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Enabling digital transformation: Organizational implementation of the internet of things

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ABSTRACT

With the steady increase in connectivity and the development of new dynamic, interconnected, and distributed technologies, management teams are seeing opportunities to digitally transform organizational processes. Following a case of Internet of Things (IoT) implementation, the aim of this paper is to explore the transformational potential of IoT and the mechanisms and processes that support or constrain IoT-enabled digital transformation in practice. Through a qualitative case study of an IoT implementation project over a period of two years, we show that IoT can create an opportunity for digital transformation by fundamentally changing organizational and individual perception of work identity and work practices. Furthermore, we show that successful IoT adoption requires proactive leadership that identifies and accounts for both technological capabilities and different stakeholder perspectives. To make use of IoT's capabilities and simultaneously mitigate the risk of privacy infringements one must leverage the role of the observer and the observed.

1. Introduction

Digital technology has significantly impacted multiple aspects of organizational life [1]. For instance, it has transformed work practices [2,3], enhanced value creation [4,5], fostered collaboration in platform ecosystems [6], spurred innovation [7], and enabled the development of new digital business strategy [8]. Over time, workplace technology has evolved from enterprise mainframes and desktop systems to mobile and cloud-based solutions, embedded devices, and big data analytics [8]. These digital artifacts are characterized by their dynamic, interconnected, and distributed nature [9]. Today, they are often referred to by the acronym SMACIT technology (social, mobile, analytics, cloud, and Internet of Things (IoT) [10], designed to be flexible, adaptable, scalable, and modifiable, robust, and secure, enabling organizations to adopt and develop agile strategies continuously [11,12].

SMACIT technologies have been identified as key enablers of digital transformation (DT), a process in which digital technology disruptions traditional practices, prompting organizations to adjust their value creation strategies while managing structural changes and organizational challenges [13]. Research within this field has explored the competitive performance gains of big data [14], the coexistence of workers and workplace Artificial Intelligence (AI) [15], the use of blockchain and IoT technology for business process management [16], and the impact on enterprise green innovation [17].

One of the most highly acclaimed SMACIT technologies is the IoT, a network of connected devices embedded with sensors and actuators to seamlessly collect, transmit, and analyze context-aware data [18,19]. The number of connected IoT devices is expected to nearly double in the coming years, from 15.1 billion today to 29.4 billion in 2030 [20], with a projected market value growth from $662.21 billion in 2023 to $3352.97 billion by 2030 [21]. IoT has been recognized as transformative force across virtually all industries [18,22], including transportation [23], health care [24], energy [25], manufacturing [26], and tourism [27]. The vast potential of IoT lies foremost in its ability to remotely monitor, control, automate, and optimize both products and processes, as well as in its capacity to uncover patterns and gauge trends based on the analysis of collected data [28–31].

Recently there has been much interest in IoT and its potential for enabling digital transformation. However, there is a dearth of empirical research exploring the organizational implications of IoT-adoption, the mechanisms and activities that lead to change in practice [1,32], and the effects on different stakeholders and organizational culture [19,33,34]. As organizations strive to make sense of and capitalize on the transformational potential of new technology, many still struggle to move beyond initial conceptualizations of what technology can do to form a deeper understanding of what digital transformation entails: where will

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change occur, what is the nature of the change, and how does change come about? Indeed, when it comes to transformational technology in general, and IoT in particular, there is a need for more empirical studies that focus on the actors, actions, and technological capabilities that drive change [11,19,32,35–37].

In this paper, we follow an IoT-implementation project over two years, studying both technological development and the organizational transformation it enabled and asking the question, "What is the transformational potential of IoT and how is IoT-enabled DT supported or constrained in practice?" We thereby answer the call to "bring clarity to the conceptual complexity and ambiguity that makes it difficult to make sense of the true opportunities created by IoT technologies" ([32] p. 574) and contribute to the discussion on DT as a process by providing empirically grounded insights into this emerging technological paradigm. Our results show that IoT can create an opportunity for digital transformation by fundamentally changing organizational and individual perception of work identity and work practices. Furthermore, successful IoT adoption requires proactive leadership that identifies and accounts for both technological capabilities and different stakeholder perspectives. In addition, to make use of IoT's data-driven capabilities and at the same time mitigate the risk of privacy infringements, one must leverage visibility through understanding the role of the observer and the observed.

The paper proceeds as follows: First, we outline previous research regarding DT and IoT. Next, we present our research methodology and describe the case study. Following the qualitative approach, our results and findings are presented as a narrative in a chronological order. We then end with a discussion of the findings, the implications of these for both research and practice, and concluding remarks.

2. Organizational digital transformation

Rapid technological evolution, increased connectivity, and extensive service innovation have compelled many management teams to prioritize DT as a central strategic concern for their organizations [13]. The concept of information technology (IT)-enabled organizational change has long been a cornerstone of the information systems discipline [38, 39], with scholars demonstrating, for example, how IT can (re)-reshape business operations [40], instigate changes in business models [41], and foster new forms of collaboration, such as company-sponsored value co-creation [42] and platform ecosystems [6]. Furthermore, IT has been a catalyst for inspiring endeavors in service innovation efforts [43], and enabled new ways of organizational strategizing [44]. Nevertheless, the speed, scale, and scope of DT processes widely surpass previous examples of organizational IT use [13]. Consequently, DT is therefore most aptly described as an evolution of previous conceptualizations capturing situations where digital technology is fundamentally changing an organization's value proposition and identity, rather than merely supporting or enhancing them [45].

To study DT processes within organizations, one must closely follow the actions and agents driving transformation and pay close attention to the digital artifact and its affordances and constraints [46]. In essence, one needs to understand **what** are the technological capabilities that create conditions for DT, **why** do firms embrace DT, **who** is involved in and affected by the DT process, and **how** does one create conditions for DT success (see Table 1)?

What are the technological capabilities that a specific digital technology carries and that create conditions for DT? This is a starting question for any firm looking to transform their business through technology [47]. DT is often viewed as an all-encompassing process affecting the entire organization, potentially reshaping internal operations, value propositions, culture, and relationships with external stakeholders [49]. Before embarking on a DT journey, it is recommended that firms create an understanding of the digital artifacts that are expected to enable organizational transformation [33,46]. Today's digital artifacts are rapidly evolving and characterized by their dynamic, interconnected, and distributed nature [9]. The ever-changing nature of technology puts added pressure on managers to identify the **what**, i.e., a certain technology's defining characteristics, and match them with organizational needs [11,12].

