic, colourful, varied, or “feral”. In this section we present our preliminary understanding about what feral data can encompass, related theories and concepts, and what its possible uses for the reimagining of human-forest data relationships might be.

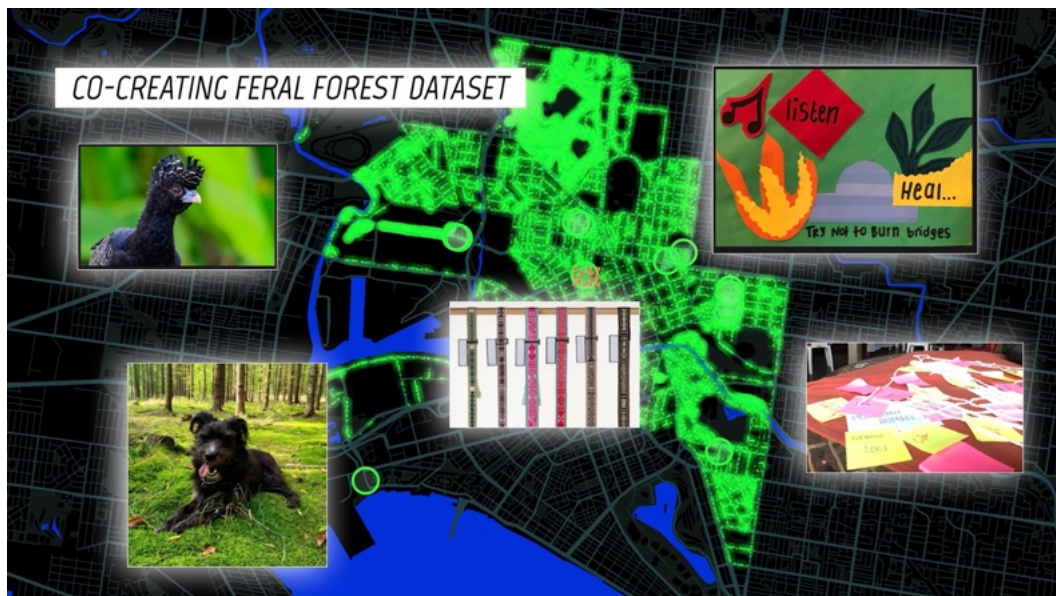


Figure 16: Feral forest data in the Feral Map captures diverse forest knowledge.

The term feral derives from the Latin *ferus*, or wild, and is mostly used in biology in the context of feral species – once domesticated creatures that have returned to the wild and become untamed. Feral species are known to have an ambivalent relationship with their local ecosystems; they can be disruptive and invasive, even displacing local indigenous species but also contribute to the enrichment of local biodiversity. There have been different attempts to define the “feral” in particularly from an anthropological perspective. In *Feral Atlas*, Anna Tsing and colleagues (2020) define feral as emerging from within human-

sponsored infrastructures but unfolding beyond human control; carrying a potential to challenge dominant ontological and epistemological discourses. Making a departure from the concept of ‘in the wild’ research, or science, Mike Michael (2018) suggests that feral can be used as a mode of engagement that, while having elements of domestication, operates within its own rules, beyond domestication. Using the example of ‘destructive testing’ videos where users destroy their iPhones to learn more about their functions, Michael talks about feral citizen science that is motivated by curiosity to explore what is hidden or made invisible, rather than by pragmatism.

Genevieve Bell (2018), reflecting on the history of how camels were initially imported to Australia for transportation and later became feral with the introduction of locomotives, talks about data and technologies becoming feral: outliving their intended purpose and slipping the received wisdom about users, contexts, and regulatory regimes to emerge in new situations as “feral versions of their former selves” (in Scroggins, 2023:85). Here, feralness marks a deviation from a norm, thus providing a useful metaphor for thinking of data becoming wild and untamed, standing in opposition to a normative order that is assumed to be rational and orderly (Scroggins, 2023). Similar to the ambivalence in feral species’ relations with local environments, nurturing and engaging with feral data – data that is messy, uncertain, eclectic, surprising – may lead to diverse outcomes. Data as a never-neutral agent can disrupt, expose, and create new social, economic, political and environmental possibilities as well as hide, exclude and foreclose others (Gitelman, 2013). In this sense, data and societal relations embedded in them act as tools for generating futures, rather than only representing existing realities and future possibilities (Henry et al. 2022). Experimenting with data as a feral, uncertain agent acting outside its domesticated anthropocentric nature can thus reveal previously invisible meanings and open a space for various unexpected connections and outcomes.

The concepts of feralness and feral data are central to the design of our experimental inquiry that encourages surprising encounters and relations to emerge among various more-than-human forest stakeholders, and that deliberately leaves room for the unexpected to unfold beyond our control as human researchers. The forest walks are shaped by various more-than-human factors that are necessarily out of human control, such as seasons, weather, technology, dogs, and the many evolving forest lives in and around the places that we walk-with. The spontaneity and feralness of the walks influence the form and texture of the forest stories that are shared by participants and add to the constellation of forest data emerging from the project. The Feral Map itself experiments with an open curation and invites contributions in varied forms, including forest stories as well as new ‘forest creatures’ to help make visible what might otherwise stay unseen. Aligning with the ambivalence embedded in

feralness, taking this open-ended, feral approach to the map's design and curation presents diverse possibilities, ranging from strengthening people's connection with particular forest creatures and places, to spam or stories that are added rather randomly and hold limited relevance. Critical to our feral data experimentation is the focus on co-creative collaboration that brings human and other-than-human forest stakeholders into playful exchange of their forest knowledge, experiences, observations and sensory impressions. The insights shared by these project contributors through the walks and the Feral Map invite diverse perspectives on what forests can be, to whom, in what kinds of power relations. By experimenting with limiting control over our co-creative inquiry, we aim to create opportunities to learn from and better understand the diverse creatures living in and around forests whose interests may remain invisible, ignored and unnoticed. By doing so, we hope to make better sense of what new forest data and relationships might be needed to help foster shifts towards forest futures where more-than-human care and justice are taken seriously, beyond mere tokenistic gestures.

In our attempts to cultivate pluralistic, more-than-human forest imaginaries and sensemaking, we also learned about certain limitations to our feral data experimentation. These include concerns with the representational nature of some of our data, especially those generated by humans from other-than-human perspectives, as illustrated by the Moss Spa story. How do these stories reflect our own human understanding and assumptions about the feral and anthropocentrism? How can an anthropocentric technology like the Feral Map claim to 'capture' other-than-human experiences? Relatedly, how can we as human researchers and practitioners think about and do co-creation with other-than-humans? For example, what could it possibly mean to include trees as participants in our walks and similar collaborative research endeavours?

Rather than offering clear answers to these questions, the Open Forest project aims to open a space for collaborative, critical and co-creative engagements with such questions among participants with diverse perspectives, experiences and agencies. What is highlighted in the project is that as humans, we are just one of many forest stakeholders, and in order to understand, and importantly to live with forests better, we need to learn from other creatures who become the forest together with us.

Conclusion

This paper introduced Open Forest as a project and a collective aiming to open a space for experimental exchange of more-than-human forest experiences, knowledge and data – including those that may be deemed unrecognizable, irrelevant, or disposable in the current dominant technological paradigm. Through experimental walks and story-sharing, Open Forest brings to attention the power

dynamics emerging from who might be able to legitimately produce data and tell the stories about forests, with a particular concern for what can constitute “data” and how this understanding might change as channelled through various more-than-human stakeholders. The feral forest datasets resulting from the collaborative project activities and inquiry help challenge dominant epistemological framings of forests and cultivate an acknowledgement for (some of) the many situated understandings of what a forest might be and to whom. While we only offer preliminary insights in this paper, we hope that our ongoing work can further encourage researchers and practitioners in CSCW and beyond who are interested in re-imagining environmental technologies, practices and data relationships to help foster liveable and care-full more-than-human futures.

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Bibliography

- Ampatzidou, C., Dolejšová, M., Choi, J. H-j. and Botero, A. (2022): ‘Feral Ways Of Knowing And Doing: Tools And Resources For Transformational Creative Practice.’ *In Proceedings of the 2021 Pivot Conference: Dismantling Reassembling – Tools for Alternative Futures*. OCAD University, July 22-23, 2021. <https://doi.org/10.21606/pluriversal.2021.0016>
- Bell, G. (2018): ‘Making life: a brief history of human-robot interaction.’ *Consumption Markets & Culture*, 21(1), 22-41. <https://doi.org/10.1080/10253866.2017.1298555>
- Botero, A., Dolejšová, M., Choi, J. H-j. and Ampatzidou, C. (2022): ‘Open Forest: Walking with Forests, Stories, Data, and Other Creatures.’ *interactions* 29, 1 (January - February 2022), 48–53. <https://doi.org/10.1145/3501766>
- Cabildo indígena Camëntsá Biyá (Director). (2013). *Jajañ, mas alla de esta vida.* (Camëntsá forest-gardens, beyond this life - video documentary), Retrieved March 5, 2023 from <https://bancocontenidos.mincultura.gov.co/FichaDocumental?id=9000>
- Chancellor, S., Guha, S., Kaye, J., King, J., Salehi, N., Schoenebeck, S., & Stowell, E. (2019, November). The relationships between data, power, and justice in cscw research. *In Conference Companion Publication of the 2019 on Computer Supported Cooperative Work and Social Computing* (pp. 102-105).
- Choi, J. H-j., Forlano, L. & Kera, D. (2020): ‘Situated Automation: Algorithmic Creatures in Participatory Design.’ *In Proceedings of the 16th Participatory Design Conference – Volume 2*. Manizales, Colombia. pp. 5-9.

- Coleman, E.A., Schultz, B., Ramprasad, V. et al. (2021): ‘Limited effects of tree planting on forest canopy cover and rural livelihoods in Northern India.’ *Nat Sustain* 4, 997–1004 <https://doi.org/10.1038/s41893-021-00761-z>
- Costanza-Chock, S. (2020). *Design justice: Community-led practices to build the worlds we need*. The MIT Press.
- Cuarán J. A., Chicunque A., S. P., Botero, A., and Sánchez-Aldana, E. (2021): ‘Tšombiach: Urdimbres y Tramas Integrales.’ *Creación desde la periferia*, 131–142. <https://doi.org/10.22267/lib.udn.024>
- Debord G. (June 1958): *"Definitions". Internationale Situationniste*. Paris (1) Translated by Ken Knabb.. Retrieved March 5, 2023 from <https://www.cddc.vt.edu/sionline/si/definitions.html>
- Dolejšová, M., Ampatzidou, C., Houston, L., Light, A., Botero, A., Choi, J. H-j., Wilde, D., Altarriba Bertran, F., Davis, H., Gil, F., and Catlow, R. (2021): ‘Designing for Transformative Futures: Creative Practice, Social Change and Climate Emergency.’ *In Creativity and Cognition (C&C '21)*, June 22, 23, 2021, Virtual Event, Italy. ACM, New York, NY, USA, 9 pages. <https://doi.org/10.1145/3450741.3465242>
- Dolejšová, M., Choi, J. H-j., Botero, A. and Ampatzidou, C. (2022): ‘Open Forest: Data, Stories, and Walking-With.’ *In Participatory Design Conference 2022: Volume 2 (PDC 2022 Vol. 2)*, August 19–September 01, 2022, Newcastle upon Tyne, United Kingdom. ACM, New York, NY, USA. <https://doi.org/10.1145/3537797.3537864>
- Dolejšová, M. and Kera, D. (2017): ‘Soylent Diet Self-Experimentation: Design Challenges in Extreme Citizen Science Projects.’ *In Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing (CSCW '17)*. Association for Computing Machinery, New York, NY, USA, 2112–2123. <https://doi.org/10.1145/2998181.2998365>
- Escobar, A. (2018): *Designs for the pluriverse: Radical interdependence, autonomy, and the making of worlds*. Duke University Press
- Fleischman, F., Basant, S., Chhatre, A. et al. (2020): ‘Pitfalls of Tree Planting Show Why We Need People-Centered Natural Climate Solutions’. *BioScience*, Volume 70, Issue 11, November 2020, Pages 947–950, <https://doi.org/10.1093/biosci/biaa094>
- Gabrys, J. (2020): ‘Smart forests and data practices: From the Internet of Trees to planetary governance’. *Big Data & Society*, 7(1), 2053951720904871. <https://doi.org/10.1177/2053951720904871>

