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Digital Transformation towards Sustainability: A Case Study of Process Views in District Heating

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Abstract. Digital transformation (DT) has the potential to change our society toward the United Nation's sustainable development goals. However, developing software for the DT towards sustainability is a complex process that may entail an emphasis on optimization, eco-feedback, reflection, and participation. This paper contributes to a better understanding of how organizations navigate this complexity of different process views with a case study of a DT in district heating. Based on ten interviews with a software development company, eight interviews with a district heating supplier, and 14 interviews with consumers, we analyze the process views on their DT. This analysis shows how organizations navigate the different process views in a DT journey when encountering and solving problems. We conclude the paper by providing propositions on what *navigating* DT implies. Furthermore, we discuss how these insights can help practitioners navigate different process views and how our findings nuance the understanding of the DT process.

Keywords: Digital Transformation, Process Views, Navigating, Sustainability

1 Introduction

Climate change is one of the greatest challenges of our time, and digital transformation (DT) has great potential to enable sustainable development [1, 2]. In the face of climate change, the scope of DT is expanding, including an increased focus on society and the individual and their role in sustainable development [3, p. 1]. In this process, digital technology can be seen as "a contributor and a potential solution to environmental degradation" [4, p. 1278]. That being said, the DT process towards sustainability is a tortuous journey with many proposed solutions, including optimizing the life cycle of the physical and digital artifacts [5], pro-active strategies [6], infrastructuring [7, 8], and increasing people's engagement in sustainability [9]. This diversity illustrates the wickedness of the climate change problem [10]. Wicked problems are "problems for which no single computational formulation of the problem is sufficient, for which different stakeholders do not even agree on what the problem really is" [11, p. 45]. We have identified four streams of literature with distinct process views on the DT towards

environmental sustainability: optimization, eco-feedback, reflection, and participation. These processes differ in their view on the problem, solution, and sustainability. Thus, there is no silver bullet and no clear path that helps organizations navigate sustainable development – the practitioners must manage problems and solutions that unfold in real-time. However, the literature falls short in describing *how* this dynamic process develops over time. Against this backdrop, we present our research question:

How do organizations navigate the different process views in the digital transformation towards sustainability?

To answer our research question, we conducted a longitudinal single-case study [12] of the DT of district heating [13] in a municipality in North Jutland, Denmark. In this case study, we followed the development of the Green Assistant - an application that provides hourly consumption data on heat, water, and electricity. This application is developed in a partnership between multiple organizations. In this article, we follow two organizations – Joules A/S (a software development company) and NortHeat (the heating domain expert) – and how they navigate the different process views in their DT journey. Furthermore, we interviewed district heating consumers in NortHeat's municipality to understand how the solutions made in the partnership influenced them.

With this case study, we build and illustrate a theory of how organizations can navigate the different process views in a DT journey. We use the distinction between the four identified process views – optimization, eco-feedback, reflection, and participation – to build a theory of multiple process views on DT towards sustainability. Furthermore, we provide propositions on what *navigating* DT implies. These insights can help practitioners navigate different process views on DT and nuance the understanding of the DT process. Lastly, we present limitations of our study and an agenda for future research.

2 Process views on DT towards Sustainability

In the relevant literature, we identified four process views that illustrate how the processes of DT towards sustainability can unfold: Optimization, Eco-feedback, Reflection, and Participation.

The optimization process view on DT towards sustainability promotes effectiveness and efficiency. Using fewer resources is seen as competitively and economically beneficial, e.g., optimizing resource-excessive services [14]. For example, in a study of support systems for transport logistics, focusing on sustainability reporting and analysis, it was found that a support system could reduce CO_2 emissions by 80% in a year [14]. From the optimization perspective, transforming the physical infrastructures through digital technology contributes to organizational and governmental sustainability goals [14–16]. However, these interventions require significant investments, and the lack of adoption of these technologies can undermine this investment in sustainable technology [16]. Thus, this process view is also concerned with how people can adopt these technologies and live up to the technology's potential to support sustainable consumption.