Table 1
Studying organizational digital transformation.

ASKING	EXPLORING	EXAMPLE REFERENCES
What?	What are the technological capabilities that create conditions for DT and how can they be conceptualized?	[11,13,33,45–47]
Why?	What is the motivation for DT, the perceived benefits of digital technology, and the potential for structural change and value gain?	[13,32,36,45,47]
Who?	Who are the actors and stakeholders that are involved in and affected by DT and what is their space for action?	[34,48–51]
How?	How are organizational conditions for successful DT created?	[52–58]

Unraveling the **why** behind firms embarking on a DT journey demands insights into the firm's strategic management and their envisioned outcomes from adopting new technology [36]. The impetus for change, whether it pertains to transforming the customer experience, specific operational processes, or the entire business model along with the envisioned value propositions, unveils the perceived benefits of incorporating digital technology. A digital strategy should capture and encompass these dimensions alongside the potential for structural changes and financial gains [47]. Thus, delving into the **why** establishes DT as a socio-cultural process comprising both technology and strategy.

Investigating **who** is involved in DT entails identifying diverse actors and stakeholders, both internal and external, and the space within which they operate [48,51]. Previous conceptualizations of agency posit that agency is distributed within structures created by the actors [59], suggesting that collecting inputs from various actors generates momentum that can enable and constrain action. A focus on the **who** thus brings a focus on transformational actions and demonstrates how DT affects different stakeholders, and vice versa, how stakeholders help shape the DT process.

Understanding **how** firms establish conditions for successful DT encompasses a deeper examination of **how** DT is enacted in practice, both on a strategic level and from the perspective of individual actors and group actors. Research has indicated that leveraging new technology is essential, but insufficient for becoming a digital organization; fostering cultural characteristics that encourage openness, learning, collaboration, and flexibility is equally critical [52–54]. The establishment of a data-driven culture has been described as one of the foremost challenges in achieving organizational DT [60] and one of the potential key barriers to digital effectiveness [61], making it a significant concern for DT leaders [62,63]. Cultivating this digital mindset [64] involves embracing opportunities afforded by new and emerging technology and shedding preconceived notions about the technology's capabilities (Iansithi & Lakhani, 2014; [56]). Previous research shows that DT requires effective digital leadership with decision-making authority and characteristics that drive transformation success, such as a manager having an eye for structure and an understanding of data-driven value creation while simultaneously promoting agility and openness [52,57, 58].

By identifying "technology and actor as the two aggregate dimensions of digital transformation" ([33], p. 233), and tracing the **what, why, who**, and **how** of DT, we can empirically study human engagement with technology and uncover the actors, actions, and technological capabilities driving transformation [11,19,32].

2.1. Transformational technology

In today's rapidly evolving digital landscape, the essence of successful organizational adaptation lies in embracing emerging digital technologies. Social media, mobile applications, big data analytics, AI, cloud computing, and IoT are all examples of digital technologies that represent a dynamic and interconnected ecosystem with the potential for profound digital disruption [1,10–12]. Despite the recognition among managers that digital transformation is essential for organizational survival and growth, many struggle to fully prepare for a digital future. This challenge stems from a lack of understanding regarding the capabilities of specific digital technologies and an insufficient grasp of the transformative potential of these technologies across different businesses and industries [61,65,66]. This knowledge gap presents an opportunity for in-depth research into specific digital technologies and the DT process [11].

Among these transformative technologies, IoT is a pivotal force capable of reshaping business processes and value propositions [18,67,68]. IoT leverages the connection of cyber-physical systems to the Internet, enabling the collection of context-aware data autonomously and on a massive scale, surpassing human processing capabilities [30,31,69,70]. Previous research has shown how IoT has been a driver for the creation of smart services based on real-time data collection [71]; enabled healthcare innovation by smart systems monitoring and tracking patients' health [72]; and improved energy efficiency through smart grids, hence reducing environmental impact of the energy use [25]. IoT has also improved transportation by embedded sensors-based systems that enable route optimization, alert drivers of available parking spots, optimize the use of street lights, report accidents and road anomalies, and manage traffic flows [73]. These have been critical in the creation of smart cities and smart public services, for example by increasing contextual awareness and enabling data-driven value creation [74,75]. As such, IoT is relevant for all sectors and industries and is projected to have a significant and positive impact on all levels of society. Current use of the word "smart" in conjunction with almost anything, almost always implies the presence of IoT (e.g., smart homes, smart cars, smart health, smart manufacturing, smart farming).

Although there is extensive research on the positive impact of IoT, it is crucial to acknowledge the studies that discuss potential risks associated with its adoption. Brous et al. [76] emphasize the risk of sensor failure or inconsistencies, which can lead to poor data quality, reduced trust in the system, and harm an organization's reputation. Thus, the authors emphasize the importance of considering technology adoption and its potential social impact. Furthermore, the adoption of IoT introduces various security and privacy concerns due to increased connectivity, making organizations vulnerable to data leakage and hacker attacks [77]. IoT data markets, crucial for many smart services, face significant challenges concerning data anonymization and secure computation [78]. In addition, IoT's ability to generate data that reveals previously invisible organizational patterns and processes can lead to increased monitoring and control, that may escalate and increase the risk of unethical use of data. For example, it has been shown that increased behavioral visibility of workers may prompt other actions, such as acts of avoidance or of resistance [79–81]. The increasing adoption of IoT technology should, therefore, also include a growing awareness of ethical concerns [82] as well as security and privacy aspects [83].

In summary, IoT implementation is expected to significantly impact both the public and private sectors [32,68,77]. Despite IoT's recurring mention as a crucial enabler of DT, the existing literature reveals a significant gap in empirical research. There is a great deal of research on IoT's potential advantages, as well as a few studies highlighting potential risks with IoT adoption. Nevertheless, there is a notable absence of empirical research that delves into the transformational capabilities of specific technologies [61,66], analyzes the mechanisms and processes that support and constrain IoT-enabled DT in practice [32], and captures how different stakeholders react to, and interact with, IoT in a workplace setting [37,60,84].