- Gaikwad, S. S.(2020): ‘Beyond Boundaries: Towards Symbiotic Relationship Between Ecological Arts and Computational Thinking for Sustainability’. *In Conference Companion Publication of the 2020 on Computer Supported Cooperative Work and Social Computing (CSCW '20 Companion)*. Association for Computing Machinery, New York, NY, USA, 257–262. <https://doi.org/10.1145/3406865.3418336>
- Ganglbauer, E., Fitzpatrick,E., Subasi, Ö. and Güldenpfennig, F. (2014): ‘Think globally, act locally: a case study of a free food sharing community and social networking.’ *In Proceedings of the 17th ACM conference on Computer supported cooperative work & social computing (CSCW '14)*. Association for Computing Machinery, New York, NY, USA, 911–921. <https://doi.org/10.1145/2531602.2531664>
- Gitelman, L. (2013): ‘“Raw data” is an oxymoron.’ MIT press.
- González, N. C., and Kröger, M. (2020): ‘The potential of Amazon indigenous agroforestry practices and ontologies for rethinking global forest governance.’ *Forest Policy and Economics*, 118, 102257. <https://doi.org/10.1016/j.forpol.2020.102257>
- Heitlinger, S., Houston, L., Choi, J. H-j., Taylor, A. and Catlow, R. (2023): ‘More-than-Human Computer Interaction for Urban Food Governance’. In Davies, Anna, Faus, Ana Moragues, Clark, Jill & Battersby, Jane (Eds.) *Handbook of Urban Food Governance*. Routledge, London. pp. 427-442.
- Henry, M., Rosin, C., and Edwards, S. (2022): ‘Governing taste: Data, temporality and everyday kiwifruit dry matter performances.’ *Agriculture and Human Values*. <https://doi.org/10.1007/s10460-022-10396-1>
- Hilviu, D. and Rapp, A. (2015): ‘Narrating the quantified self.’ *In Adjunct Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2015 ACM International Symposium on Wearable Computers (UbiComp/ISWC'15 Adjunct)*. Association for Computing Machinery, New York, NY, USA, 1051–1056. <https://doi.org/10.1145/2800835.2800959>
- Kanstrup, A. M., Bertelsen, P., and Madsen, J. Ø. (2014): ‘Design with the feet: Walking methods and participatory design.’ *Proceedings of the 13th Participatory Design Conference: Research Papers - Volume 1*, 51–60. <https://doi.org/10.1145/2661435.2661441>
- Kloppenborg, K. (2022): ‘Peer-Producing a Common Knowledge Resource for Personal Science’. *In Companion Publication of the 2022 Conference on Computer Supported Cooperative Work and Social Computing (CSCW'22 Companion)*. Association for Computing Machinery, New York, NY, USA, 223–227. <https://doi.org/10.1145/3500868.3561403>
- Knight, T. et al. (2021): ‘How effective is ‘greening’ of urban areas in reducing human exposure to ground-level ozone concentrations, UV exposure and the ‘urban heat island effect’?’ An updated systematic review. *Environmental Evidence*, 10(1) 12.

- Le Dantec, C.A., Asad, M., Misra, A. and Watkins, K.E. (2015): ‘Planning with Crowdsourced Data: Rhetoric and Representation in Transportation Planning.’ *In Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing (CSCW '15)*. Association for Computing Machinery, New York, NY, USA, 1717–1727. <https://doi.org/10.1145/2675133.2675212>
- Light, A. (2022): ‘Ecologies of subversion: troubling interaction design for climate care.’ *interactions* 29, 1 (January - February 2022), 34–38. <https://doi.org/10.1145/3501301>
- Lupton, D. (2016): *The quantified self*. London: Wiley.
- Kaziunas, E., Ackerman, M. S., Lindtner, S., and Lee, J. M. (2017): ‘Caring through data: Attending to the social and emotional experiences of health datafication.’ *In Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing (pp. 2260-2272)*. DOI: <http://dx.doi.org/10.1145/2998181.2998303>
- Mattern, S. (2021): ‘Tree Thinking’ *Places Journal*, <https://doi.org/10.22269/210921>
- Michael, M. (2018) ‘Destroying iPhones: feral science and the antithetical citizen.’ *Public Understanding of Science*, 27(6), 731-744. <https://doi.org/10.1177/096366251773814>
- Muller, M., Aragon, C., Guha, S., Kogan, M. et al. (2020): ‘Interrogating Data Science.’ *In Conference Companion Publication of the 2020 on Computer Supported Cooperative Work and Social Computing (CSCW '20 Companion)*. Association for Computing Machinery, New York, NY, USA, 467–473. <https://doi.org/10.1145/3406865.3418584>
- Ojha, H., Maraseni, T., Nightingale, A., and Bhattarai, B. (2019): ‘Rescuing forests from the carbon trap.’ *Forest Policy Econ.* <https://doi.org/10.1016/j.forpol.2019.01.007>.
- Open Forest Collective (2022): ‘Open Forest’ *CreAtures Co-Laboratory Catalogue*. Edited by Dolejšová, M. DOI:10.5281/zenodo.7525506
- Parmiggiani, E., Monteiro, E. and Hepsø, V. (2015): ‘The Digital Coral: Infrastructuring Environmental Monitoring.’ *Comput Supported Coop Work* 24, 423–460 . <https://doi.org/10.1007/s10606-015-9233-6>
- Prost, S., Mattheiss, E. and Tscheligi, M. (2015): ‘From Awareness to Empowerment: Using Design Fiction to Explore Paths towards a Sustainable Energy Future.’ *In Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing (CSCW '15)*. Association for Computing Machinery, New York, NY, USA, 1649–1658. <https://doi.org/10.1145/2675133.2675281>
- Puusaar, A., Montague, K., Peacock, S., Nappey, T. et al (2022): ‘SenseMyStreet: Sensor Commissioning Toolkit for Communities.’ *Proc. ACM Hum.-Comput. Interact.* 6, CSCW2, Article 324 (November 2022), 26 pages. <https://doi.org/10.1145/3555215>
- Ruppert, E., Isin, E., and Bigo, D. (2017): ‘Data Politics.’ *Big Data & Society*, 4(2), Article 2.

- Scroggins, M. (2023). 'A feral science? Dangers and disruptions between DIYbio and the FBI.' *Critique of Anthropology*, 43(1), 84-105. <https://journals.sagepub.com/doi/pdf/10.1177/0308275X231157559>
- Springgay, S. and Truman, S. E. (2017): *Walking methodologies in a more-than-human world: WalkingLab*. Routledge.
- Tolmie, P., Crabtree, A., Rodden, T., Colley, J. et al. (2016): "'This has to be the cats": Personal Data Legibility in Networked Sensing Systems.' *In Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing (CSCW '16)*. Association for Computing Machinery, New York, NY, USA, 491–502. <https://doi.org/10.1145/2818048.2819992>
- Tsing, A. L., Deger, J., Keleman, A. S., and Zhou, F. (2020): *Feral Atlas: The More-Than-Human Anthropocene*. Stanford: Stanford University Press
- Vitos, M., Altenbuchner, J., Stevens, M., Conquest, G. et al. (2017): 'Supporting Collaboration with Non-Literate Forest Communities in the Congo-Basin.' *In Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing (CSCW '17)*. Association for Computing Machinery, New York, NY, USA, 1576–1590. <https://doi.org/10.1145/2998181.2998242>

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Matters of Data Care: The Role of Domain Expertise in Enactments of Care for Medical Data

Natalia-Rozalia Avlona

Department of Computer Science, University of Copenhagen

naav@di.ku.dk

Irina Shklovski

Department of Computer Science, Department of Communication, University of Copenhagen

ias@di.ku.dk

Abstract. The increasing digitisation of the healthcare services has transformed the provision of patient-centred care to data-centric healthcare. The increasing digitisation of healthcare has asymmetrically affected the data workers in the public healthcare sector, where care comes to be enacted through the often-invisible human labour in algorithmic systems. In this paper, we demonstrate how the value of patient-centrism becomes a multidimensional matter of data care for a diversity of domain experts handling health data. Enactments of patient-centrism are informed by the values and backgrounds of each “data-handler” situated within the values and concepts of their domain expertise. In

particular, we demonstrate how patient-centrism manifests as care for data quality, care for data privacy and security, and care for accessibility, shaped throughout by differentiated concerns for regulatory compliance.

Introduction

The increasing digitisation of healthcare services has transformed the provision of patient-centric care into data-centric healthcare (Gotz et al 2016; Zahid et al, 2021). Particularly, the employment of AI-powered systems for automated decision-making in the public and private healthcare sector has slowly shifted the enactment of patient-centrism as a human-centred care practice towards a data-centric one (Sunarti et al, 2021). Research on the increasing datafication and automation of healthcare provision has produced scholarship addressing two different concerns. One strand of critical research has shown how automation has asymmetrically affected the often invisible and devalued data work by the healthcare professionals in the public health sector (Bossen, Pine et al. 2019; Møller et al. 2020). On the other hand, scholars have problematised how data-centric practices in caregiving can signal “technosolutionism” in the ways the care for health data is enacted (Kaziunas et al., 2017; Murphy, 2015). The turn towards technological solutions in the realm of healthcare can privilege a kind of logic of choice, shifting responsibility for healthcare decision-making towards the patients and their immediate caregivers (Mol, 2008). Such emergence of patients as researchers and “health data producers” can become exacerbated in the context of personalised medicine, where the availability of well-structured data can be synonymous with the capacity to receive life-saving care (Prainsack, 2017). While how healthcare professionals and patients experience data-driven healthcare is now well-researched, little is known about the practices of data experts working with health data.

In this paper we explore how data-centric care is materialised by data experts, the “data handlers” who are preoccupied with the “data production” in the health-tech sector. We present ethnographic findings from a study of the data practices of data experts working on the design of an AI-powered platform for patients for clinical trials match-making. We demonstrate how the data practitioners enact the patient-centric approach, dubbed as their “north star metric”, and materialise care in practice. We find that “patient-centrism” becomes a multidimensional matter of data care for a diversity of domain experts handling health data. Enactments of patient-centrism become informed by the values and backgrounds of each “data-handler” situated within the values and concepts of their domain expertise. As the majority of these experts, with one notable exception, work with patient medical data but do not directly engage the patients themselves, we show the different

forms of enactments of care when care is not a “human-centred” matter but a “data-centred” one.

Patient-centrism as a positively perceived value in our study in the health tech sector is closely tied to the logic of choice (Mol, 2008). It is not only about having the patient in the centre, as a receiver of health care but also seeing the patients as “researchers-consumers” of curated treatment options. We show how data experts enact patient-centrism through their data care practices. We find that differences in domain expertise shape expert understanding of major concerns when they have to “carefully” handle health data. We identify these concerns of the experts as care for data quality, care for data privacy and security, and care for accessibility, and show how these were differently understood and performed by the experts with mono-disciplinary technical backgrounds and those with an interdisciplinary background that included some type of medical expertise.

Related Work

Data work has been discussed as a matter of invisible care work (Møller, Bossen et al., 2020; Bossen, Pine et al., 2019), as a matter of the affective relationships between humans and data (Pinel et al., 2020), as a matter of care practice and ethos (Baker & Karasti, 2018; Fotopoulou, 2017), as well as a matter of care (politics) embedded in the design of data practices (Kaziunas et al., 2017).

Current research on data work in the healthcare sector demonstrated the implications of the digitalisation of the data work of physicians, nurses, secretaries, and clinical documentation improvement specialists. Researchers have highlighted the invisibility of the laborious and time-consuming manual data work in these settings and raised concerns about the asymmetrical re-skilling which will threaten some of these jobs, in accordance with the assumptions about its susceptibility to automation (Bossen, Pine et al. 2019; Bossen, Pine et al. 2018; Møller, Bossen et al., 2020; Bossen, 2020).

In a comprehensive study, Kaziunas et al have problematised how the data-centric practices in caregiving signalled “technosolutionism” in how care for health data is enacted, introducing “caring -through-data” as an alternative lens that makes visible the multiple and contextual relationships between care and data (Kaziunas et al., 2017). Feminist scholars have conceptually “unsettled” the tensions and politics of care in the context of datafied health practices and citizen data practices. (Martin, 2015; Murphy, 2015; Fotopoulou, 2018). Pinel and colleagues used the lens of care in order to foreground specific forms of data works in a research laboratory and disclose the power dynamics that inform the “affective and attentive engagements with data”, which are undervalued and often relegated to the lower in the hierarchy staff. (Pinel et al., 2020)

Scholars have also shown how the intentions of data scientists and designers in the “curation”, “creation”, and “design” of data are crucially affecting the data

creation (Muller et al, 2019; Feinberg 2017; Baker & Karasti, 2018). To date, surprisingly, the enactment of data care, as a matter of domain expertise in complex health-tech environments, has not yet been systematically examined. The notion of the domain and its associated logics in computer and data science has been discussed as a troubling organising principle, challenging the idea that technical disciplines such as data science and computer science could ever be domain-independent in their application (Ribes, 2019). In this research, we explore the role of domain expertise in enactments of care for patients and for their data in the healthcare context.

Methodology

Our aim was to explore how the data practitioners in the health tech industry think and enact (with) care when they handle the data in the processes required for the development of medical algorithmic systems. Our study was conducted in a northern European company in the health-tech sector.

Context

The company is a mid-size start-up primarily developing an AI-powered platform for matching patients with advanced clinical trials for new drug and experimental procedure development. Part of their services is the provision of assistance to the patients by medical experts (Patient Navigators) in order to have their medical conditions assessed and submitted for an eligibility assessment for a Clinical Trial or an Expanded Access Programme; The company primarily handles two data sources. They collect data from the patients and their physicians. They also collect data from public databases with the clinical trials' requirements and data from pharmaceutical companies. The overall company goal is to develop AI that can automate all the manual processes and effectively match patients to clinical trials and expanded access programmes globally.

Data Collection

The first author conducted a series of online preliminary interviews and discussions from February to May 2022, in order to acquire an understanding of the company and its data practices. During this preliminary period, our approach was exploratory, as we developed recruitment criteria for the experts that would be interviewed in situ. The first author then spent three weeks between May and June 2022 at the company's headquarters conducting research through participant observation in a selection of company meetings and spending time with selected teams, as well as conducting in-person semi-constructed interviews. In total, 13

experts were interviewed, with an average of 65 minutes in length, whilst we conducted follow-up interviews with two of the experts.