The eco-feedback process view on DT towards sustainability promotes behavioral change through consumer data. The Eco-feedback process is built on the assumption that people will act per the information available and consume in a manner that "provides them with the most personal gain at the least personal cost" [17, p. 2136]. From this process view, the purpose of digital technology is to provide meaningful information about consumer consumption [18]. Furthermore, it is argued that digital technology can help change consumers' perceptions of energy and increase energy literacy [19]. Consumers can learn about energy by following their consumption data over time [19]. However, it has also been shown that some consumers have difficulty understanding and acting upon the information [17]. Thus, it is essential to consider how this information should be visualized to become meaningful, thus leading to sustainable consumer behavior.

The reflection process view on DT towards sustainability promotes challenging the status quo through design towards deliberate practices. The reflection process view advocates that digitalization at a societal level ought to change social practices and initiate reflection as a prerequisite for social change [20]. The reflection process view advocates a thorough understanding of everyday practices (e.g., cleaning and cooking) to challenge the unsustainable structures that shape them [21, 22]. From this process view, the prevailing practices characterized by instant service, high quality, and ubiquity are unsustainable [23]. The proposed solution is to make the consumers reflect on their consumption practices and increase their awareness of environmental sustainability [24, 25]. Thus, the reflection process view is about learning, awareness, and deliberate practices.

The participation process view on DT towards sustainability promotes achieving change through increased people's engagement. Organizations can lose the users' process view and limit users' experiences with sustainable technologies in the race towards effectiveness. A proposed solution regards involving citizens in designing through co-designing activities, thus democratizing digital solutions [26] or introducing a *sustainability champion* - a person who fights for sustainable values - to disseminate sustainable values among the employees [27]. In this view, the role of digital solutions is not to feed information passively to the consumer but to give a space where experiences and assumptions can be challenged and shared [9]. Thus, enabling decision-making and developing a capacity to act sustainably [28, 29]. Furthermore, when stakeholders share experiences, this allows for critical reflection [30] and mutual inspiration, strengthening the community feeling [31]. In this process view, human engagement in sustainable development becomes the key to achieving sustainability. Therefore, digital technology assumes a supportive role in establishing shared values, practices, activities, and knowledge.

We have summarized and operationalized the four process views by identifying their different success criteria for developing software for DT towards sustainability (see Table 1). These different process views offer alternative explanations of the *problem*, the *solution,* and *sustainability*. The alternative explanations to the climate change

problem are inevitable because "there are no right or wrong answers, only answers that are better or worse from different points of view" [11, p. 45]. Thus, we theorize that DT towards sustainability is a single process [32, p. 121] that can unfold in a multiplicity of ways [33].

Table 1. The process views on the digital transformation towards sustainability

Process Views	The problem, the solution, and view on sustainability
Optimization	*The problem* is that people are bound by unsustainable processes, infrastructures, and services. *The solution* is a continuous search for processes, infrastructures, and services to enhance. *Sustainability* pertains to efficiency and effectiveness
Eco-feedback	*The problem* is that people are unaware and, therefore, less sustainable. *The solution* is to provide actionable consumption feedback to increase environmental literacy. *Sustainability* is actionable information.
Reflection	*The problem* is that people are bound by the status quo. *The solution* is to create provocative and speculative designs to challenge the status quo. *Sustainability* is a radical change in the state of mind.
Participation	*The problem* is that people are not activated or engaged. *The solution* is to increase people's engagement in design activities and design to support sustainable user activities. *Sustainability* is increased human engagement.

3 Method

To unfold the four process views on DT towards sustainability, we conducted a longitudinal single case study [12] of how NortHeat and Joules A/S navigate different process views on the DT of district heating. Our units of analysis were problem-solving actions, and to identify what actions constitute the different process views, we applied the success criteria for DT towards sustainability (see Table 1). One way of capturing a process is through narrative [34]. Therefore, in our inquiry into actions that constitute the DT of the district heating process, we conducted narrative interviewing [35] with several relevant stakeholders from both organizations over two years.