3. Method

This case study uses a qualitative, process-oriented approach [85] to examine the mechanisms and processes that enable or constrain IoT-driven change in practice. Process studies emphasize understanding organizational phenomena as they unfold over time and allow us to study the actions and reactions of stakeholders participating in a DT project. Rather than focusing on outcome or end states, process research is more concerned with the **how** and **why** questions – how events evolve and why certain patterns emerge. Thus, this approach enabled us to explore the reasons behind the emergence, development, growth, and conclusion of important events and patterns within the project. Moreover, the temporal nature of our study was essential for understanding these dynamics and identifying the key stakeholders at different stages in the process [86].

3.1. The digital transformation project – "Roomie"

The study was conducted in a northern Swedish municipality with approximately 130,000 residents. Driven by a "digital-first" initiative, the local government embarked on a digital transformation journey in 2018, touching all facets of municipal life – from connected elderly care to smart facility maintenance. Our study's focal point was a project aimed at digitally transforming the custodial management of public buildings through an IoT solution. The municipal buildings, including schools, nursing homes, health centers, and culture and recreation facilities, amount to a total of 1 million square meters of space that needs to be cleaned on a regular basis. The system, "Roomie," its associated mobile application, and the LoRa network on which it operated were built and set up by a third-party developer (henceforth called SysDev). The municipality would own the system and its resultant data, whereas SysDev would retain the intellectual property rights of the software. This arrangement ensured municipal control over the generated data, while also permitting SysDev to refine the software further and potentially market it elsewhere. The pilot for Roomie was rolled out and tested in a municipality townhouse, a building with approximately 500 different rooms, housing around 1100 employees. In the pilot project, 30 of those rooms were equipped with sensors and connected to the Roomie system.

Roomie, in its initial installment, was powered by 50 sensors that continuously relayed the statuses of the rooms they monitored. Strategically placed in offices, meeting rooms, corridors, and restrooms, the sensors tracked room entries and exits, air quality, and occupancy. By collecting data on room usage, the sensors could determine cleaning needs. Cleaners could view the sensor data in real-time through a graphical user interface, which listed rooms by their maintenance needs from most urgent (marked with a red circle) to least urgent (marked with a green circle). This dynamic list was continuously updated as sensors detected room activities throughout the day. The goal was to prompt cleaners based on real-time needs, departing from their traditional schedule-based tasks. Initially, this data was accessible via a website on a tablet attached to cleaning carts. As the project advanced, it evolved into a downloadable mobile application compatible with tablets and personal smartphones. Our study followed the Roomie project and its stakeholders for two years, during which the IoT solution was developed, implemented, tested, and evaluated in several cycles.

3.2. Data collection

We used two methods to collect our data for this study: interviews and observations. The semi-structured interviews [87] integrated pre-determined key questions and the flexibility to dive into emerging topics during the discussions. The questions centered on digital transformations **what, why, who**, and **how** of digital transformation. Specifically, we aimed to delve into the actors, actions, and technology, emphasizing the stakeholders' expectations, experience, and reactions to the Roomie system. The interviews were conducted individually, each lasting 45 to 50 min on average. We carried out a total of 18 interviews. All interviews took place at the participants' workplace, were audio-recorded and subsequently transcribed. Participants were anonymized and identified solely by their respective roles to maintain confidentiality. We informed participants about this anonymization process to encourage candid responses, emphasizing the voluntary nature of their participation in our study.

Besides the interview, the second author spearheaded the data collection and spent significant time on-site observing the IoT system directly and participating in stakeholder meetings. In addition to the formal interview, several informal, non-recorded conversations were conducted during observations. These casual interactions further enriched our understanding of stakeholders' viewpoints and perceptions and provided supplementary data [88]. In Table 2, we list the number of interviews performed, the stage of the project, and the average interview time.

3.3. Data analysis

Fig. 1 depicts the chronological progression of the project, highlighting key events. The timeline is organized into columns, each representing a six-month period. These columns are further divided into quarterlies from top to bottom, illustrating the project's progression from commencement to conclusion.

Adopting a grounded theory approach [89], our data underwent an iterative four-stage analysis. First, all transcribed interviews underwent initial coding. A total of 132 unique codes emerged from this process. Alongside each code, a time stamp connected it to a specific project phase (see Fig. 1), and we associated each with the role of the interviewees. For instance, codes such as "big data" and "agile work" were singular in occurrence, whereas "changing work" and "uncertainty" frequently surfaced.

Second, we ordered the 132 initial codes by their frequency of appearance, fostering focused coding. Through this, we discerned patterns of co-occurring codes. For example, the code "stress" that was recorded 14 times often appeared with "increased workload" and "negative impact." Consequently, these were regarded as a property of the "stress" code. We further nuanced our understanding by examining the empirical data through diverse stakeholder lenses. This process cumulated condensation of the second-order coding into 24 codes.

Third, on thorough discussion, the 24 codes coalesced into four pivotal themes. These themes encompassed the narrative of the IoT-enabled DT process over time, from both the organizational and the individual worker perspectives. In particular, they highlight conceptualizations of IoT, DT process mechanisms, and the potential for current and future transformation brought about by the system implementation (see Table 3).

Last, after identifying the emergent themes from our data, we engaged in continuous dialogue with existing related research to further refine and validate our findings [89]. This iterative process allowed us to juxtapose our empirical grounded insights with extant knowledge, facilitating a richer and more nuanced understanding. By revisiting related research, we could discern patterns and make connections that might not have been initially evident. This grounded our findings in the broader academic discourse and ensured that our interpretations were both novel and resonant with established knowledge.

4. IoT-enabled digital transformation

In this section, we present the results of our study. Building our narrative around the process timeline of the Roomie project, we account for the different stakeholders' conceptualizations of – and experiences with – IoT in an organizational setting. Additionally, we trace the potential for IoT-enabled transformation as the project progressed and the hopes for the future, as it eventually came to an end.

4.1. Initializing the roomie project

The primary driver for the Roomie project was the project manager (PM), who was a municipal business developer tasked with leading municipal digitalizing efforts. With this project, the PM saw the opportunity to transform municipal facility management, using IoT to optimize operations and improve both service and working conditions. Roomie was characterized as a digital transformation project and considered both a technical and organizational implementation that was expected to fundamentally change the way the cleaners worked in terms of their day-to-day activities.