Data analysis

We analysed the situated data-centred practices of the experts handling patients' data for the development of an AI-powered platform for the match-making of patients and clinical trials. The experts in our study were predominantly engaged with the data creation process for the development of the AI-powered platform and were handling primarily two sources of data. They collected data from the patients and their medical practitioners and data from public databases about clinical trial requirements. Data work in the company followed two routes. The first route prepared and structured data sets created from patient data and clinical trial requirements for the development of the algorithmic system- both as an AI model and online platform interface- to support match-making of patients with suitable clinical trials. The second route, termed "the expanded access programme," offered alternatives and options for the patients who could not enrol in a clinical trial, making available still experimental drugs to people who have reached the limits of traditional medical systems.

Across all of the patient-oriented data collection processes, patients were assisted by experts, called "patient navigators." The job of patient navigators was to provide support to patients as they entered their data into the platform interface, ensuring that all data the patients produced was curated into a proper "structure" for use by the company. Further, they ensured that the patients provided sufficient data to have all of their options for clinical trial participation and access experimental treatment regimens open to them.

The first author used Dovetail to transcribe the interviews, which were manually corrected. Transcriptions were integrated with the field notes, photographs, and notes from the preliminary interviews. We employed a grounded theory approach for data analysis. Initial open coding resulted in 350 codes, moving to axial and selective coding as themes emerged. We used a situated analysis approach (Clarke, 2005) to visualise the complex processes and practices of the data handlers, enabling us to dis-assemble these processes into an ecosystem of high-skilled human labour-domain expertise, technological artefacts, and infrastructures. Selective coding focused on the identified practices of care, as accounted for by the experts expressing their values and describing their enactments in their daily workflow.

Researchers' Standpoints and Insights

The specificity of the technical jargon in this context was a reflection of the combined medical and technological expertise transversing the traditional understanding of the domain (Ribes, 2019). The experts in the organisation

communicated with many abbreviations. This “terminology” barrier was acknowledged by the first author as a concern with regard to her epistemic preconceptions and standpoint. The first author asked for clarifications from the experts within the company as much as possible. During analysis, we worked to make sure that this did not impact our understanding of the data.

To facilitate operations, many of the experts in the company had mixed backgrounds, often combining technical expertise and medical expertise, transcending domain specificity through interdisciplinary practices. The experts we interviewed worked in the following departments (teams): Engineering Department (AI Team, Frontend Team, Platform Team, Product Team, UX Design Team), and Operations Department (Quality Team, Medical Team, Project Management, Real-World Data Team). With the exception of the Medical Team, which was composed of experts with predominantly, but not exclusively, medical or health science expertise, the background of the experts we interviewed in the rest of the teams was schematically falling into one of the two categories. Experts were either mono-disciplinary with computer science or design expertise or had a mixed background where a background in medical or pharmaceutical science complemented expertise in computer science, design or economics and management. Our analysis showed that such interdisciplinarity often systematically informed decisions taken in data practices we describe below.

Findings

The idea of patient-centrism was core to the company ideals and their overall company policy. As one participant once exclaimed in an informal discussion, “Our north star metric is on treating and helping patients. That's what we do” (P6, field notes). The concept of patient-centrism came up in the preliminary investigations very often. As such, during the on-the-ground research within the company, we added the question “what does “patient-centric mean to you” to all of the interviews and paid attention to mentions of patient-centric ideas and concepts in informal conversations. We have found that patient-centrism serves as the primary value that is enacted in the care practices of the experts working with health data within the company. Patient-centrism, as a care-value leading both the company’s brand and the experts' concerns, was firmly tied to what Mol (Mol, 2008) terms the logic of choice through a focus on the provision of options to patients in order to enable access to clinical trials or treatments.

Below, we articulate firstly how patient-centrism as a positively perceived care value is informed by the logic of choice interpreted as having options. Secondly, we identify three forms of data care enacted as: care for data quality, care for data privacy and security, and care for accessibility. Throughout these practices of care, we demonstrate how background and domain expertise differentiated the understanding and enactment for each. Further, we show how each form of data

care was mediated and shaped by considerations of regulatory compliance with myriad data and medical data regulations.

Care for Data Quality

The experts in our study who were predominantly thinking and enacting patient-centrism through their care for the data quality were either engaged directly in the data-annotation process or responsible for the overview of the data collection and analysis of the health data.

Data annotation experts had a dual background in pharmaceutical science and computer science. The data annotation process entailed cleaning and structuring the health data that the patients submitted through the platform interface with the assistance of the patient navigators. They also filtered, updated, curated, and structured the requirements of the clinical trials as the second source of data that would feed the algorithm. In this context, being patient-centric was strongly related to achieving high quality data as a major outcome. Nevertheless, both data annotation experts expressed empathy towards the patients despite not having any direct contact with them and handling only their data. As one pointed out, they felt this was in part a result of their mixed background: *“always have the patient in the back of my mind (...) I think it would be much more difficult if that shared medical knowledge wasn't there”* (P2 interview).

Caring for data quality was translated as the need to ensure *“the medical correctness of the data (...) provided”* (P2 interview). Both annotators saw this as crucial not only for the company technology development purposes, but also for supporting patient goals. For them, what was at stake with the lack of accuracy, during the data annotation process, was patients potentially losing access to a life-saving or life-supporting treatment. For the expert with a similarly dual background, who was responsible for having an overview of the building up of data processing automation processes in the company, caring for the data meant making sure that the data structure of patients reflected their true needs: *“Especially for medical profiles, you really want to be one hundred per cent sure that's the data that structured is actually in line with the original source because it can have implications on the treatment options that we provide to the patient. And any further treatment, of course, the patient could take. So you don't want to make any mistakes there”* (P1, interview).

At the same time, experts with a computer science background focused on accuracy and cross-checking as one of the markers of data quality: *“we don't just leave it with the assumption that the patient knows all of the ins and outs it's reviewed by the Patient Navigator. And also that medical profile is then verified by the physician once we've got the physician. Yeah. So we make sure that the information that we've got is accurate”* (P6, interview). Here the patient was treated in a similar fashion to the other auxiliary data sources, as a data source

that needs to be verified. While all of the experts were deeply concerned with ensuring that the platform “worked” to achieve company goals, those with a mixed medical background were more likely to bring up the reasons and goals of the patients seeking treatment as their focus (from field notes). They also differed in how much they saw the patient “*the main source of reliable data*” (P5 interview).

The company had to engage many different “clients” but provision of patients for clinical trials made pharmaceutical companies one of their main sources of income. As such, the data and technical experts often commented on the fact that there was a balancing act of addressing the pharmaceutical companies’ needs for more patients and data, with the needs of the patients themselves. This manifested in their discussions of the design of interface tools for data collection directly from patients. Here we observed deep concerns with data reliability: “*So people always, yeah, no matter how you think, how well you designed it, there's always something you've missed, but there's always something that is interpreted differently. So you really have to spend a lot of time designing something that's fully approved that's I think the main concern or the main threats*” (P5 interview). The reliability and the correctness of data as well as the ability to ensure a correct data structure was key to matching people with drugs and procedures that would help them. As such, we observed great care with which patient data was analyzed and handled in this respect, as an expert in the expanded access programme explained: “*if you look at a medicine, for example, does it extend your life, does it improve your quality of life or doesn't have severe side effects. And, and yeah, if we analyze that carefully, those data, that we can draw a conclusion, whether that drug, whether the benefits outweighed the risks*” (P5, interview).

Curiously, although all of the experts were concerned with data quality through attention to data reliability and accuracy, what that entailed in terms of what they paid attention to aligned along disciplinary lines. Where experts with singular technical domain expertise were concerned with data itself and its usability, experts with mixed medical background were also concerned with the patient experience and their goals as well, broadening their purview of care.

Care for Data Security & Data Privacy

While the experts above cared for the correctness, structure and reliability of the data, as their care was a matter of data quality, two more shared concerns emerged as a care entanglement: the care for data privacy and security. When the expert of our study, with a background solely in computer security had to take care of the backend of the platform containing patient and clinical trials data, their major concern was how to “*make sure that my database is secure enough to hold personal information, for example*” (P4, interview). The security of the data

storage is crucial in order for the company and subsequently the patients to be protected from data leakage, which could lead to a range of possible harms. Security experts were concerned with data theft or other forms data leakage, from competitors *“then steal our clients, just giving an example, right.?”*, to a patient who used the platform and *“wants to be helped gets a text by some weird company – Hey, we know you are in this condition, we have this special offer of weird medicine for you”* (P4, interview). In a similar fashion, the frontend developer who shares a computer science background, P8 was mainly concerned with security: *“I think security is just everyone's responsibility because yeah, there can be security leaks in any format”* (P8, interview). Security however, is not only about ensuring that data leakage will not happen, but that the patients' data becomes selectively available for different stakeholders and uses, as a matter of privacy. This, according to the backend expert P4, is achieved with different API keys that *“if the outside world, let's say one of our clients needs, the data, or we want to share something with them, we have an API key that can feed it through them (...) but they don't have direct access to the database. Nobody will get direct access to them.”* In the same line, data security, for the expert working for the data annotation of the platform, with a dual background in pharmaceutical science and computer science, meant securing the data storage, so as there is no data leakage: *“So through our private cloud, so that all our database are now in a VPC. That's really important so that no man in the middle, you call it, okay can't access the data because some data leakage will end our journey. I'm really aware of that. So, yeah, it's really important”* (P3, interview). These concerns with security manifested both as a form of care for patients but also as a recognition that any data leakage would spell disaster for the company's future given the regulatory context governing handling of health data in Europe.

This security-privacy entanglement however, was also enacted as a “matter of concern” (Latour, 2004) beyond compliance to regulatory standards. The experts who engaged in the data annotation process, were additionally perceiving privacy as a “matter of care” and ethics coming as part of the medical background. For example for the expert P3, engaged in the data annotation process, securing the privacy of patients' data is particularly important particularly because of the sensitivity of these information: *“I think it's one of the top priorities to defend our medical information because I think medical information is the most, one of the most private sensitive information available.”* Furthermore, protecting the sensitivity of these medical information by ensuring the filtering of who has access to it, is a concern similarly felt by the expert P2, who also works for the data annotation process: *“And then I say, okay, but they don't think from a patient perspective, every physician in practice should be able to access your information if they have the codes. Because from experience in pharmacy, for example, sometimes patients don't want to talk to professionals there. And then I tried to explain from a patient perspective, how this could be a bad experience which*

could hurt the patient in any way for example, and we discuss it and then the solution gets changed so that it better protects patients and takes patients into account.” The emphasis on the patient perspective was an interesting part of the observation where platform features were discussed extensively. Here concerns for data accuracy and considerations of access and privacy came into conflict.

Experts with a computer science background wanted to ensure there was as much opportunity for data verification as possible through a range of medical professionals getting access to data. Yet access to data for verification could have implications for patient privacy even where regulatory constraints allowed for it. For both of these experts P2 and P3, the professional ethics of the partly medical science backgrounds seemed to inform their understanding of what data privacy means and how to remain patient-centric with data. Patient-centrism in this sense when it comes to data privacy, became more than merely complying with the GDPR and medical data regulatory constraints, but trying to get into the patients’ shoes, predicting possible hurts if their medical information is shared with others. Enacting this kind of sensitivity towards patients’ data means being empathetic to the patients, a value that is contested and discussed as a care ethics imperative in health care practice. (Bas-Sarmiento et al, 2018; Adams 2018).

Care for Accessibility

One of the major goals of the company we studied was to create better access to experimental medical procedures for people who faced the limits of broadly available medical treatments. The idea of accessibility became a value and an enactment in itself even as it was strongly connected to concerns for privacy and security. As P7, an expert with a dual background in medical science and UX design explained, the major concerns went far beyond GDPR compliance: *“meeting, the regulatory and the GDPR standards for compliance. It's also like on the ethical standpoint. And that's also why I'm pushing more for, how do we look at accessibility, especially when it comes to a health care service is always ethics involved.”* For them, caring for the patients is translated into wider issues of platform accessibility by *“widening the kind of healthcare inequality between different socioeconomic groups by enabling people with better access to technology to have better care of their health”* (P7 interview). In this sense, translating the default design concern of user-centricity as the expert, P10 (interview), with a solely design background engaged with the interface design of the platform, expressed *“when designing, I would say, yeah, always putting the user first, so really understanding what the users need so that you yeah. You offer them something that they can use then.”* means having a patient-centric design concern in mind. A further value infused in the way that data care is enacted through the design of patient-centric and accessible AI-powered platforms, is the value of empathy. When working on the interface of the patients to clinical trials

match-making platform, designers should “ *grow empathy from interacting with the users and in that way, like the data we're capturing is being captured in the minds of the employees to grow that empathy so that we're all developing our services and improving our services with the users in mind*” (P7 interview).

We observed here an interesting bifurcation of forms of care for usability and its purpose. While the idea of empathy fits neatly into the maxims of design thinking that govern traditions of much contemporary design education, the experts with the mixed medical background once again brought a broader lens to their considerations and justifications of enactments of care. Going beyond just usability and just compliance, there was a broader sense that design decisions as well as data collection, management and processing decisions also had ethical and political implications of inequality in access to medical care.