The relevant stakeholders were organizational employees who had a decisive role that impacted how both organizations navigated the different process views. Based on this criterion, we interviewed the CEO at Joules A/S, the R&D Section Manager from Joules A/S, the Head of Energy Supply, and the IT Project Manager from NortHeat (see Table 2). The interviews' purpose was to gather insight into how the two organizations

viewed and solved situated problems that guided this DT journey. This DT journey started in 2018 as a collaboration between NortHeat and Joules A/S to exploit data from the installed smart meters in the district heating area's 110.000 households.

Table 2. The number of interviews and the stakeholder description

Data collection	Stakeholders
Joules A/S 10 Semi-structured interviews (February 2020 – February 2022)	• 5 x Section Manager responsible for R&D • 3 x Section Manager responsible for partnering with Utility companies • 2 x CEO responsible for vision and mission for Joules A/S
NortHeat 8 Semi-structured interviews (September 2020 – February 2022)	• 5 x Project Manager responsible for Green Assistant roll-out • 2 x IT-Project Manager responsible for digital infrastructure • 1 x Head of Energy Supply er responsible for providing vision and mission for the DT of district heating.
Green Assistant users 14 Semi-structured interviews (April 2020 – November 2020)	• 2 x Finn, a Construction Engineer – uses the app monthly • 2 x Svend, a Municipal Worker – uses the app weekly • 2 x Anne, a Municipal Worker – uses the app daily • 2 x Erik, a Taxi Driver – uses the app monthly • 2 x Karen, a retired Secretary – uses the app monthly

NortHeat has been working towards producing renewable energy heat and sought to transform district heating digitally. Therefore, NortHeat partnered with Joules A/S – an electricity provider and an application developer. They did not buy or sell services or products from each other. Instead, they pooled their resources and capabilities into developing a consumer-oriented mobile application for tracking and predicting heat consumption. Joules A/S benefited from this collaboration regarding data access, a large user base, and expertise in district heating. NortHeat, on the other hand, benefited from access to skilled developers and an already working solution that had proven its worth for electricity consumption.

Nevertheless, both organizations shared an overall concern for sustainable energy consumption in their digitalization efforts. Yet, as shown by the subsequent unfolding of the four process views, they still entailed ambiguity when navigating the more specific concerns in practice. Furthermore, we have conducted two rounds of semi-structured interviews with seven citizens of NortHeat's municipality (see Table 2). We used insights from these interviews to illustrate how the consumers perceived the solutions made in the partnership. For all the interviews, we used interview guides and recorded them through Microsoft Teams or a recording device (the interview guides will be provided on request).

In our analysis of the interviews, we identified problem-solving actions conducted by various stakeholders that illustrate how organizations navigate the different process views on the DT towards sustainability through the following steps (adapted from [36]):

1) We listened to all recordings, transcribed them, and read the transcriptions to familiarize ourselves with the empirical data.
2) Critically identify quotes in the data and code these appropriately in relation to the four identified process views (see Table 1):
    i) We searched for problems, solutions, and views on sustainability in the empirical data.
    ii) We operationalized four process views by codifying their different success criteria for developing software for sustainability (e.g., the optimization process view had codes such as *service, infrastructure, process, efficiency,* and *effectiveness).*
    iii) We checked if the identified problems, solutions, and different views on sustainability work in relation to the identified four process views (e.g., if a quote referred to any kind of *efficiency* and *effectiveness,* we related it to optimization).
3) The chosen quotes were analyzed to illustrate how organizations navigated this DT journey:
    i) We searched for decisive action in the DT process that enabled the organizations to continue their journey (e.g., reciprocating each other's process views).
    ii) From these actions, we have abductively [37] elicited three propositions on what navigating DT towards sustainability entails.

4 Analysis

In the following sections, we unfold how NortHeat and Joules A/S navigate the four process views in their DT journey. In addition, we incorporated the consumers' experience with the Green Assistant to gain an understanding of how the actions made in the partnership influenced and were perceived by the consumers.