> *[…] They [the cleaners] are completely analogue – they have a system to report problems, but in their daily work they do not have anything. So, this [project] is a digitalization of a previously undigitized operation. I think that is nifty. (PM, Initiation)*

SysDev, an external project partner, handled the technological development. They created Roomie, the IoT framework to which the sensors were connected. Additionally, they developed the application where system information was displayed and the graphical interface for that application. In contrast to the municipal stakeholders, SysDev saw the project as a product development initiative, in which the economic incentive was more heavily in focus. They planned on using the results from the project to determine if they would move toward making this into a commercial product. They thus had a future vision of IoT leading to both technical and business expansion from the very start.

The new system enabled data-driven condition monitoring of rooms, essentially supporting a shift from scheduled-based cleaning to need-based cleaning. The basic idea was that Roomie would use sensor data to make visible room utilization and based on that information, determine the need for cleaning. The ordinary cleaning work practice followed a pre-determined schedule, moving around the buildings in a set route, and cleaning areas at regular intervals, whether necessary or not. Roomie would provide real-time information about room availability and room condition, as well as provide estimates of how much time would be needed to clean a certain area. This was expected to help cleaners make informed decisions and prioritizations, save time, and decrease stress by optimizing cleaners' movements through buildings, and improve the quality of the cleaning services by attending to areas with the greatest need of maintenance first. The PM reasoned that the introduction of IoT could raise the status of general maintenance work, which was at the time considered as being mainly low-tech and low-skilled labor. Furthermore, they hoped to transform the actual process of cleaning, experimenting with sensors and parameters to achieve a

Table 2
Number of interviews with participants throughout the Roomie project.

PROJECT PHASE	INTERVIEWS						
	Project Manager	District Managers	Team Leader	Cleaners	SysDev	Total #	Minutes per interview
Initiation	1	2	1	1	0	5	60
Implementation (early stage)	1	1	1	2	2	7	45
Implementation (late stage)	1	0	0	2	0	3	60
Evaluation	1	1	1	0	0	3	45
Total	4	4	3	5	2	18	

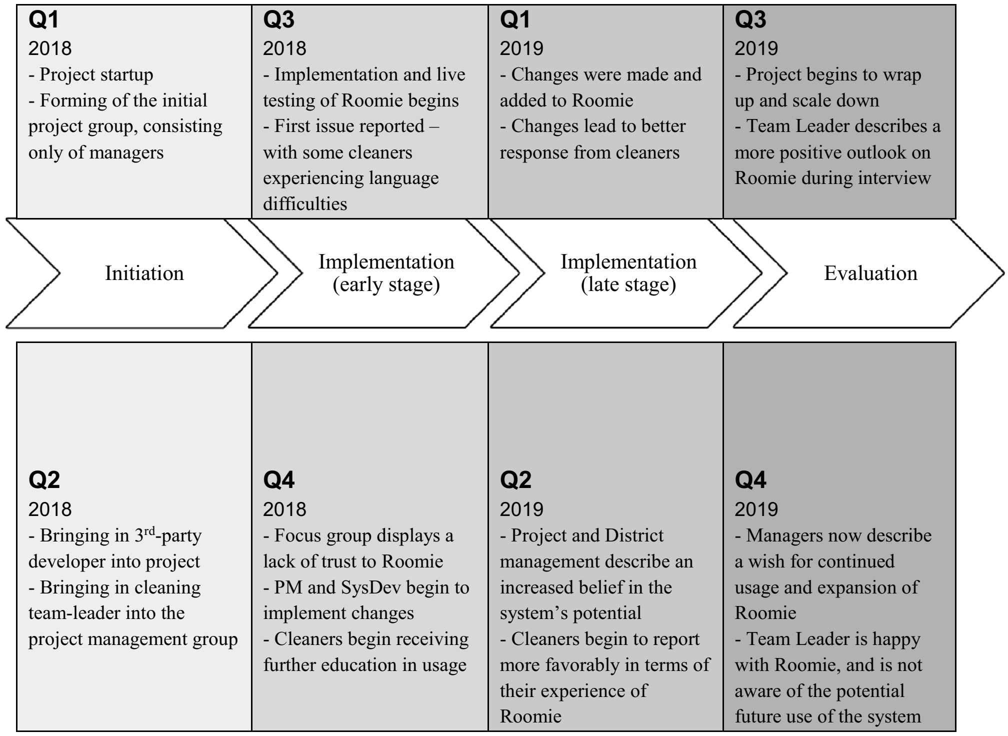

Fig. 1. Timeline detailing noteworthy events throughout the Roomie project.

Table 3
Themes encompassed the narrative of the IoT-enabled DT process over time from both management and worker perspectives.

Themes	TRANSFORMATION NARRATIVE	
	Organizational level	**Worker level**
Conceptualizations of IoT	Improving efficiency Optimization Effectivization Technical implementation Organizational implementation Increased monitoring and control	Decreasing stress Saving time Improved effectiveness Decision support Changing work practices An application to be used as a tool for work
Creating conditions for IoT adoption and DT	Symbolic value of technology Becoming data driven Creating a digital mindset	Openness toward technology Learning by doing Education
Potential for transformation	Transforming organizational identity: Cleaning as part of the organization, transforming work practices and profession status	Transforming own identity: Cleaning as part of self, transforming professional identity and sense of self
Future vision	Technical expansion Expanding scope of business	Technical improvements Functional improvements

desired result.