Discussion

An underlying goal of this exploratory paper is to show how data-centric care, as a matter of data work in the “patient-centric” health tech sector, enacts a diversity of “matters” that affect and are affected by the domain expertise of the “data-handler”. To this end, our fieldwork allows us to contribute to the CSCW theories of data practices, going beyond the “articulation work” in the increasingly digitised healthcare sector (Bjørnstad & Ellingsen, 2019; Bossen, Pine et al, 2019) and patient-centred ethnographies of care (Mol, 2008; Prainsack, 2018). Our contribution engages and problematises the notion of patient-centric data care towards two ends. Firstly, as a practice that is enacted differently, even when the experts work with the same intentions for the “data-handling”, and in this sense, sensitising the concept of domain expertise in a health-tech context. Secondly, as a matter of care, that affects the data creation, by embedding in its design not only the values of the data handlers but also the patients as instructed data co-creators.

What happens when values such as “being patient-centric” are articulated as a strong guiding principle in a company where data-driven technologies working with medical data are primary? The idea of patient care in this context can be articulated as data care, but what constitutes caring for data depends not only on the roles experts occupy but also on their singular or mixed backgrounds. Mixed backgrounds seem to open the range of concerns and the types of inquiry these experts bring up. In our case, data-centric care was translated into ensuring the quality of data, its compliance to regulatory standards as a matter of ensuring the data privacy and the data security. Data-centric care also emerged as a concern for medical treatment accessibility, where socio-political considerations became mixed together with more traditional concerns of usability.

The logic of options as patient-centric value proposition in the data-driven health care.

The logic of providing patients with choices, has been thoroughly articulated in the work of Mol, and conceptualised as the logic of choice versus the logic of care. (Mol, 2008). Mol tackled the artificial binary of these two seemingly opposed logics, which were based on the assumption that the provision of care diminishes the agency of the patients, whilst the provision of choices, tied to the logic of patient-consumer, leaves space to the patient for “active” choices. Further in this direction, Prainsack problematised the emergence of the patient-researcher, an activated patient who becomes a data contributor. What is narrated a story of participatory empowerment, seems to replace the need for publicly funded infrastructures (Prainsack, 2017).

Our findings, however, suggest that provision of options can be a matter of politics as an enactment of care, where there is recognition that options are never evenly available to everyone. In our case, the logic of options essentially informed the idea of patient-centrism as a care value. Here the patient is indeed envisaged as a “researcher-consumer” of the already curated options for accessing clinical trials or treatments outside clinical trials.

Curiously, despite the rhetoric of automation in a medical technology company (Bossen, Pine et al. 2019; Moller et al. 2020), we found that it served more as a narrative that promises the provision of optimised options, where in reality, the workflow relied on a range of experts who directly assist the patients in data creation. In fact, this less visible human factor, rather than mere algorithmic excellence, was what gave the company its competitive advantage, according to the experts we interviewed. As expert P6, who leads the Engineer Department, explained: “*the difference between us and other companies is that the people that connected with us, they have the option to speak to a patient navigator, who's a trained medical professional that will talk to them about their options and what they can do.*”

As such, patient-centrism as a value was articulated in three different ways. Firstly it resulted in a focus on options to access treatment when the formal health care system has exceeded its limits. Secondly, and despite the company’s narrative about providing patients AI-powered options for the best clinical trials match-making options, the options provided relied substantially on the carework of the human experts. In fact, medical experts assisted and instructed patients on how to fill in the right information to the platform and then to either be matched with suitable clinical trials or if they are proved not to be eligible, to be assisted to access a treatment outside of clinical trial. Thirdly, being patient-centric emerged as different forms of empathy where the addition of a medical background enabled a broader set of considerations in the design, development and enactment of company technologies and goals with respect to patients they engaged.

References

- Baker, K. S., & Karasti, H. (2018, August). Data care and its politics: Designing for local collective data management as a neglected thing. In *Proceedings of the 15th Participatory Design Conference: Full Papers-Volume 1* (pp. 1-12).
- Bjørnstad, C., & Ellingsen, G. (2019). Data work: A condition for integrations in health care. *Health informatics journal*, 25(3), 526-535
- Bossen, C. (2020). Data work and digitization: the impact of computerized systems and automation on healthcare professionals. *XRDS: Crossroads, The ACM Magazine for Students*, 26(3), 22-25.
- Bossen, C., Pine, K. H., Cabitza, F., Ellingsen, G., & Piras, E. M. (2019). Data work in healthcare: An Introduction. *Health Informatics Journal*, 25(3), 465-474
- Clarke, A. (2005). *Situational Analysis: Grounded Theory after the Postmodern Turn*. Thousand Oaks, CA: SAGE.
- de La Bellacasa, M. P. (2011). Matters of care in technoscience: Assembling neglected things. *Social studies of science*, 41(1), 85-106.
- Feinberg, M. (2017, May). A design perspective on data. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (pp. 2952-2963).
- Fotopoulou, A. (2019). Understanding citizen data practices from a feminist perspective: Embodiment and the ethics of care. In *Citizen media and practice* (pp. 227-242). Routledge.
- Gitelman, L. (Ed.). (2013). *Raw data is an oxymoron*. MIT press.
- Gotz, D., & Borland, D. (2016). Data-driven healthcare: challenges and opportunities for interactive visualization. *IEEE computer graphics and applications*, 36(3), 90-96.
- Kaziunas, E., Ackerman, M. S., Lindtner, S., & Lee, J. M. (2017, February). Caring through data: Attending to the social and emotional experiences of health datafication. In *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing* (pp. 2260-2272).
- Martin, A., Myers, N., & Viseu, A. (2015). The politics of care in technoscience. *Social studies of science*, 45(5), 625-641.
- Mol, A. (2008). *The logic of care: Health and the problem of patient choice*. Routledge.
- Møller, N. H., Bossen, C., Pine, K. H., Nielsen, T. R., & Neff, G. (2020). Who does the work of data?. *Interactions*, 27(3), 52-55.
- Muller, M., Feinberg, M., George, T., Jackson, S. J., John, B. E., Kery, M. B., & Passi, S. (2019, May). Human-centered study of data science work practices. In

Extended abstracts of the 2019 CHI conference on human factors in computing systems (pp. 1-8).

Murphy, M. (2015). Unsettling care: Troubling transnational itineraries of care in feminist health practices. *Social studies of science*, 45(5), 717-737.

Pine, K. H., Bossen, C., Chen, Y., Ellingsen, G., Grisot, M., Mazmanian, M., & Møller, N. H. (2018, October). Data work in healthcare: Challenges for patients, clinicians and administrators. In *Companion of the 2018 ACM Conference on Computer Supported Cooperative Work and Social Computing* (pp. 433-439).

Pinel, C., Prainsack, B., & McKeivitt, C. (2020). Caring for data: Value creation in a data-intensive research laboratory. *Social Studies of Science*, 50(2), 175-197.

Prainsack, B. (2017). Personalized medicine. In *Personalized Medicine*. New York University Press.

Ribes, D., Hoffman, A. S., Slota, S. C., & Bowker, G. C. (2019). The logic of domains. *Social studies of science*, 49(3), 281-309.

Ribes, D. (2019). How I Learned What a Domain Was. *Proceedings of the ACM on Human-Computer Interaction*, 3(CSCW), 1-12.

Sunarti, S., Rahman, F. F., Naufal, M., Risky, M., Febriyanto, K., & Masnina, R. (2021). Artificial intelligence in healthcare: opportunities and risk for future. *Gaceta Sanitaria*, 35, S67-S70.

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Supporting Inter-Agency Collaboration in Emergency Management: Recurring Challenges Relevant for CSCW

Bjørn Erik Munkvold

Centre for Integrated Emergency Management (CIEM), University of Agder
bjorn.e.munkvold@uia.no

Abstract. Emergency management requires effective collaboration between different agencies. This work implies several challenges due to a heterogeneous mix of actors with different procedures, practices, and support tools. Despite being focused in various research streams, emergency responders still report challenges with sharing information and establishing shared situational awareness in responding to complex events. The paper presents results from a large-scale digital tabletop exercise that illustrate recurring challenges related to support for collaborative procedures, a communication network structure combining several media, use of geocollaborative tools, and configuration of collaborative environments in co-located operations centers. CSCW researchers are well positioned to further address these challenges and thus make an impact in a domain of high societal importance.

Introduction

Emergency response in large-scale incidents requires effective collaboration among a number of actors from different agencies, including first responders (police, fire, health services), public authorities at different levels (municipalities, county governor, national directorates and ministries), infrastructure providers, as well as volunteers. This kind of work setting is complex and challenging, involving information sharing and coordination between different disciplines with varying practices, procedures, terminology and tool support, operating under demanding conditions and time pressure. The term inter-agency collaboration is here used to denote this complex form of inter-organizational collaboration, as established in the domain of emergency management (see e.g., WHO, 2020). While being focused in CSCW and other research fields for several decades (Pipek et al., 2014), evaluations from both real events and emergency exercises document recurring challenges in sharing information effectively for establishing shared situational awareness.

Based on insights from a large-scale tabletop exercise involving 20 different organizations, this paper discusses core challenges related to inter-agency collaboration that CSCW research could contribute to resolve. The paper is thus a call to arms for the CSCW research community to strengthen the focus on supporting collaborative practices in emergency management, a domain that is of increasing importance at community, national and global level in society.

The next section briefly points to relevant work in CSCW as well as other areas. Then our emergency exercise is presented as an illustration of possibilities and challenges in creating shared situational awareness in a complex scenario. Based on the exercise evaluation results, core challenges relevant for CSCW research are discussed.

Brief overview of related work

Research on technology support for emergency management is quite fragmented, being pursued in different disciplines and communities such as information systems, computer science, crisis informatics, geoinformatics, as well as CSCW. Typically, the research in these areas is disseminated in different conferences and journals, with little cross-fertilization and aggregation of knowledge between these fields. As an example, the international conference on information systems for crisis response and management (ISCRAM) that has been running annually since 2004 (see iscram.org) is still little cross-referenced in ‘mainstream’ information systems literature and CSCW research (though with some exceptions).

A special issue of the CSCW journal from 2014 focused on Crisis Informatics and Collaboration (Pipek et al., 2014). In their introduction to the special issue the editors present a comprehensive view on the crisis informatics term, to include “an interdisciplinary perspective on the socio-technical, informational and collaborative aspects of developing and using technologies and information systems in the context of the full disaster lifecycle” (op.cit., p. 339). They here also refer to “collaborative resilience” that involves “collaborative services and technologies to improve the resilience of cities, infrastructures, logistic chains, etc. through public-private partnerships” (p. 340). Of the six papers accepted for this special issue, four focused on practices involving crowdsourcing and/or social media. A later comprehensive review by Reuter et al. (2018) also documents how the crisis informatics research has had a core focus on the role of social media in crisis management.

The special issue paper most relevant for the focus in this article is the study by Ley et al. (2014), reporting from the initial stage of developing inter-organizational collaboration functionalities in the form of an inter-organizational situation assessment client and an inter-organizational information repository. Their work highlights the complex nature of these inter-organizational practices and the resulting need for improvisational support, as well as the challenges involved in validating the solution concepts because of the limited possibilities for real-life testing in emergencies.

In general, the CSCW research focusing on awareness is also relevant in the context of this paper. In an extensive review of 25 years of awareness research in CSCW, Gross (2013) summarizes several research streams, concepts and technological developments relevant for coordination and collaboration in emergency management. This includes media spaces, collaborative virtual environments, and shared workspaces, based on technology support for capturing, storing, and presenting awareness information to the users. Interestingly, this review article neither includes any explicit mention of the term ‘situational awareness’, nor refers to the model by Endsley (1995) defining three levels of situational awareness: the perception of elements in the current situation, comprehension of the current situation, and projection of the future status. This model by Endsley is a core reference in much research on emergency preparedness and response (Steen-Tveit and Munkvold, 2022), with over 11000 citations. While this could then be viewed as an example of the mentioned disconnect between CSCW research and the research related to technology support for emergency management, it should also be noted that the mentioned article by Ley et al. (2014) does indeed discuss Endsley’s model. And another article in the same special issue also presents a collaboration tool supporting shared situational awareness through visualization of real time information in a common map (Heard et al., 2014).

Based on this brief mapping of research in CSCW and other areas relevant for supporting collaboration among agencies involved in emergency preparedness and response, the next section presents a case to illustrate challenges involved in this domain.

Case illustration: Supporting shared situational awareness in a large-scale forest fire exercise

The INSITU research project (insitu.uia.no) funded by the Research Council of Norway and led by the Centre for Integrated Emergency Management (CIEM) at the University of Agder, focused on developing solutions supporting information sharing and situational awareness in complex emergency events involving collaboration between many stakeholders (Munkvold et al., 2019). As part of this project, a large-scale digital tabletop¹ exercise was conducted to explore the potential of supporting shared situational awareness in a forest fire scenario. The scenario involved three simultaneous forest fires in three neighbor municipalities, with each fire threatening critical infrastructure due to flames and/or smoke (hospital, railway, road traffic, cell towers and electrical substations). This kind of scenario is also included in the national risk analysis developed by the Norwegian Directorate for Civil Protection (DSB), described as three large simultaneous forest fires getting out of control and thus challenging the response capacity and resulting in serious consequences for life and property (DSB, 2019). In our exercise, each of the three fire scenarios were developed by local fire chiefs to ensure sufficient realism.