4.1 The optimization process view

The optimization process promotes effectiveness and efficiency; sustainability is viewed as using fewer resources to complete a task. This process view was pervasive in Green Assistant and NortHeat's actions and overall vision for their DT journey. One of the significant challenges was unreliable access to consumption data. NortHeat was ambitious to create a digital service that offers consumers *fast* and *frequent* consumption data; thus, they installed smart meters in 110.000 households. The old flow-based system did not support the new task of providing consumers with a frequent and detailed consumption overview. The new smart meters could provide each household's heating data hourly; thus, it was essential to ensure that data flow is constant and seamless to the consumer:

Our largest challenge, almost from day one, is the delay in the data. Sometimes it's two days, and it's funny because that's fast compared to what we are used to, but the consumer, for instance, is used to looking things up on Facebook and not having to wait days before it gets into the app. (Head of Energy Supply, NortHeat)

The Head of Energy Supply at NortHeat describes this optimization challenge as an issue of consumers' expectations towards what is *immediate* consumption. He believes that consumers' expectations are formed by using other digital technologies, not their current heating practices. Therefore, the organization sought to make a robust digital infrastructure without delay in data. As a result, the two organizations – Joules A/S and NortHeat – had a workshop in which they jointly solved this optimization problem:

We make linear smoothing of data and other calculations before sending data to Joules. Our role is to make sure that Joules receives quality data that fits with their neural network, which makes "the budget." (IT Project Manager, NortHeat)

After the workshop, the two organizations designed a solution that accommodated the needs of both organizations. When receiving smart meter data from the third-party data supplier, NortHeat processed the received data to accommodate the digital infrastructure at Joules A/S. Thus, NortHeat ensured the best possible consumer experience with the Green Assistant. This optimization issue is currently partially resolved. The delays in data are still occurring; however, these occurrences are less frequent and less perceivable by the consumers. Furthermore, as described by the R&D Section Manager, the goal of this DT journey is a complete automatization of energy flow in a household:

We have a saying at our parent organization – "We create energy to live life." This sound fluffy, but we want to help people so that it becomes easy to live their lives. We want to take care of everything else and try to make it as green as possible – complete automation of the energy flow in the home. (R&D Section Manager, Joules A/S)

The ambition to automate the energy flow in the home presents an insight into how Joules A/S perceives sustainability and the consumers' role in the sustainability movement. Sustainability is viewed as an automated and reduced energy flow in a household. Thus, from the optimization process view, the part of a consumer becomes passive – they should be able to live their lives while the optimized infrastructure supports their everyday practices. This view is shared by Finn, a construction engineer:

It would be way more convenient to buy something that could be more efficient, and then you wouldn't have to think about it again for some time. (Finn, Interview 1)

Finn prefers not to frequently interact with his energy system, which endorses Joules A/S's ambition to create a "complete automation of the energy flow in a home." During the optimization process, the two organizations navigated through consumers' expectations of digital services and the limitations of the digital infrastructure.

4.2 The eco-feedback process view

The eco-feedback process view on DT towards sustainability promotes behavioral change through consumer data; sustainability is viewed as actionable information enabling energy-conservation behavior. The eco-feedback process view is predominant when NortHeat and Joules A/S are working on solving a need to increase the consumers' energy literacy about heat and sustainability. One of the significant challenges from

this process view is communicating consumption in an understandable and actionable way. This challenge is particularly evident in how to communicate *sustainable* consumption. Initially, the consumption was provided through a budget. However, providing the monetary value of the consumption does not necessarily promote conservation behavior – the assumption is that if the energy is cheap, people will use it. A proposed solution was to communicate the CO_2 emissions of a household. However, this solution is limited by the consumers' (lack of) knowledge about the CO_2 emissions:

*CO_2 is difficult to understand. A hundred grams CO_2, how much is it? We see our task to explain consumption differently. We can tell you how green you are. But how do we define "green"? One way is to show a percentage in reduction. This is at least something we hear a lot about and something that could be more intuitive for consumers. (*R&D Section Manager, Joules A/S)