> *[…] We have not made a business case saying: 'The goal is to make this much money', it is pretty hard to do something like that. But [rather] first and foremost, 'Can we clean this way at all?', and if we cannot clean this way, is it a problem with the technology – do we need to measure something else? (PM, Initiation)*

The PM contacted two facility management district managers (DM) that each oversaw day-to-day operations within their own cleaning districts. Although the DMs described themselves as not at all familiar with DT projects, they both had an expressed interest in IoT systems and were excited by the prospect of having a tool to manage their employees better and monitor their work more efficiently. Both DMs had several different cleaning crews reporting to them, but for the Roomie project, it was decided that one specific building, the municipal townhouse, and its group of cleaners were going to act as test site and crew. By limiting the cleaning area and the number of persons involved, the PM would be able to closely monitor the progress and have direct access to the thoughts and experiences of the Roomie cleaning crew. The DMs were aware of similar types of systems used in other settings and were overtly positive to the project. They saw Roomie as a chance to experiment with incorporating technology into work practices without having to allocate funds from their own budget. In addition, they thought it could be an opportunity to envision future system integration into other parts of their organization. When asked about their own expectations and hopes for the project, the DM responsible for the Roomie cleaning crew stated that:

> *"I am thinking, a bit, that this can sort of increase the status of the profession, when there is some technology being introduced and that you are working in a different way – that it becomes a bit more interesting. So, I hope, well… That facility maintenance becomes a bit more interesting profession, basically." (DM 1, Initiation)*

The stakeholders whose work was the most affected by the new technology were the cleaning crew of nine cleaners and their team leader (TL). Coming from various backgrounds, many with very low digital maturity, this group initially expressed some general skepticism toward Roomie. They were not used to anyone investing time and money in their work or being interested in their opinions. As such, they were not fully convinced that the system was being implemented for their benefit and questioned whether there was an ulterior motive behind the project:

> *There has got to be something more to this than just 'making our work easier', because I mean – we are always the last ones in everything when it comes to… when it comes to planning and everything. So there must be something else in the background for this [system implementation], but what that could be I don't know. (Cleaner 3, Initiation)*

Initially both the PM and DMs expressed that the primary goal of the Roomie project was to use data in a way that could improve work, reduce stress, and save time for the individual cleaners who could use Roomie as an effective daily decision-making and prioritization tool. However shortly after implementation, the PM began to further explore how the collected sensor data could be used to monitor work and spot trends, in the hopes of managing resources more efficiently:

> *[The cleaners say:] "We go around and clean whether it's necessary or not". And that means that we have a… *laughs* presumptively inefficient resource management. […] A good solution would be that you could present an overview regarding how facilities are used based on previous cleaning, and better understand the actual need. (PM, Implementation, early)*

4.2. Creating conditions for system acceptance

As the project moved from initial conceptualizations to the implementation phase, the TL for the cleaners became more involved and participated in meetings with the other project stakeholders. Many of the cleaners, including the TL, did not fully grasp the potential strategic value of the system, something that the TL attributed to them not being invited to participate in the initial project discussions, putting them at a disadvantage from the start. Although the TL had personal experience of using digital applications, this was the first time that the cleaners had ever been a part of a DT project. However, once part of the group, they found that the project meetings often focused on the several technical issues that arose. This made the TL feel like they neither contributed to the discussion nor understood many of the aspects of the system:

> *[…] And I am like 'I have no knowledge regarding any system, how things work!' – so many things just go straight over my head, and I am just like; [putting their hands over their face] 'I do not understand anything', 'Why am I even here?'. (TL, Implementation, early)*

The TL's primary function as a member of the project group was to relay back and forth between the group meetings and the cleaning crew. Their own perceived difficulties in meaningfully participating in the discussions made this a challenging and stressful task. Despite the TL's efforts to become involved in the project and represent the opinions of the entire cleaning crew, they felt that the cleaners' perspective was often overlooked. SysDev, being responsible for the technical development of Roomie, indirectly validated the TL's feeling of going largely unnoticed, describing how they normally turned to the DMs to get input and design suggestions from the worker perspective:

> *During the design process we have had… Kind of more from the [district] management for the cleaners, who have had input, but I guess they represent their group, so to speak. (SysDev Usability Expert, Implementation, early)*

The cleaners' shallow understanding of the capabilities of the Roomie system provided a managerial challenge in terms of getting everyone invested and interested in what IoT could do and how data-driven work practices could transform their work. The PM tried to overcome these challenges by further including the TL in project group meetings and actively attending to the suggestions that were being made (such as graphical additions and fixes) thus acknowledging the TL's contributions. Through these efforts, the PM managed to increase the cleaners' acceptance of the system, but interestingly, many cleaners still did not see the system as an integrated part of their work identity. Roomie affording need-based cleaning – a completely transformed way of working – but was regarded as an add-on that took time away from "real work." Some questioned the green circle/red circle status function in Roomie. They pointed out that a recently cleaned room, indicated by a green circle next to its name in the Roomie application, could become dirty very quickly again as people moved through buildings, changing its status to red. This made them question their own work ("didn't I just clean that area?") and made them unsure of how to interpret system prompts:

> *It [Roomie] is good for conference rooms, but it is not good for offices, toilets, or cafeterias where there are people every day, and if you clean, people come again after five minutes, and then there's no difference even though you've cleaned. [] Often, I am done, but then I start to question if I've cleaned this area or not. One does not know. (Cleaner 2, Implementation, late)*

Indeed, some claimed that interacting with the system increased both their workload and stress, and that they did not have time to, for example, perform mandated system checks while they were trying to perform their work. Instead, they spent time on their breaks logging into the system and backtracking their movements, checking cleaned rooms off their lists. This way of working was in stark contrast to the PM's initial vision of efficient and well-planned operations based on real-time data:

> *One of my colleagues told me that 'I just do not have the time when I am in the area where I work. It is better that we sit in the breakroom and fix it after we are done'. They must spend their breaktime after work having to fix this [Roomie]-app, you know? It is like homework—- an extra thing *laughs*. (Cleaner 2, Implementation, late)*

Another pertinent aspect was the cleaners' feeling that they had performed their job long enough to be able to do it without a system telling them where to go, which stood in direct opposition to the PM's vision of becoming a data-driven organization:

> *[…] They [management] think it is going to make it easier to clean – [that] it is a tool to help us. But from my own perspective it is just more of a problem for us because we are stressed, and we have less time and more work. And we have outside [of the municipal building] work as well. […] It is also hard for non-native speakers that have a hard time with the language and using a computer. (Cleaner 2, Implementation, early)*

The managers indicated that they were indeed aware of issues and could point to aspects that had been brought up. The DMs were, for example, informed of the initial suspicion regarding the purpose of the system and the cleaners' thoughts that optimizing would ultimately lead to a cutback in personnel. They repeatedly stated that this was not the intention and instead stressed that Roomie was implemented to make work practices more effective and efficient. We could see, however, that while initially both the PM and DMs expressed that the primary goal of the Roomie project was to use data in a way that could improve work for the individual cleaners, this goal was in fact adjusted shortly after Roomie was put into use shifting the focus to efficient resource management.