Facilitated by the County Governor of Agder as partner in the INSITU project, altogether 70 participants from 20 different organizations were involved in the exercise. These organizations included first responder agencies (police, fire and health services), civil defense, municipal and county government crisis teams, the Norwegian Directorate for Civil Protection (DSB), the Crisis Support Unit at the Norwegian Ministry of Justice and Public Security, as well as critical infrastructure providers (energy and telecommunications companies, public road administration, railroad).

Figure 1 provides an overview of the different stakeholders involved in a complex emergency event such as the forest fire scenario in this exercise. While a detailed description of the figure is beyond the scope of this article, it serves to depict the different levels (local, regional and national) involved in this kind of large-scale and complex event. The main purpose of the exercise was to gain experience with sharing situational pictures from the incident command at the local level through the regional level coordinated by the County Governor, and

¹ A tabletop exercise is a discussion-based session where team members discuss their roles during an emergency and their responses to a particular emergency situation ([Ready.gov/exercises](https://www.ready.gov/exercises))

further to the national level represented by DSB and the Crisis Support Unit (CSU) at the Ministry of Justice and Public Security.

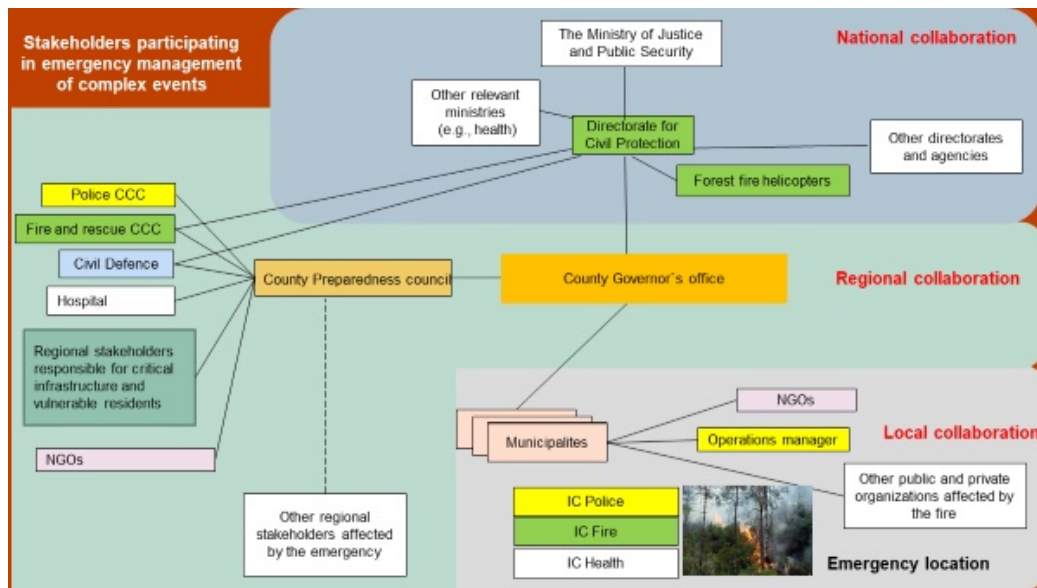


Figure 1. An overview of stakeholders involved in a complex emergency event (courtesy of Dag Auby Hagen, County Governor of Agder)
 CCC = Command and Control Center, IC = Incident Command

Collaboration tools used in the exercise

The collaboration platform used for the exercise was the forest fire module of the DSB map system (kart.dsb.no) in combination with the Norwegian critical communication network (Nødnett). The map system gives access to thematic layers of information relevant for a forest fire scenario, such as forest-related information, vulnerable objects and critical infrastructure. Except for in some regional exercises and a very small number of real fire events, the use of this map system is limited. Instead, the different agencies typically use their own map systems with little or no interoperability (Opach et al., 2020). A goal of the exercise was thus also to show the potential of using a common map system for being able to share geolocated information related to the incident. For the tabletop exercise, four user logins were created for the different categories of users. One user login for each of the three fires, intended for the local fire departments and the municipalities, and a fourth login for users with a coordinating function at the regional (County Governor, critical infrastructure providers) and national (DSB, CSU) level. The latter user category could then monitor the three fires simultaneously, and also add their own information in the map to supplement or edit the information from the local incident command. For the radio

communication network, a common call group was established where all participants having access to a terminal could report and/or listen in. In addition to regular users of this network (first responders and some of the critical infrastructure providers) we also provided terminals to other organizations that currently are not users of this network such as the municipalities and the County Governor's office, to explore whether this additional channel of information would be considered useful for situational understanding. For both the map system and the communication network, video tutorials were made available to the participants three weeks before the exercise. This also included voluntary exercise tasks in use of the map system that could be submitted to the research team.

Since the exercise took place during a phase of partial Covid-19 lockdown, Microsoft Teams was used as the communication platform. This also meant that several of the participants from the involved organizations participated from their home office instead of being co-located in their respective crisis teams. However, the participants did not report this to have any significant impact on their work during the exercise.

Evaluation from the exercise

The evaluation of the exercise was based on several sources of data. During the exercise, the research team followed the conversation in the radio communication network and had access to all four user logins of the map system. Further, we were copied on textual situational reports that were sent from the incident command to the County Governor's office, including screendumps from the map system. Immediately after the exercise, a first impression session ('hot washup') was conducted where representatives from each of the participating agencies briefly shared their experiences from the exercise. This session was recorded. After the exercise an online survey was distributed to the participants asking about their perceived situational awareness, access to information, and use of the support tools (map and communication network). Also, some of the participating organizations (DSB, County Governor) provided written evaluations. Finally, during the week after the exercise we conducted six online group interviews with a total of 25 participants from 17 different organizations. Each interview lasted 1,5 hours, giving a total of 9 hours of recorded interviews that were transcribed in full. The interview data, observation notes, and other material collected during the exercise, were analyzed together related to the themes focused in the exercise, i.e. experiences with the common map support in combination with the audio communication, and how this was used for situational reports and information sharing between the agencies involved. The results were summarized in an evaluation report from the exercise (Munkvold et al., 2021).

Overall, the participants found the exercise scenarios to be realistic, and reported that the use of a common map in combination with the communication network provided a better situational awareness than they normally would have in a complex scenario like this. Especially the users in a more supporting role (municipalities, critical infrastructure providers) perceived to be better able to follow the scenario, as in their normal mode of operation their crisis management team would depend on telephone calls with the incident command and/or a liaison from the police:

“The municipality received limited information on the phone, and with a map that was updated regularly we had access to a lot of information that could be used to make good decisions for the municipality as early as possible.” (Municipal emergency coordinator)

The exercise also identified several issues in need for further improvement (so-called learning points) related to the inter-agency collaboration. The local incident command at the fire services were responsible for preparing and sharing the map information, including detailed geospatial information on the fire fronts and the response operation. These maps from the fire scenarios were then intended to be processed further at the coordinating level. However, a combination of lack of training in the rather complex map system with limited intuitive functionality, lack of analytic capability related to geospatial data, as well as time pressure, resulted in that the detailed maps from the incident scene were not processed further before being passed on to the next level in the information chain. This again resulted in that the CSU at the national level received maps with a level of detail not useful to them. As summarized by DSB in their written internal evaluation of the exercise:

“The CSU expected situational reports on whether life or health was threatened, and whether those handling the situation had sufficient resources to save lives (if needed), and then whether any critical societal functions were threatened or could be affected. [...] We managed to convey a situational picture of the positions of the field personnel, the location of the fire and where the fire hoses were placed, but we could not communicate the essential regarding vulnerabilities, such as Nødnett [the critical communication network] or other infrastructure.”

It was also pointed to a general lack of clearly defined procedures and templates for situational reports, and the County Governor receiving these reports “in different formats, and at different times”.

Apart from this, the study also resulted in a detailed list of requirements for improved map support, which is being considered by DSB for further modernization of their map support.

Discussion and suggestions for further research

While this exercise was designed and conducted as part of a research project, the focus on inter-agency collaboration is highly relevant for regional and national large-scale emergency management exercises in Norway. After the 2011 terrorist

attack in Norway (Rimstad et al., 2014), collaboration among emergency responders was defined as one of four core principles of emergency preparedness and response in Norway. Yet, despite the ensuing emphasis on this collaboration principle, a recurring challenge reported in evaluations from both real events (e.g., the near grounding of the Viking Sky cruise ship (DSB, 2020) and the Gjerdrum landslide (HRS, 2021)) and large-scale exercises (e.g., Trident Juncture 2018 NATO exercise (Grunnan et al., 2020)), is to obtain situational awareness and a common situational understanding.

Thus, based on the findings from our tabletop exercise as well as a broad mapping of current practice for inter-agency collaboration and information sharing conducted in the INSITU research project, we here discuss some core research challenges where the CSCW community could bring relevant expertise.

Support for collaborative procedures

Our study identified a general lack of procedures defining inter-agency information sharing. While the different organizations have internal procedures and ‘action cards’ for different scenarios, these typically do not specify what information should be shared with other organizations and how. Also, when observing emergency exercises involving personnel that are not trained as first responders, we see that the existing procedures often fail to be activated or are deviated from. Part of the reason for this is that personnel in supporting organizations may only have emergency preparedness and management as a limited percentage of their position (such as in smaller municipalities), and the emergency drills conducted once or twice per year are not sufficient for internalizing the procedures and related support tools in use (if any).

Given the unique characteristics and unforeseen elements of any crisis event the need for some improvisation in response operations is well accepted (e.g., Ley et al., 2014). Still, the practitioners we interacted with in our research project pointed to a need for better procedural support than what they currently have access to. The ICT systems in use by Norwegian emergency responders today provide very little support for collecting and integrating information from different sources. With the support systems mainly serving as repositories of the plans and procedures, and being mostly used for logging of the emergency response activities, the decision-makers themselves need to identify sources of relevant information and collect this rather than the system automatically pushing this to the responders.

The research on collaboration engineering (CE) focuses on “the design and deployment of repeatable collaborative work practices that can be executed by domain experts without the ongoing support of external collaboration professionals” (de Vreede and Briggs, 2019). Supporting the argument by Koch et al. (2015) on the possible benefit from combining CSCW and CE research, we

argue for developing a set of partially automated collaborative scripts that can be implemented in the incident management systems to aid the decision-maker in the required information management procedures.

Combined use of audio and textual support

At the operational level², the critical communication network is the main means of communication, both within each agency and for inter-agency communication. The exercise illustrated the benefit of combining audio communication with a common map, for obtaining a more precise situational awareness. The first responders have pre-defined call groups and procedures for their internal and inter-agency communication. But in practice these procedures are not always followed “by the book”, and as showed in our exercise there are also several organizations involved in large-scale events that do not have access to the critical communication network and thus must rely on other channels.

In the forest fire exercise, the common call group created was considered to give added insight for some users, although it was also considered time-consuming to follow all the communication exchange in this call group. And for the first responders being used to their specific call groups to support their work, the extended scope of a “common for all” group was perceived to generate noise. What is still needed is to develop a systematic communication network structure, adapted to the different roles involved and the available communication channels.

Use of geocollaborative tools

The analysis from the exercise showed a generally low proficiency in the use of the digital forest fire map among the involved participants. Thus, the training provided prior to the exercise was instrumental for being able to make use of the map solution. However, as described in the case example, advancing from being able to read and interpret a map to also being able to further analyze and modify the information represents a further challenge. Developing map services that automatically guides the user in building a common operational picture (COP) adapted to the level of operation (operational, tactical and strategic) would here be a significant improvement of today’s practice.

Co-located collaboration in joint command and control centres

While not covered explicitly in our digital tabletop exercise, a relevant area for CSCW is also the current trend of establishing common regional Command and Control Centers (CCC) for the first responders. Being co-located is expected to

² This paper here refers to the three-tier command and control structure, i.e. operational, tactical, and strategic (Bharosa et al., 2010). In Norwegian emergency management, the three levels are often referred to as tactical, operational and strategic.

make inter-agency information sharing and coordination easier and faster, and positive experiences of this have been reported (e.g., Antonsen and Ellingsen, 2019). There are also examples of a more extended co-location concept such as Samfunnssikkerhetens hus ('House of Societal Security') in Bergen, where also supporting organizations such as road administration, energy services and others are included.

The configuration of these CCCs and the related new work practices are still under development and there are regional pilots and practices being tried out. The rich body of CSCW research on operations centers and control rooms (see Silvast et al. 2022 for a recent review), could here provide an important basis for developing well-functioning configurations of such collaborative environments.

Conclusion

This study has highlighted several core challenges of inter-agency collaboration in emergency management that align well with the focus and expertise of CSCW researchers. While presented under separate sub-headings, these challenges are also connected within a broader framing of developing effective collaborative work practices for inter-agency emergency management.

The case illustration from the emergency exercise contributes to show the complexity in developing a shared situational awareness in a large-scale incident involving many stakeholders at different levels. The challenges identified from this exercise are not specific for a forest fire scenario, and also apply to other complex scenarios resulting from natural or man-made hazards.

As implied in the title of this paper, many of these challenges have also been reported in previous research. However, as the challenges remain largely unsolved, there is a need for a strengthened research focus. The CSCW community can here have a strong impact on practice in a domain of critical societal importance.