Joules A/S found that the CO_2 emissions are not *intuitive* for the consumers and are challenging to understand and act upon. This solution is not feasible from the eco-feedback process view, which emphasizes the *actionability* of the information. Therefore, Joules A/S, in collaboration with NortHeat, is currently working on solving this energy-literacy issue. In heating, one of the eco-feedback issues is teaching the consumers what good and sustainable heating consumption is. Joules A/S and NortHeat work iteratively on finding a design that provides enough information so that the consumer understands the nuances of heating consumption and can act on it:

First, we did some reasonably complex mock-ups and ran a demo for NortHeat. And we were told that "It may be too complex, they [consumers] cannot understand it," - so we took a few iterations where we cut it to simplify it. (CEO, Joules A/S)

As exemplified in the quote by the CEO of Joules A/S, providing enough information without increasing the complexity of the Green Assistant is a tricky balance to find. In navigating this issue, Joules A/S relies on NortHeat's understanding of the heating domain and its consumers. Both organizations are collaborating on designing a solution that balances the need for simplicity and detail. That being said, this issue does not only belong to the heating domain - balancing simple and detailed eco-feedback is an issue within all areas of energy and resources (water and electricity):

We swing a lot between different extremes when we design this app; it should be as simple as possible, but […] if we have any relevant information, we should not hide it. (Pod Owner, Joules A/S)

As described by the Pod Owner from Joules A/S, identifying the balance between simplicity and detail is an iterative process, which requires reflection from the designers and developers. The reflection regards identifying what is *relevant* information and how it could be presented without increasing the complexity. However, the interface of an application can also become too simple. For example, Svend became frustrated while using the Green Assistant because he could not get the information the way he was used to:

I don't understand why they've chosen to show consumption as money spent. Down on my meter, it's written in m^3 and temperature, but there's no simple way to show that

in Green Assistant unless you, of course, download the raw data, but then I might as well read [the meter] myself. (Svend, Interview 2)

Svend is a knowledgeable consumer who was already frequently interacting with his energy system. Svend argues that presenting the consumption as money spent did not necessarily represent *actual* consumption. His understanding of relevant information is firmly rooted in his previous experience with his heating system – going down to his cellar to read his meter, which provided the consumption information in m^3 and inflow temperature. Svend's assessment of the application illustrates how difficult it can be to balance the needs of consumers with varying levels of knowledge.

In the eco-feedback process, the two organizations navigated the delicate balance between the consumers' knowledge about sustainability and what is perceived as relevant information by the consumer.

4.3 The reflection process

The reflection process view on DT towards sustainability promotes challenging the status quo through design towards deliberate practices. In our case, *deliberate* practices imply a greater consciousness about energy production and consumption. The status quo to be disrupted is how consumers understand energy consumption and their role in energy production, consumption, and trading. The reflection process view is predominant when Joules A/S presents its vision for the future of electricity in Denmark:

The next thing we look at is energy communities; if a household has too much electricity, then it should be able to sell it to its neighbor. Why should we not be able to make use of surplus energy and sell it at better prices while alleviating the electricity grid? Something should be done about that, and we view it as our future mission. (R&D Section Manager, Joules A/S)

As described by the R&D Section Manager from Joules A/S, the ultimate goal of this DT journey is to disrupt the energy system. They view the disruption as democratizing energy trading and deliberate peer-to-peer trading, enabling a stronger energy community. Joules A/S views its role as a mediator promoting and supporting the energy community. However, NortHeat does not have the same ambition:

We do not have an exaggerated expectation that consumers will have to sit daily and trade energy. The energy flow must run automatically, but consumers must be involved somehow. (Supply Manager, NortHeat)

As described by the Supply Manager at NortHeat, they view the end goal of this DT journey as a full automatization and an increased involvement of the consumers. This difference in the end goal may be due to differences in the resources the organizations produce. For example, Joules A/S is a daughter company of a larger electricity concern in Denmark, and electricity is one of the resources consumers can produce themselves. NortHeat is, however, among other things, a heat provider. Unfortunately, heat is a resource that is difficult to make and trade peer-to-peer.