4.3. Bridging expectations and visions for the future

As the Roomie project progressed, there was both a change in work practices in terms of how maintenance work was being performed when aided by the IoT technology and a change in attitude toward the Roomie application. One noticeable mindset change was that the cleaners began referring to Roomie more often as an "app" rather than as a system. This new conceptualization seemed to help frame the system in a more understandable fashion. As time went on, the cleaners started to use the system more in line with the PM's original expectation and became more vocal about things that they appreciated with it.

> *It's a… a way for us to keep track of… For us, it is, well the advantage is that if you have a lot to do in a day you can check Roomie and see that 'Oh, here there is actually no need to panic and run off and clean' or the other way around 'This is something that I should attend to right away.' It is an easier way to organize work. […] It saves time. (Cleaner 5, Evaluation)*

There were still some interaction difficulties, especially for non-native Swedish speakers, who sometimes had trouble understanding written text in the Roomie application. There was also a visible shift toward a stronger emphasis on training and explaining, compared to the earlier way of learning by doing, which had positive effects in terms of how the cleaners felt about the system:

I have got to say that I was probably more negative before the whole thing started – thinking; 'This will never work', but then again, I am rather negative from the get-go, so that was a given. But, no, still - I do think that 'Yeah, it has worked out well.' (Cleaner 4, Evaluation)

From the perspective of the TL, she confirmed that the cleaners liked the system better and that they were currently using it, despite the project being over. When asked what she thought that the future for the project would be, or if it would be continued, she was skeptical, stating:

I am thinking that it is not going to become anything, that it was a pilot-thing and I do not think that the municipality will use it. It does not really feel like it, because it would be too expensive to purchase. […] We have been asking if we are going to get this system, but we have not gotten an answer. (TL, Evaluation)

The TL described one issue that they had throughout the project was indeed the involvement of the DMs, where she felt like there were multiple disagreements. Although the TL felt that the PM was attentive and listened to their suggestions and critique, the involvement of the DMs made things harder throughout:

The DMs are often like that – they have a lot of opinions, but they often do not know how it works on the front line. That is the problem – this is the way we work – but they do not really have a clue. (TL, Evaluation)

As the project ended, the PM moved on to new digitalization projects within the municipality. The DMs, however, wanted to continue using Roomie and expand the system. They did not feel confident that they had the required technological know-how to take the next step, and had asked for a new PM to handle things moving forward:

The problem has been that we within the cleaning-service do not have the knowledge regarding the technology and what is required to take the next step, so what we have done is that we have applied for money for a project manager, or someone that can be responsible for this, to take the next step and maybe expand it further to more areas. (DM 1, Evaluation)

Drawing on the experiences of the Roomie project, the PM investigated new areas where IoT could be put to use, with the ultimate goal of enabling DT and establishing a data-driven mindset within the entire municipality. They envisioned future trials with a similar system, but with a focus on optimization of organizational strategy and more efficient delegation of work:

Look, if were to do these optimizations in the operations where we have, well… let us say 100 percent of the staff - maybe we should try doing this with 85 percent of the staff instead. Or they can do something else. I mean that is the cold truth - that if you are optimizing something you need to actually make things more optimized, and IoT can be used to accomplish that – as well as digitalization in general. (PM, Evaluation)

This indicated a change of direction, from the initial focus on using real-time data to understand the conditions of rooms and discern patterns of usage, to using collected data to monitor workers and optimize work practices. Although the former was connected to improving work conditions, the latter brought up concerns about worker privacy and ethical use of data. When asked if they believed that any potential monitoring aspects of this technology could lead to problems with workers or workers' unions the PM stated that:

Sure… Sure, anything that can be interpreted, or misinterpreted, is. So, you must… Like with all digitalization you need to show in which way it is a tool in your work. (PM, Implementation, late)

The Roomie project was a delimited attempt at digitally transforming municipal facility management, specifically the work practices of its custodial workers, through the implementation of IoT technology. After two years of developing, testing, and evaluating the system, it was eventually decided that Roomie would become a permanent fixture in the municipal cleaning services. Although the cleaners' attitude toward the system eventually became more positive, the risk of cutbacks seemed to be an issue that remained in the back of their minds. Even those who did like the system, when asked what they thought the purpose of Roomie was, stated, albeit in a joking manner, that:

*Cleaner 4: Well, I do not really know… employing less people? *Laughs* I'm not sure. Cleaner 5: Yeah, exactly, we will lose our jobs. *Laughs* (Cleaners 4 and 5, Evaluation)*

5. Discussion

In this section, we delve deeper into the lessons learned from empirically studying an IoT-enabled digital transformation project over time and discuss the implications of our findings in relation to our research question: What is the transformational potential of IoT and how is IoT-enabled DT supported or constrained in practice?

5.1. The transformational potential of IoT

IoT is considered a key transformative technology that will have a large impact on organizations, fundamentally transforming their value proposition and identity [32,45,67]. Previous research has pointed out that there is a dearth of empirical research exploring the organizational implications of IoT adoption and the effects on different stakeholders and organizational culture [1,19,32–34], providing motivation for our study which followed an IoT-enabled DT project and its stakeholders over two years.

The Roomie project embodied a municipal desire to digitalize operations and implement a data-driven mindset. As seen in the transformation narrative surrounding the project, the IoT system was attributed with significant symbolic and practical value. Focusing on the system's capability to collect, transmit, and analyze context-aware, real-time data painted a positive picture of the expected and envisioned value brought on by IoT adoption. Roomie was not only expected to improve efficiency and effectiveness through increased monitoring and control, but it would also optimize work, transform organizational identity, and, on a symbolic level, augment the cleaning profession's status. For the individual worker, IoT was presented as a tool that would save time, decrease stress, and provide decision support, and that had potential to transform both work practices as well as one's professional identity and sense of self. From a municipal perspective, which was upheld by the managers, there was a very good grasp of "what" capabilities IoT had and "why" DT efforts should be initiated. However, during our study, we saw that this transformation narrative was not easily established within the cleaner group, who foremost saw Roomie as an "application on a tablet." They expressed that the system had a relatively low impact on their daily "hands-on" work of cleaning municipal buildings.