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References

- Antonsen, Y. and Ellingsen, M.-B. (2019): 'Samlokalisering av nødmeldingssentralene til politi, brann og helse utvider praksisfellesskapet og læring om samvirke (Co-location of police, fire and health emergency coordination centrals expands the community of practice and learning about cooperation)', *Nordisk Politiforskning*, vol. 6, no. 1, pp. 46-64.
- Bharosa, N., Lee, J. and Janssen, M. (2010): 'Challenges and obstacles in sharing and coordinating information during multi-agency disaster response: Propositions from field exercises', *Information Systems Frontiers*, vol. 12, pp. 49-65.
- De Vreede, G. J. and Briggs, R. O. (2019): 'A Program of Collaboration Engineering Research and Practice: Contributions, Insights, and Future Directions', *Journal of Management Information Systems*, vol. 36, no. 1, pp. 74-119.
- DSB (2019): 'Analyses of Crisis Scenarios 2019 – Disasters that may affect Norwegian Society', Norwegian Directorate for Civil Protection.
- DSB (2020): 'Evaluering av Viking Sky-hendelsen (Evaluation of the Viking Sky incident)', Norwegian Directorate for Civil Protection.
- Endsley, M.R. (1995): 'Toward a Theory of Situation Awareness in Dynamic Systems', *Human Factors*, vol. 31, no. 1, 37-64.
- Gross, T. (2013): 'Supporting Effortless Coordination: 25 Years of Awareness Research', *Computer Supported Cooperative Work* vol. 22, pp. 425-474.
- Grunnan, T., Endregard, M., Siedler, R.E. and Elstad, A.-K. (2020): 'Norwegian societal security and state security – challenges and dilemmas. *Proceedings of the 30th European Safety and Reliability Conference and the 15th Probabilistic Safety Assessment and Management Conference*.
- Heard, J., Thakur, S., Losego, J. and Galluppi, K. (2014): 'Big Board: Teleconferencing Over Maps for Shared Situational Awareness', *Computer Supported Cooperative Work*, vol. 23, pp. 51-74.
- HRS (2021): 'Evaluering - Redningsaksjonen og den akutte krisehåndteringen under kvikkleireskredet på Gjerdrum (Evaluation – The rescue operation and the acute crisis management during the quick clay landslide at Gjerdrum), Hovedredningsentralen.
- Koch, M., Schwabe, G. and Briggs, R.O. (2015): 'CSCW and Social Computing', *Business & Information Systems Engineering*, vol. 57, pp. 149-153.
- Ley, B., Ludwig, T., Pipek, V., Randall, D., Reuter, C. and Wiedenhoefer, T. (2014): 'Information and Expertise Sharing in Inter-Organizational Crisis Management'. *Computer Supported Cooperative Work*, vol. 23, no. 4-6, pp. 347-387.
- Munkvold, B.E., Gjørseter, T., Hagen, D.A., Opach, T., Pilemalm, S., Radianti, J., Rustenberg, K., Rød, J.K., Snaprud, M. and Steen-Tveit, K. (2021): 'Evaluering av INSITU skogbrannøvelse (Evaluation of INSITU forest fire exercise)'. Project report, SAMRISK project INSITU, University of Agder, Norway. ISBN 978-82-8427-050.
- Munkvold, B.E., Radianti, J., Rød, J.K., Opach, T., Snaprud, M., Pilemalm, S. and Bunker, D. (2019): 'Sharing Incident and Threat Information for Common Situational Understanding. *Proceedings of the 16th International Conference on Information Systems for Crisis Response and Management (ISCRAM 2019)*, pp. 1357–1363.
- Opach, T., Rød, J.K., Munkvold, B.E., Radianti, J., Steen-Tveit, K. and Grottenberg, L.O. (2020): 'Map-based Interfaces for Common Operational Picture'. *Proceedings of the 17th International Conference on Information Systems for Crisis Response and Management (ISCRAM 2020)*, pp. 276-294.

- Pipek, V., Liu, S.B. and Kerne, A. (2014): 'Crisis Informatics and Collaboration: A Brief Introduction', *Computer Supported Cooperative Work*, vol. 23, pp. 339-345.
- Reuter, C., Hughes, A.L. and Kaufhold, M.-A. (2018): 'Social Media in Crisis Management: An Evaluation and Analysis of Crisis Informatics Research', *International Journal of Human-Computer Interaction*, vol. 34, no. 4, pp. 280-294.
- Rimstad, R., Njå, O, Rake, E.L. and Braut, G. S. (2014): 'Incident Command and Information Flows in a Large-Scale Emergency Operation', *Journal of Contingencies and Crisis Management*, vol. 22, no. 1, pp. 29-38.
- Silvast, A., Virtanen, M.J. and Abram, S. (2022): 'Habits Over Routines: Remarks on Control Room Practices and Control Room Studies', Online first article, *Computer Supported Cooperative Work*.
- Steen-Tveit, K. and Munkvold, B.E: (2021): 'From common operational picture to common situational understanding: An analysis based on practitioner perspectives', *Safety Science*, vol. 142, 105381.
- WHO (2020): 'Inter-agency collaboration'. World Health Organization, Retrieved May 2, 2023 from <https://www.who.int/emergencies/partners/inter-agency>.

Torbjørn Træland Meum (2023): ECSCW 2023 Exploratory Papers Instructions. In: Proceedings of the 21st European Conference on Computer-Supported Cooperative Work: The International Venue on Practice-centered Computing on the Design of Cooperation Technologies - Exploratory Papers, Reports of the European Society for Socially Embedded Technologies (ISSN 2510-2591), DOI: 10.18420/ecscw2023_n02

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Scaling Digital Remote Care Technology: Installed Base Cultivation

Torbjørn Træland Meum

University of Oslo

torbjotm@ifi.uio.no

Abstract. Digital remote care is considered a solution to address the rising costs of healthcare by moving the treatment of patients to the homes, supporting a shift from episodic to continuous care, and promoting preventive care. However, it remains a challenge for user organizations (e.g., hospitals and health centers) to scale digital remote care to large patients' populations beyond small-scale pilot projects. Research has shown that the implementation and deployment of digital remote care requires the reorganization of resources, responsibility, competences in the organization, as well as the development of the existing infrastructures. These processes are therefore challenging, and the existing organizational, infrastructural, and digital capabilities of a user organization seem to play a critical role. Thus, in this paper, we address the research question of what is the role of existing socio-technical arrangement (installed base) in the scaling of remote care? We have addressed this question by conducting a case study in a primary care setting in Norway. This study contributes to increased insight into how existing socio-technological arrangements affect the configuration, adoption, and scaling of digital remote care for people with chronic illness.

Introduction

Digital solutions are considered key enabler to promote health, prevent diseases, and provide patient-centered care that meets citizens' needs (European Commission, 2018). International strategies have called for a paradigm shift in the way healthcare is organized (World Health Organization, 2015) and highlight the need for new models that enable patient-centered services and a shift from hospital-centered systems to more integrated care structures (European Commission, 2018). The increasing use of digital technologies has changed how and where care is delivered, i.e., remote care, telecare, telehealth (Bardhan et al., 2020). The terms telecare, telemedicine and telehealth are often used interchangeably; however, we use the term remote care which “involves the delivery of health and social care to individual within the wider community with the support of ICT enabled systems” (Barlow et al., 2012, p.225). Research in telehealth and remote care has increased considerably in recent years and several studies have shown how the use of digital technologies for patients with chronic diseases has provided clinical benefits as well as increased the patient's safety and self-awareness of their clinical condition (Morton et al., 2017). However, several studies have pointed out the challenges of implementing telehealth programs in daily practice (Varsi et al., 2019) and the need to theorize the distinct processes required to achieve widespread adoption (James et al., 2021).

Remote care technologies are collaborative tools that support the communication and coordination of patient and health professionals. Their use fundamentally changes the traditional interactions between patients and health professionals (Andersen et al., 2011; Bardram et al., 2005) and should be designed to support a variety of user needs (Woll & Bratteteig, 2019). They are also tools that transform the role of patients from care receivers to active data generators (Cerna et al., 2020) co-producing meaningful data (Miria Grisot et al., 2019). Most of the CSCW literature on remote care technologies has studied the design and use of these technologies on a small scale for specific group of patients and specific health conditions. We still have limited insights into how these technologies can be scaled and what the implications of scaling are for patients, health professionals, and their collaborative interactions.

Scaling of digital technologies has predominantly been conceived as a technical exercise following a linear trajectory from initial adoption to diffusion (Barlow et al., 2012). However, recent studies have also highlighted a practice approach to scaling (Barrett & Orlikowski, 2021) and scaling-up as a process of establishing the infrastructure needed to support widespread implementation of innovations (Greenhalgh & Papoutsi, 2019). Researchers in the CSCW domain have pointed to the need to conceptualize scaling as a bottom-up strategy and the socio-technical, transformative dimension of the scaling process (Rossitto et al., 2020).

In this study, we draw on the literature of information infrastructures and the evolutionary dynamics that characterize heterogeneous sociotechnical networks in which a wide range of activities are supported and shared by a larger community (Ciborra, 2001). Specifically, we work with infrastructures literature where scaling is conceptualized as a process of *installed base cultivation*. This means that scaling is shaped by the existing resources, technologies, practices, and organizational structures that are already in place (Aanestad et al., 2017; Hanseth & Lyytinen, 2010). Thus, understanding how the installed base shapes the scaling process is critical to conducting successful implementations beyond small-scale projects. In this paper we address the following research question: *what is the role of the installed base in scaling digital remote care?*

We have conducted research designed as a case study on the implementation and scaling of a digital remote care solution. The paper makes two contributions to CSCW research on the implementation of health information technologies. First, we offer a rich account from the perspective of user organization of the challenges of scaling. Second, we contribute to a conceptualization of scaling as an installed base cultivation. This paper is structured as follows. First, we position the study in relation to relevant literature on remote care technologies in the CSCW domain and present our conceptual lens of Information Infrastructure. Second, we present the research setting and method. Then, we discuss the preliminary findings from different viewpoints of the key stakeholders. Lastly, we conclude the paper with a summary and our future work.

Literature review

Research on remote care technologies in CSCW

Studies in CSCW have for a long time focused on the design of technologies to support remote care. For example, a literature review of CSCW research in healthcare illustrated how various applications and devices have been developed and deployed to support long-term interaction between patients living with chronic diseases and healthcare professionals (Fitzpatrick & Ellingsen, 2012). The use of remote care technologies has increasingly been used in elderly care and has changed the coordination of work in healthcare services. For example, Woll and Bratteteig (2019) argued that current technological solutions are not robust enough to support the various users' needs and proposed a comprehensive elderly care trajectory model. The increasing use of telecare solutions has also led to the establishment of central coordination hubs for remote care services. Farshchian et al. (2017) have studied a modern call center designed to provide services for the independent living seniors. One of the main findings of the study was "the tension between the episodic nature of existing call centers and the

continuous nature of elderly care” (p. 335). Moreover, Personal Health Records (PHR) have also increasingly been used to enable person-centered healthcare services and patient-provider interaction. There are different types of PHRs; some are connected to institution-based systems, and some are not. However, a key feature is that it is under the control of the patient and thus transforms the information space between the patient and healthcare professionals (Vassilakopoulou et al., 2018). Vassilakopoulou et al. (2018) characterized PHRs as hybrid information spaces and investigated design tensions related to the hybrid nature of PHRs.

Several studies have shown how digital technologies for remote care have changed collaborative practice between patients and clinicians. For example, a study by Bardram et al. (2005) illustrated how home-based monitoring and treatment of hypertension transformed the patient-physician relationship. A similar study by Andersen et al. (2018) illustrated that patients and clinicians had different perspectives on illness and emphasized the importance of aligning the concerns of patients and clinicians in the design of person-centered digital services. The increasing use of remote care technologies has also illustrated the emerging need for data work in the healthcare which has been defined as “any human activity related to creating, collecting, managing, curating, analyzing, interpreting, and communicating data” (Bossen et al., 2019 p. 466). A study by Grisot et al. (2019) focused on novel nursing practice in the context of remote care and claimed that data work is crucial in remote care and plays an even more central role than in traditional care. Furthermore, they argued that data work is not only about analyzing the data element accumulated in the system but also includes the work of deciding what is relevant data and “guiding the patients into co-producing these data” (p.615). A similar study by Cerna et al. (2020) illustrated how digital technologies for patient-generated health data (PGHD) changed categorical work for chronic care and identified design implications to inform the design of collaborative systems. All in all, these studies have demonstrated how the use of digital remote care has reconfigured the practice, i.e., redistribution of roles and accountabilities, as well as a common information space for digital remote care. Furthermore, Mønsted et al. (2020) demonstrated how a system for preventive care was enacted through a pilot implementation. They further emphasized that pilot implementation has a generative role in infrastructure evolution and suggested that further research should elaborate on the mechanisms that facilitate infrastructure evolution. All in all, previous studies have provided a rich understanding of the situated practice of remote care and how it enables collaboration in local practice. However, less attention has been on large-scale implementation and how digital remote care has been scaled up to new areas and changing needs.

Scaling as Installed base cultivation

Our research engages with an understanding of scaling from Information Infrastructure studies. This body of research addresses issues of design, development, implementation, and scaling of large infrastructural technologies (Grisot, Hanseth, & Thorseng, (2014), and has shown that processes of managing IT innovation in the healthcare context, and the associated challenges and conditions for successful outcomes, are particularly challenging (Currie & Guah, 2006; Dickens et al., 2011; Greenhalgh et al., 2010; Hanseth et al., 2006). Information infrastructures are digital technologies with complex evolutionary dynamics (Ellingsen & Monteiro, 2003; Hanseth & Lyytinen, 2010; Ribes & Polk, 2014). A core dynamic in infrastructure evolution is scaling. Scaling is the process of extending the scope of digital systems by adding new users and/or functionality either in its current context of use or by incorporating it in other settings (Sahay & Walsham, 2006). Scaling is therefore about handling the problems and challenges associated with making changes [and] “to scale in response to new patterns of use and new services” (Monteiro, 1998 p.229).