Furthermore, from the reflection process view, consumer involvement implies changes in practices towards more deliberate energy consumption through the Green Assistant. Anne is an illustrative example of how an application can change consumers' practices:

You bet it has worked […]! It's almost a game for us, you know, getting to the next level by using less than the day before […]. [When] it was a bit cold in the morning, I thought "no" to myself. Because I can read the heat consumption, I choose to put on one more sweater instead of turning up the heat. (Anne, Interview 1)

Anne explains that her heating practices were changed due to the Green Assistant, e.g., putting on a sweater instead of turning up the heat, thus, enabling a more deliberate energy conservation practice.

With this process view, we illustrate how two organizations can have different aspirations for the DT journey while collaborating. In the reflection process, the two organizations navigated by accepting different end-goals of the journey.

4.4 The participation process view

The participation process view on DT towards sustainability promotes achieving change through increasing people's engagement. This process view is predominant in how NortHeat and Green Assistant's A/S view the consumers' role in the sustainability movement. In the sustainable transition of district heating, consumer engagement is vital because energy use and energy production are mutually dependent – a utility company must supply energy that meets the consumers' demand. Therefore, they are not just passive stakeholders but critical actors that can further or hinder this sustainability transition:

The system is as strong as its' weakest link. […] Consumers must be a part of this transition, but that is a difficult task. For the past ten years […], we have looked into it and found that there's almost nothing as uninteresting for people as energy use in their houses. […] So, our task is to get consumers more engaged. (Supply Manager, NortHeat)

The Supply Manager sees the consumers as the *weakest link* in this sustainable transition. NortHeat's decade-long experience has shown that consumers are not interested in their heat consumption, and increasing engagement is not an easy task. Therefore, in distributing the Green Assistant, NortHeat is trying to increase the consumer's interest. Both NortHeat and Joules A/S see this task as one of the shared goals of this DT journey:

Our goal is to engage our customers and help them become more sustainable. But more importantly, to make it easy for them to do and be green. (R&D Section Manager, Joules A/S)

The R&D Section Manager at Joules A/S emphasizes the need to engage the consumers to act sustainably and "more importantly" make it *easy* to do and be sustainable. This emphasis on easiness demonstrates that Joules A/S does not view engagement as *activism*, which might imply radical and ongoing action for change. Instead, Joules A/S

views engagement as a long-term commitment to sustainable living by investing in automation (e.g., smart thermostats or smart power outlets). This view is based on the assumption that consumers, on average, are not willing to engage with their energy system often and deliberately. For example, Erik, a taxi driver, used the application to engage more with his heating system from a more informed position:

Yeah, it's nifty because I usually can see […]whether we're good or bad that day and if we need to improve. If it's red, I probably have to turn down the thermostats or something. Before, you didn't really have a clue. (Erik, Interview 1)

Another way Joules A/S and NortHeat have engaged the consumers in this DT journey is by viewing them as co-creators. For example, NortHeat has a focus group of consumers commenting on interface design in the Green Assistant. Furthermore, NortHeat and Joules A/S use customer support to gain consumer feedback on their experience with the application for future application iterations.

The participation process view presents a new insight into consumers' role in navigating this DT journey. The consumer is essential in this journey in two ways. Firstly, the consumer's engagement in DT is vital because energy use directly influences how energy is produced. Secondly, the consumers are value co-creators by helping identify new ways of improving the application.

5 Discussion

There is no clear path that helps organizations navigate sustainable development because "there are no right or wrong answers, only answers that are better or worse from different points of view" [11, p. 45]. Thus, a DT process towards sustainability can unfold in a multiplicity [33] of ways (see Table 1), which increases the process's complexity. We theorize that this process consists of at least four process views: optimization, eco-feedback, reflection, and participation. In illustrating our theory through a longitudinal case study, we found that the DT towards sustainability is a process that can non-sequentially encompass all four process views. In the relevant literature, process views can be perceived as mutually exclusive. For example, the eco-feedback process view is criticized for viewing people as rational and autonomous. The critique is that designers and software developers fail to recognize that human consumption "is shaped by infrastructures, technologies, and institutions" [17, p. 2136]. However, our process theory of four views on DT suggests that all four process views can be present in a DT process without being mutually exclusive – a single journey can have multiple paths toward the desired outcome. Based on our illustrative case study, we present three propositions on what the process of navigating a DT journey implies:

Involvement of multiple stakeholders that reciprocate each other's process views: In our case of DT towards sustainability, the organizations pooled their resources and capabilities into a solution meeting the needs of both organizations and the consumers. For example, NortHeat processed the received data to accommodate the digital infrastructure at Joules A/S. This finding supports previous research stating that the DT

process goes beyond the collaborative efforts of a single team, a single organization, or a single project process [38]. Developing software for DT requires involving customers in becoming value co-creators [39, 40] and establishing strategic partnerships with external organizations [41]. To successfully navigate a DT journey, the partnering organizations must collaboratively move towards a shared vision [42]. In the case we studied, this collaboration implied the different stakeholders reciprocated each other's process views. For instance, Joules A/S and NortHeat view consumer engagement as a long-term commitment to sustainable living by actively investing in automation and participation, which is also evident in their effort to increase the consumers' energy literacy about heat and sustainability through eco-feedback.

Responding to turbulence in the environment while encompassing multiple process views: In navigating the DT towards sustainability, the two organizations had to deal with turbulence in the environment. Turbulence is the condition of "unpredictability in the environment because of rapid changes in customer needs, emerging technologies, and competitive actions" [43, p. 444] — for example, the consumers' expectations towards what is *immediate* heating consumption. The two organizations recognized that consumers' expectations were formed by using other digital technologies, and their digital infrastructure needed further development to solve this problem. Thus, our case study corroborates the previous research that responding to turbulence or changes in the environment is a vital organizational capability in a DT process [44]. However, we add that successfully responding to the turbulence in the environment encompasses multiple process views. For example, while responding to the consumers' expectations, the organizations simultaneously (i) accommodated what consumers view as immediate eco-feedback, (ii) sought to increase (and accommodate) the consumers' energy literacy, (iii) supported (and challenged) consumers energy practices, and (iv) involve the consumers as co-creators or value. Thus, in terms of process multiplicity theory [33], responding to the turbulence in the environment can open the space of possible paths to follow, which helps in discovering paths not yet taken.

Reassessing the past process with different views to adjust the plan of action: We found that navigating DT is not a simple sequential process; it is an ongoing reassessment of past process views to adjust the course for the future. For instance, the Green Assistant provided consumption through monetary value, which did not further the overall goal of the two organizations to engage the consumers to act sustainably – navigating in the 'wrong' direction. The two organizations had to reassess the decisions made in the past to identify a new way of providing consumption information in a manner that promotes sustainable behavior. A single decision is not self-contained; it changes over time and has consequences for future work. Our third proposition thus corroborates the process multiplicity theory [33] that the past carries the potential for what can happen in the future [33, 45].

Our findings are helpful for practitioners in two ways. Firstly, organizations should be aware that there are multiple process views. This awareness can contribute to developing more multifaceted software that addresses more than one problem. Secondly, when

collaborating with other stakeholders on developing software for the DT, simply being aware of other processes' views is not enough. To successfully navigate the DT process, the organizations must i) reciprocate each other process views, ii) respond to the turbulence with a multiplicity of process views, and iii) reflectively reassess the past to improve and plan for the future.

Our process theory has limitations that invite future work. The first limitation is regarding the small scale and scope of our inquiry. For example, we examined two organizations in Denmark's district heating context and how they collaborate in navigating their DT journey. Therefore, exploring whether our findings are scalable and transferable to other DT journeys, e.g., waste sorting [46] or the transport sector [47] would be interesting. The second limitation is the focus on problems and solutions – there might be another way of differentiating the paths in the DT process. For example, a literature review [48] distinguishes the processes in DT by identifying the *advantages* and *disadvantages*. We, however, did not find any of the process views superior to the others.

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