The gap between management expectations and operational realities can be seen as an example of IoT-introduced goal heterogeneity [32]. IoT systems are naturally heterogenous, involving and connecting multiple objects, environments, and people [69], and as such they produce heterogenous data that can inform multiple, co-existing, and sometimes conflicting goals [32]. Data from the same IoT system can simultaneously be used for a variety of purposes that requires stakeholders to prioritize between different potential system outcomes [32]. The Roomie project shows that the disconnect between the management and the worker perspective led to vastly different conceptualizations of IoT's transformational potential and that the use of IoT had the potential to augment those differences further. This study thereby highlights the importance of acknowledging the existence of – and achieving a balance between – incongruent expectations or competing conceptualizations. This becomes especially important in a hierarchical environment where power is not equally distributed among the different stakeholders and where the goal prioritization dialogue might primarily occur on a managerial level.

Previous research has shown that although DT is critical to continued organizational survival and growth, firms need help to fully capture value from new technology [1]. It has been suggested that this failure to digitally thrive stems from an insufficient understanding of the capabilities of specific digital technologies and their potential to enable transformation [61,65,66]. Based on the results of our study we posit that to understand the transformational potential of IoT and its effects on DT in practice, it is necessary, but not sufficient, to recognize the affordances and constraints of the digital artifact and the organizational motivation for change. Our study shows that the transformational potential of IoT was well understood on a managerial level, resulting in them being able to express an established "what" and "why." However, although the transformation narrative was a fair conceptualization of IoT's capabilities, it needed to translate into practice and match the experience of all stakeholders. Failure to do so hampered the DT process and made achieving fundamental change difficult. We thus extend DT research by demonstrating the importance of identifying and accounting for the actors and stakeholders involved in and affected by DT, their conceptualizations of technology, and their space for action. The transformational potential of IoT ultimately does not lie in its capabilities but in stakeholder acceptance.

5.2. Creating conditions for change

The objective of an organizational DT project is to create fundamental change. A crucial aspect of any DT process would be creating conditions that enable said change. Previous research has shown that digital leadership [52,57,58] that fosters a culture of openness, learning, collaboration, and flexibility is crucial to achieving organizational acceptance of new technology and creating new value [52–54]. Vice versa, the failure to establish a data-driven mindset is posited as a significant barrier to achieving digital effectiveness [61].

One of the most significant challenges in the Roomie project was establishing a digital mindset among all stakeholders, not only on the management level. The cleaners, who were most directly affected by the system implementation, had trouble understanding what the system could do and how it should be used. In addition, they also questioned the other stakeholders' motives and knowledge, especially the district managers. The cleaning crew perceived themselves as workers with a fixed mission and could neither appreciate the need to become data-driven nor acknowledge that Roomie could fundamentally change the nature of their work. Their rather dismissive attitude initially affected their willingness to transform their work practices. It also affected the team leader who had one foot in both camps, being part of the cleaning crew but also a member of the project group. The TL was instrumental in conveying the thoughts and experiences of the cleaners to the project manager, making the PM alter their approach.

Realizing that the cleaners' lack of enthusiasm could in part be attributed to their strong identity as analogue workers, the Roomie PM actively worked to turn things around and create conditions that supported instead of constrained DT. The PM managed to exhibit leadership characteristics that eventually inspired exploration and promoted a growth mindset, through attentive listening, an open and inclusive attitude, and constant system development based on the team leader's feedback. This increased the willingness to learn, trust, participate, and communicate, which are all considered important cultural values that promote digital transformation [52,56]. Hence, cultivating a digital mindset involves identifying and embracing the transformational potential of technology and shedding preconceived notions about the technology's capabilities (Iansithi & Lakhani, 2014; [56]). Toward the end of the project, not only had their work processes transformed, but the cleaners' perception of the system had also changed and become more positive as a result of an improved understanding of how it worked and could be applied in a way that was beneficial not only for managers but also for themselves.

The insights from the Roomie project show that IoT-enabled DT can be supported and constrained by stakeholder actions. The PM and DMs initially thought that the addition of IoT to the cleaners' analog work context would automatically augment the status of their profession and transform their professional identity. They expected the cleaners to be curious and excited to explore the system once it was installed. They counted on learning-by-doing as the primary way of adopting the system and gaining an understanding of its capability. The result was in effect the opposite, in part due to the cleaners' difficulties in conceptualizing the IoT technology and its transformational potential, and in part due to the managers underestimating the pride that many cleaners took in their established work practices. Once they understood that it would take active leadership to create conditions that supported change, the PM encouraged learning through education, spending more time on showcasing the system and its functionality. In this way, the PM managed to help the others in reconceptualizing technology and establishing a digital mindset. The Roomie project was in time deemed a success, despite initial pitfalls.

5.3. IoT-enabled digital transformation

The transformational potential of IoT is mainly attributed to its ability to afford the establishment of a data-driven mindset, through the collection and analysis of real-time contextual data [31]. IoT systems enable organizations to use data from their own environment to look for patterns, identify behaviors, and aid decision-making, with or without human intervention. As such, they make it possible for organizations to transform both work identity and work practices [32]. In contrast to other digital technology, IoT, with its seamless collection of context-aware data, is a cyber-physical system in which humans simultaneously can be a part of the system and a user of it. We argue that this system opaqueness, meaning it is partially invisible to humans, can lead to a shallow understanding of what the system is and can do, which increases the risk of unethical use of data and escalating monitoring and control.

Considering a hypothetical organizational administrative system, the employer would generally provide the necessary software and hardware access. In such a context, it is implicitly (and often explicitly) understood that the organization will be able to monitor the user with respect to their use of company software and hardware. This kind of monitoring is seemingly transparent because it is understood and sometimes even agreed on in writing among users. In comparison, the monitoring capability of IoT is not as clearly identifiable by the users acting within it. In fact, moving through a building, a cleaner would also generate sensor data, for example triggering presence sensors, thus becoming a data point of the system while at the same time using the system data to plan their work. As the DT project progressed, the managers gradually began to see the potential for further optimizing work practices and routines by extending the analysis of both the generated sensor data and the Roomie application usage. They believed that the insights they could gain from such analysis would enhance business strategies and help them transform further. However, it would also make the monitoring and analysis of specific users possible. This capability to use system data to provide extended analysis of not only room usage, but also workers' behavior, was not understood by the cleaners, who believed that the monitoring potential of the technology was limited to conveying the status of the rooms that they would see in the Roomie application.