Several studies have illustrated some of the challenges of changing large, complex systems and emphasized the crucial role of existing technologies, practices, and regulations (i.e., installed base) in the evolution of information infrastructures (Aanestad et al., 2017; Grisot et al., 2014). Hanseth and Lyytinen (2010) have defined an installed base as “consisting of a set of IT capabilities and their users, operation and design communities” (p.4). The scaling of digital technologies is thus influenced by existing sociotechnical arrangements and “inherits strengths and limitations” from the installed base (Star & Ruhleder, 1996). The seminal work by Star and Ruhleder (1996) has defined some key properties that characterize when a system becomes an information infrastructure. They emphasize how infrastructure is embedded into other structures, social arrangements, and technologies. Furthermore, they describe infrastructure as a fundamentally relational concept that occurs in relation to organized practices. *“An infrastructure occurs when the tension between local and global is resolved. That is, when local practice are afforded by large-scale technology, which can be used in a natural, ready-at-hand fashion”* (p. 114). Similar studies have also emphasized the interrelation aspect of information infrastructure and how the installed base both enables and constrains infrastructure evolution (Aanestad et al., 2017). The installed base provides some IT capabilities to expand the information infrastructure. At the same time, existing technologies and habits challenge this growth and entail negotiations and adaptations to cultivate the installed base to evolving needs. The notion of “cultivation” is used as a metaphor to illustrate the organic growth of the installed base as an iterative and incremental process (Aanestad et al., 2017; Ciborra, 1997). Several studies have provided insight into how the installed base affects the growth of e-health infrastructures (Aanestad et al., 2017) and will in this study be used as a

conceptual tool to explore how it affects the scaling of digital remote care technologies.

Research Site and Methods

This study is part of a larger research project on the implementation, use, and scaling of digital technologies supporting high-quality remote patient care. The primary objective of the project is to investigate how digital technologies can be scaled, adapted, and evaluated to ensure high-quality remote care for patients with chronic illness or patients who need long-term follow-up from health professionals at hospitals or municipal home care services.

In this study, we have followed the implementation and scaling of digital remote care in a primary care setting in Norway. The municipality involved in this study has adopted digital remote care by participating in a national trial that lasted from 2018 to 2021. The target population for the trial has been patients with chronic diseases such as chronic obstructive pulmonary disease (COPD), diabetes, cardiovascular disease, as well as mental disorders and cancer. Based on the experience gained in the national trial, it has been decided to scale the digital solution to more users and user areas in health and care services.

The digital solution was initially developed by a Norwegian vendor to offer remote care for patients with chronic diseases. The digital solution is an integrated collaborative solution, based on health management cloud platform technology, and connected devices. The solution consists of a web-based patient portal and a patient application, as well as a set of integrated measuring devices. The patient portal for clinicians is developed for healthcare professionals to handle digital home follow-up, which integrates a range of patient-driven medical devices that support home-based care, such as medical measurements, symptom reporting and rehabilitation. The mobile application designed for the patients' end is used in combination with relevant measuring equipment, which automatically transmits the measurement results via Bluetooth to the patient's tablet or smartphone. The measurement results are immediately visible to the patient, and in the mobile application, patients can also answer clinical questions and register symptoms and side effects. The results are simultaneously transferred to a web-based patient portal so that health personnel can follow up on the values that come in and provide individual follow-up. The solution is integrated with several wearable measuring devices for patients to take measurements at home, for example, for blood pressure, blood sugar levels, weight, temperature, pulse, oxygen saturation, lung function and capacity, etc. The data are automatically recorded and transmitted via Bluetooth to the patient's end device. The scalability of the platform enables constant integration of new and appropriate measuring devices. The digital user interface also offers video conferencing and chat

functionality that enables synchronous and asynchronous communication between patients and health professionals.

Research method

This study applies the interpretive approach to case study research (Walsham, 1995) and the aim of the research is to gain insight into how digital remote care is adopted and adapted to practice and what the installed base means for scaling across different contexts. Furthermore, this study is part of an ongoing multi-site, longitudinal project to follow the scaling of digital remote care through time and space. Specifically, we have followed the actors and factors involved in scaling digital remote care, how existing systems and habits affect scaling, and how scaling is enacted across different practices.

Data collection has been a combination of semi-structured interviews and the collection of archival documents. In the first phase of the study, we collected publicly available documents such as national strategies, reports, evaluations, and hearings. In addition, we have had access to some internal reports and evaluations. These documents have been used to gain insight into the historical development of digital remote care in Norway. To get a more in-depth understanding of the unfolding use of digital technologies, we carried out 14 interviews with key stakeholders in the project, i.e., health professionals, project managers and the supplier. The interviews focused on issues related to: How they perceive the use of digital remote care; how it affected practice; how it affected collaboration and coordination of tasks; and how challenges were handled. Most of the interviews were conducted in the local context in the municipality or at the hospital, but because of the pandemic, 4 interviews were conducted on Zoom. The interviews lasted approximately 45 – 60 minutes and was recorded and fully transcribed.

Analysis of data was inspired by a grounded theory approach and the area of enquiry guided the coding process (Charmaz, 2014). The initial step in the analysis was based on open coding to identify incidents related to adoption, use, and scaling. All the incidents/events identified in the empirical material were assigned a code and a descriptive label. When all the data had been examined, the initial codes were organized and reassembled in a new way. This process involved reflecting on activities and processes to make sense of how different stakeholders perceived the use of digital remote care. The analysis was an iterative process moving back and forth between the initial codes to compare incidents and the relationship between the codes. At this stage in the analysis, more focused coding was used to conceptualize larger segments of data. The theoretical framework on scaling information infrastructures was used as an analytical lens to identify some theoretical themes that provided a more comprehensive understanding of how digital remote care was enacted in practice.

NVivo software package (version 12) was used throughout the analysis to code, organize and visualize data.

Findings

Preparation and configuration of digital remote care

National strategies in Norway have pointed to the need for better coordination between specialist and primary care as well as the need for more patient-centered health services. Digitalization is regarded as a measure to achieve these goals and national initiatives have been implemented in recent decades. A national program for welfare technology was implemented during 2014–2018, which involved the introduction of digital alarms, medication dispenser systems and localization technologies in the municipalities. This program has been continued during 2018–2021 as a national trial for the use of digital remote care which included six projects in different municipalities in Norway. The target group for the trial was chronically ill patients with a medium to high risk of deterioration of their condition and increased need for health and care services. The main objective of the trial was to gain knowledge and experience with the use of digital remote care as well as recommendations for further implementation and scaling.

The management of the national trial was handled by the Norwegian Directorate of Health, which provided financial support as well as support to organize local workshops and meetings. For example, workshops were organized with key stakeholders in the local projects, i.e., nurses, GPs, and vendors. Service designers were also involved in the trial to facilitate methods and tools in the design of new patient pathways. Service designers provided tools to define specific objectives, map the existing service, and difficulties in existing practice as well as proposed solutions for follow-up of patients. Stakeholders in the local projects invested time and effort in the development of new patient pathways that formed the basis for the design of the new digital solutions.

Different models for the follow-up of patients were used during the national trial. However, most of the local projects decided to establish local/regional follow-up centers to make the best use of the professional resources. Staff at the follow-up center played a key role in the follow-up of patients during the trial and include training, guidance, and daily follow-up of the patient's self-monitoring. The main components for self-monitoring that became available in the digital solution during the trial were measuring devices for vital signs, questionnaires for reporting symptoms and a self-care plan which is a plan of patients' goals and measures to follow up on their own health.

Cultivating and extending practice

The municipality included in this study has gradually adopted digital solutions in health and care services and has since 2014 participated in national initiatives for the use of digital remote care. Participation in these projects has enabled an incremental development of digital remote care in line with emerging needs. Health professionals in the municipality have experienced the usefulness of the digital solution as stated by a project manager in the municipality: *“Many of the solutions in the App have been developed in collaboration with the municipality and those who work at the follow-up center, and that is part of the reason why we think that the solution works so well for us now”*.

The municipality provides health and care services to a large population, and several follow-up centers have been established that play a key role in the digital follow-up. Firstly, employees at the follow-up center are involved in the enrolment of patients who may benefit from digital follow-up. Patients can either be referred internally from the home care services in the municipality, by their GP or from the hospital. The referral to digital remote care follows existing routines for interaction between different levels of the health service. For instance, referrals from the hospital are sent as an electronic message to the case manager in the municipality who forwards it to the follow-up center. After the patient has been enrolled, a 14-day trial period begins. The trial period usually takes place as follows: The nurse at the follow-up center makes a home visit to get to know the patient, delivers equipment and provides training in the use of the digital solution. Based on experience during this period, an agreement is made for further follow-up in an interdisciplinary meeting between healthcare personnel and patients.

The local follow-up center is open Monday through Friday from 8 a.m. to 4 p.m. and is located close to the homecare service in the municipality. The daily follow-up is performed by nurses and involves professional assessments of self-reported data from the patient. An overview of patient-reported data is available in the user interface to both patients and healthcare professionals. In addition, the results have a color code (red, yellow, green) and if the measurement is above or below the threshold value set by the doctor, the result has a red code. This makes patients more aware of their own clinical condition while healthcare professionals have access to patient-reported data to make clinical assessments. The digital follow-up of patients involves professional knowledge and skills as stated by a project manager in the municipality: *“They say that they use more of their nursing skills (...) many professional assessments on how to react. They need to assess alerts, messages that the patient has sent, and answers to questionnaires, and be able to put them together and give a good assessment of how to follow up on the patient further. I think those who work there think it is very good to be able to use their assessment skills”*.

Clinical judgement is an essential part of nursing, and the display of patient-generated data provided a good overview of the clinical condition over time as a

support in the clinical decision-making process. The nurses also use clinical data stored in the EPR (medication list, test results etc.) if they need more information about the clinical situation. They also have the opportunity to make a video call with the patient to clarify the situation.

As briefly outlined above, the use of patient-generated data has become a useful resource in the follow-up of patients and evolved to become part of everyday practice. Although the use of structured questionnaires and self-treatment plans have not been part of existing practice in home care services, these have become an "extending hand" in the digital follow-up.

The usefulness of the digital solution has led to scaling to new patient groups such as follow-up of the patient with cancer. In this case, cancer nurses were involved in the follow-up of the patients, which required interdisciplinary collaboration as explained by a project manager. *“Then we had to create new pathways for this group because they had to be followed up by other resources and a completely different arrangement (...) so we had to reorganize a bit to meet the needs of the user group and the employees who followed them up. And then there was also much closer involvement of the GPs and there was close involvement of local hospitals in the recruitment phase”*. In addition, the digital solution was adapted to the follow-up of COVID-19 patients during the pandemic and an infection control team in the municipality was responsible for the daily follow-up. The adaptability of the digital solution shows that digital remote care can be useful in different contexts and there are now ongoing activities to scale the digital solution in the municipality.

Negotiating cross-boundary coordination

The initial usefulness of digital remote care has gradually been adopted by a large user community in the municipality. However, the scaling of the digital solution is still at an early stage and some key issues have been identified that need to be addressed in the further process. On the one hand, digital remote care has led to increased interaction between the municipality, GPs, and the hospital. The GPs have an important role in the follow-up of patients by approving and revising the self-treatment plan used by staff at the follow-up center. For example, electronic messages are used if the nurse needs medical advice from the GP or needs to make changes to the self-treatment plan. The use of the self-treatment plan has thus facilitated coordination between health professionals and the patients, and the nurse at the follow-up center has become a link between the GP and the patient. However, interaction across professional and organizational boundaries remains a challenge. For example, some GPs and hospital doctors are concerned that digital follow-up may lead to additional work as illustrated in a statement from a project member in the municipality: *“It has been quite challenging to establish a good interaction with the GPs and there are several reasons for this.*

The GP is overloaded with work, and they do not always see the benefit of using digital home follow-up.”

Another issue that has been discussed is the need for integration between various digital solutions used in the healthcare service. Firstly, there is a lack of integration between the digital solution for remote care and the EPR used in the municipality. This leads to additional work and manual procedures to share information among health professionals working in the municipality. Secondly, there is a lack of integration between the digital solution for remote care with the EPR systems used at the hospital and by the GPs, which challenges the overall follow-up of the patients. Traditionally, electronic messages are used to exchange information between municipalities, hospitals, and GPs. However, this entails additional work and there is a need for integrated solutions to facilitate interaction between different actors in the health service. To resolve this issue, activities have been initiated to develop standardized interfaces to transfer data between the digital solution for remote care and EPR systems use in the municipality, at the hospital and by GPs. Furthermore, activities have been initiated to sort out what information is useful to whom and in what situations. Some doctors are concerned that access to self-generated data from the digital solution may lead to information overload as shown in a statement from a project member in the municipality: *They also have a policy that they never want more data than they need, so if they are going to get information, it must be proven that the information is of use to them*”. A similar statement from the Norwegian Medical Association illustrates this issue: *“Importing large amounts of data of limited relevance could lead to data overload and could create additional work and risk. What is clinically useful and relevant may be lost in the amount of irrelevant and noisy data”*. The first step in solving this issue was to map the need for sharing information among various stakeholders. The goal is to develop an integrated solution that is adapted to different roles, tasks, and responsibilities.

Discussion

In this study, we have illustrated how digital remote care has been adopted and further scaled by adding new users and functionalities across organizational units. The findings illustrate a successful bottom-up strategy that evolved gradually from existing practice. However, the findings also show how issues emerged and challenged further scaling across professional and organizational boundaries. We argue that the installed base played an important role and will further elaborate on the cultivation of the installed base and how it affected the scaling of digital remote care.

Firstly, the design and development of digital follow-up was based on the existing installed base, i.e., the organizational, institutional, regulatory, and sociotechnical arrangements that are already in place (Aanestad et al., 2017). For

example, the first phase of the local project in the municipality was based on existing practice to define the goals of the digital follow-up of patients and formed the basis for the development of patient pathways. Professional knowledge and experience in follow-up of patients with chronic diseases also formed the basis for the development of functionalities in the digital solution. Digital capabilities enabled a more patient-centered follow-up and functionalities for self-management were gradually developed in close collaboration between health professionals, service designers and the provider. This process illustrates how the installed base can be a resource for creative design and enable the growth of information infrastructures (Aanestad et al., 2017; Hanseth & Lyytinen, 2010).

Secondly, the cultivation of the installed base implies an iterative and incremental adaptation over time (Aanestad et al., 2017; M. Grisot et al., 2014; Hanseth & Lyytinen, 2010). Implementation and scaling of digital remote care have been going on for a long time with a gradual adaptation and expansion of the service. They started with the small-scale implementation that provided direct usefulness and motivated further scaling. In the first phase, they also selected a limited group of patients who could benefit from a patient-centered follow-up. This strategy has been quite successful and both patients and healthcare professionals are quite satisfied with the solution and motivated to further scaling. User mobilization is an important part of the cultivation process and previous research has highlighted strategies that provide immediate benefit and motivate users and then generate positive network effects; that is, the IT capability derives its value from the size of its user base (Hanseth & Lyytinen, 2010 p.13). This strategy of user mobilization promotes the growth of the installed base and creates momentum for further adoption (Grisot et al., 2014). As illustrated above, the potential usefulness has gradually motivated users who have gradually expanded their use of the digital solution in the municipality. However, several constraining mechanisms of the installed base were also revealed during the implementation process. For example, it is still a challenge to share information across professional and organizational boundaries. The adoption of digital remote care was supposed to improve interaction among all actors involved in the digital follow-up of patients. However, existing infrastructure challenges information sharing between the municipality, hospital, and GPs. For example, it was difficult to mobilize the physicians because they did not see the immediate usefulness of digital remote care. This issue illustrates the bootstrapping problem (Mønsted et al., 2020) and has slowed down the scaling to new user groups.

Another challenge was the lack of integration between the digital remote care solution and EPRs. The use of electronic messages has been a well-established solution in health care and was also used to share information between nurses and GPs. However, it was not sufficient when the nurse had to copy data from the digital remote care solution into an electronic message. According to Cabitza et al (2019), duplication of data in different systems may lead to inconsistencies and

additional work in aligning different sources of information (Cabitza et al., 2019). Consequently, there are ongoing activities to integrate various systems and to agree upon some rules for exchanging information between the digital remote care solution and EPR systems. This involves sociotechnical negotiation to balance the need for standardization and local customization (Monteiro, 1998; Sahay & Walsham, 2006).

Conclusion and further research

In this study, we have addressed the role of the installed base in the scaling of digital remote care in primary healthcare in Norway. Firstly, we have illustrated how existing socio-technical arrangements influenced the configuration of digital remote care. Second, we argue that the cultivation of the installed base involves an iterative and incremental adoption over time. Third, we have illustrated how cross-boundary negotiations enabled further growth of the installed base.

Scaling of digital care in Norway is still at an early stage, and further research will focus on how scaling is adapted to other contexts in the health service. For example, we have conducted data collection at a hospital that is in the process of scaling digital remote care for outpatient clinics and home hospitals for children. Furthermore, we will focus on the interaction between hospitals and municipalities, which will provide new knowledge about integrated health services across organizational units.

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References

- Aanestad, Margunn, Grisot, M., Hanseth, O., & Vassilakopoulou, P. (2017): Information Infrastructures and the Challenge of the Installed Base. In Marunn Aanestad, M. Grisot, & P. Vassilakopoulou (Eds.), *Information Infrastructure within European Health Care: Working with the Installed Base* (pp. 25–33). Springer.
- Andersen, T., Bjørn, P., Kensing, F., & Moll, J. (2011): Designing for collaborative interpretation in telemonitoring : Re-introducing patients as diagnostic agents. *International Journal of Medical Informatics*, vol. 80, no.8, pp. e112–e126.
- Andersen, T. O., Bansler, J. P., Kensing, F., Moll, J., Mønsted, T., Nielsen, K. D., Nielsen, O. W., Petersen, H. H., & Svendsen, J. H. (2018): Aligning Concerns in Telecare: Three Concepts to Guide the Design of Patient-Centred E-Health. *Computer Supported Cooperative Work: CSCW*, vol. 27, no.(3–6), pp.1181–1214.
- Bardhan, I., Chen, H., & Karahanna, E. (2020): Connecting systems, data, and people: A

- multidisciplinary research roadmap for chronic disease management. *MIS Quarterly: Management Information Systems*, vol.44, no.1, pp. 185–200.
- Bardram, J. E., Bossen, C., & Thomsen, A. (2005): Designing for Transformations in Collaboration – A Study of the Deployment of Homecare Technology. *Proceedings of the 2005 International ACM SIGGROUP Conference on Supporting Group Work*, pp. 294–303.
- Barlow, J., Hendy, J., & Chrysanthaki, T. (2012): Scaling-up remote care in the United Kingdom: Lessons from a decade of policy intervention. *Assistive Technology Research Series*, vol.30, pp. 223–236.
- Barrett, M., & Orlikowski, W. (2021): Scale Matters: Doing Practice-based Studies of Contemporary Digital Phenomena. *MIS Quarterly*, vol. 45, no.1b, pp. 467–472.
- Bossen, C., Pine, K. H., Cabitza, F., & Piras, E. M. (2019): Data work in healthcare : An Introduction. *Health Informatics Journal*, vol.25, no3, pp. 465–474.
- Cabitza, F., Ellingsen, G., Locoro, A., & Simone, C. (2019): Repetita Iuvant: Exploring and Supporting Redundancy in Hospital Practices. *Computer Supported Cooperative Work*, vol. 28, no. (3–6), pp. 61–94.
- Cerna, K., Grisot, M., Islind, A. S., Lindroth, T., Lundin, J., & Steineck, G. (2020): Changing Categorical Work in Healthcare: the Use of Patient-Generated Health Data in Cancer Rehabilitation. *Computer Supported Cooperative Work*, vol. 29, no.5, pp. 563–586.
- Charmaz, K. (2014): *Constructing Grounded Theory: A practical Guide through Qualitative Analysis* (Vol. 2). Sage Publications, Ltd.
- Ciborra, C. U. (1997): De profundis? Deconstructing the concept of strategic alignment. *Scandinavian Journal of Information Systems*, vol. 9, no. 1, pp. 67–82.
- Ciborra, C. U. (2001): *From Control to Drift: The Dynamics of Corporate Information Infrastructures*. Oxford University Press.
- Currie, W. L., & Guah, M. W. (2006): It-Enabled healthcare delivery: The U.K. national health service. *Information Systems Management*, vol. 23, no.2, pp. 7–22.
- Dickens, A. P., Richards, S. H., Greaves, C. J., & Campell, J. L. (2011): Interventions targeting social isolation in older people: a systematic review. *BMC Public Health*, vol. 11, no.647, pp. 1–22.
- Ellingsen, G., & Monteiro, E. (2003): A Patchwork Planet : Integration and Cooperation in Hospitals. *Computer Supported Cooperative Work*, vol.12, pp. 71–95.
- European Commission. (2018): *Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Regions "on enabling the transformation of health and care in the Digital Single Market: empowering citizens and building a healthier society*. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018DC0233>
- Farshchian, B. A., Vilarinho, T., & Mikalsen, M. (2017): From Episodes to Continuity of Care: a Study of a Call Center for Supporting Independent Living. *Computer Supported Cooperative Work*, vol. 26 no. (4–6), pp. 309–343.
- Fitzpatrick, G., & Ellingsen, G. (2013): A Review of 25 Years of CSCW Research in Healthcare: Contributions, Challenges and Future Agendas. *Computer Supported Cooperative Work*. vol. 22, no. 4-6, pp. 609–665.
- Greenhalgh, T., Hinder, S., Stramer, K., Bratan, T., & Russell, J. (2010): Adoption, non-adoption, and abandonment of a personal electronic health record: Case study of HealthSpace. *BMJ (Online)*, vol. 341, no. c5814, pp. 1–11. <https://doi.org/10.1136/bmj.c5814>
- Greenhalgh, T., & Papoutsis, C. (2019): Spreading and scaling up innovation and improvement. *BMJ (Online)*, vol. 365, no.(May), pp. 1–8.
- Grisot, M., Hanseth, O., & Thorseng, A. (2014): Innovation Of, In, On Infrastructures: Articulating the Role of Architecture in Information Infrastructure Evolution. *Journal of the Association for Information Systems (JAIS)*, vol. 15, no. 4, pp. 197–219.
- Grisot, Miria, Moltubakk Kempton, A., Hagen, L., & Aanestad, M. (2019): Data-work for personalized care: Examining nurses' practices in remote monitoring of chronic patients.

- Health Informatics Journal*, vol. 25, no. 3, pp. 608–616.
- Hanseth, O., Jacucci, E., Grisot, M., & Aanestad, M. (2006): Reflexive Standardization: Side Effects and Complexity in Standard Making. *MIS Quarterly* 2006, vol. 30, (Special Issue), pp. 563–581.
- Hanseth, O., & Lyytinen, K. (2010): Design theory for dynamic complexity in information infrastructures: the case of building internet. *Journal of Information Technology*, vol. 25, no 1, pp. 1–19.
- James, H. M., Papoutsis, C., Wherton, J., Greenhalgh, T., & Shaw, S. E. (2021). Spread, Scale-up, and Sustainability of Video Consulting in Health Care: Systematic Review and Synthesis Guided by the NASSS Framework. *Journal of Medical Internet Research*, vol. 23, no. 1, pp. 1–15.
- Mønsted, T., Hertzum, M., & Søndergaard, J. (2020): A Socio-Temporal Perspective on Pilot Implementation: Bootstrapping Preventive Care. *Computer Supported Cooperative Work*, vol. 29, no. 4, pp. 419–449.
- Monteiro, E. (1998). Scaling Information Infrastructure: The Case of Next-Generation IP in the Internet. *The Information Society*, vol. 14, no. 3, pp. 229–245.
- Morton, K., Dennison, L., May, C., Murray, E., Little, P., McManus, R. J., & Yardley, L. (2017). Using digital interventions for self-management of chronic physical health conditions: A meta-ethnography review of published studies. *Patient Education and Counseling*, vol. 100, no 4, pp. 616–635.
- Ribes, D., & Polk, J. B. (2014): Flexibility Relative to What ? Change to Research Infrastructure. *Journal of the Association for Information Systems*, vol. 15 (Special Issue), pp. 287–305.
- Rossitto, C., Lampinen, A., Bødker, S., Light, A., Berns, K., & Hui, J. (2020): Reconsidering scale and scaling in CSCW research. *CSCW'20 Companion*, pp. 493–501.
- Sahay, S., & Walsham, G. (2006): Scaling of health information systems in India: Challenges and approaches. *Information Technology for Development*, vol. 12, no. 3, pp. 185–200.
- Star, S. L., & Ruhleder, K. (1996): Step Toward and Ecology of Infrastructure: Design and Access for Large Information Spaces. *Information System Research*, vol. 7, no. 1, pp. 111–134.
- Varsi, C., Solberg Nes, L., Kristjansdottir, O. B., Kelders, S. M., Stenberg, U., Zangi, H. A., Børøsund, E., Weiss, K. E., Stubhaug, A., Asbjørnsen, R. A., Westeng, M., Ødegaard, M., & Eide, H. (2019): Implementation Strategies to Enhance the Implementation of eHealth Programs for Patients With Chronic Illnesses: Realist Systematic Review. *Journal of Medical Internet Research*, vol. 21, no. 9, pp. 1–19.
- Vassilakopoulou, P., Grisot, M., & Aanestad, M. (2018): Between Personal and Common: the Design of Hybrid Information Spaces. *Computer Supported Cooperative Work*, vol. 28, no. 6, pp. 1011–1038.
- Walsham, G. (1995): Interpretive case studies in IS research : nature and method. *European Journal of Information Systems*, vol. 4, no. 2, pp. 74–81.
- Woll, A., & Bratteteig, T. (2019): A trajectory for technology-supported elderly care work. *Computer Supported Cooperative Work*, vol. 28, pp. 127–168.
- World Health Organization. (2015). *WHO global strategy on integrated people-centred health services 2016-2026*. <https://apps.who.int/iris/handle/10665/155002>