Bernstein [80] argues that the advantages of increased transparency, such as the capacity to monitor, learn, and control, afforded by technology that uses data to render the invisible visible, may become risks when the perspective is changed from the observer to the observed. We could see that IoT's data collection and analysis capabilities, although believed to increase transparency, in practice afforded partial invisibility. As a result, the cleaners were simultaneously assuming the role of the observers and placed in the role of the observed. This provides an interesting perspective on IoT-enabled DT and offers an explanation for the paradoxical behavior of the users, in being vocal about disliking the concept of managerial micro-management (resisting being the observed reaction), while becoming increasingly positive toward the Roomie application that, in essence, allowed for *more* micro-managing (but which appeared to them as allowing them to be the observer). It would also explain the paradox of managers stating explicitly that monitoring was not the intention of the system (taking the perspective of becoming the observed), while simultaneously gravitating toward solutions that included increased monitoring (seeing the value in doing the observing). Thus, if organizations only assume the role of the observer, IoT systems can become instruments of surveillance, potentially infringing on privacy and personal freedom. To mitigate risk, one might expect efforts to increase the transparency of the system itself, considering the perspective of the observed. However, the very act of becoming aware of one's role as being the observed often prompts other action, for example not using the system as intended or creating workarounds to avoid system use [79–81].

Based on our study we can conclude that IoT-enabled DT is a complex phenomenon, in part because of the very capabilities of IoT that afford both goal heterogeneity and partial visibility, as well as blur the lines between being the user of a system and being a part of the system itself. It would seem then, that to achieve DT through IoT use, managers must not only leverage the role of the observer and the observed, but also account for the system opaqueness of IoT. On a practical level, this means clarifying usage intentions and ensuring that ethical standards are in place so that IoT use strengthens both the organization and its employees. Furthermore, while IoT data can be used to inform decision making on all organizational levels, this requires developing a digital mindset [64] and fostering user acceptance while at the same time balancing management control and the potential for increased worker autonomy. IoT-enabled DT thus places a lot of responsibility on managers to not only have a clear vision and the technology to support it, but to exercise digital leadership that builds a culture of engagement.

6. Conclusions and suggestions for future research

In this paper, we set out to answer the research question: What is the transformational potential of IoT and how is IoT-enabled DT supported or constrained in practice? Through a qualitative case study, we have performed an in-depth exploration of an ongoing DT process with IoT as the enabling technology and offer the following insights for both researchers and managers.

First, our results show that IoT has the potential to fundamentally change organizational and individual perceptions of work identity and work practices, which creates an opportunity for DT. We extend DT research by demonstrating the importance of identifying and accounting for the actors and stakeholders that are involved in and affected by DT, their conceptualizations of technology, and their space for action. The transformational potential of IoT ultimately does not lie in its capabilities, but in stakeholder acceptance, especially considering that IoT capabilities may augment heterogeneous goals. From a management perspective, this insight can serve as a guide for managers seeking to make use of IoT and prompt them to prioritize bridging the knowledge gap and foster acceptance through involvement, in addition to making sure that the new technology is aligned with both organizational and personal objectives.

Second, creating conditions for change entails facilitating organizational acceptance of technology. Technology alone does not create fundamental change; organizational culture must also transform. Our study showed that proactive leadership made a difference in promoting a data-driven mindset and helping reconceptualize both technology and work. Navigating the complexity of DT within an organization requires managers to underscore the significance of digital leadership, effective communication, and stakeholder engagement.

Third, IoT affords partial visibility that can lead to a shallow understanding of what the system is and can do. To make use of data-driven capabilities and at the same time mitigate the risk of privacy infringements, one must leverage the role of the observer and the observed. By clarifying usage intentions and ensuring ethical standards are in place, managers can help steer IoT use from potentially intrusive to empowering for both the organization and its employees.

Answering the call to "bring clarity to the conceptual complexity and ambiguity that makes it difficult to make sense of the true opportunities created by IoT technologies" ([32], p. 574), we explored the **what, when, who**, and **how** of DT, allowing us to identify the transformational potential of IoT and offer insights into IoT-enabled DT. Furthermore, by providing stakeholder perspectives from different organizational levels and highlighting the connection between IoT capabilities and goal heterogeneity we have explored the socio-cultural conditions that influence DT success or failure and contributed to research on how to create conditions for DT in practice. As we have shown, our research also has practical implications for managers seeking to use IoT to transform their organizations, by pointing to the importance of 1) paying attention to both technological capabilities and identifying the actors and stakeholders that are involved in, and affected by, DT, 2) actively leading the change process, as well as 3) managing ethical aspects connected to IoT use.

Focusing on a single case study of a DT project in a specific context limits our study. We thus see a need for more studies that consider the organizational perspective of digital transformation, exploring how change is enacted and re-enacted over time in different contexts, at various organizational levels and within different stakeholder groups. Although this research was mainly focused on internal organizational stakeholders, future research could target distributed and interorganizational use of IoT and the possibilities that a collaborative data-driven mindset generates. The use and potential re-use of data raises interesting questions of, for example, data ownership, value creation, and user control that could be further explored. In addition, because the IoT is expected to continue to grow exponentially, generating massive amounts of data and increasing behavioral visibility, it would be interesting to delve deeper into the ethical aspects of IoT implementation and use, exploring whether the experienced difference in perspective of being the observer or being the observed is something that will become even more pronounced as the IoT takes off or if humans will be conditioned to constant monitoring. What happens when technology becomes ubiquitous, and use is not a choice, at least not on an individual level? These are questions that future studies should further explore.

CRediT authorship contribution statement

Ulrika H. Westergren: Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Formal analysis, Conceptualization. **Viktor Mähler:** Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Taline Jadaan:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization.

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