

Invisible Digi-work

Compensating, Connecting, and Cleaning in Digitalized Organizations

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Document Version
Final published version

Published in:
Organization Theory

DOI:
[10.1177/26317877241235938](https://doi.org/10.1177/26317877241235938)

Publication date:
2024

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Citation for published version (APA):
Justesen, L., & Plesner, U. (2024). Invisible Digi-work: Compensating, Connecting, and Cleaning in Digitalized Organizations. *Organization Theory*, 5(1). <https://doi.org/10.1177/26317877241235938>

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Download date: 11. Feb. 2025





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Organization Theory
Volume 5: 1–26
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sagepub.com/journals-permissions
DOI: 10.1177/26317877241235938
journals.sagepub.com/home/ott



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Abstract

The aim of this paper is to develop a theoretical vocabulary that allows us to better understand not only the visible effects of digitalization on organizations but also the invisible work that arises in and around the digitalized organization to prepare, maintain and repair its key features. Drawing on feminist science and technology studies and their classic concept of invisible work, we challenge some of the dominant spatial root metaphor assumptions in current research and develop an alternative metaphoric of digital work and the digitalized organization. We develop the theoretical concept of invisible digi-work as a corollary to the already established concept of digital work and flesh out three types of work that we conceptualize as invisible connecting, compensating and cleaning work. This analytical framework captures aspects of work that tend to be out of sight and devalued in dominant accounts. As such, it represents a theoretical alternative to imageries of digital spaces that lead to an overemphasis on the affordances of new digital technologies, establishing an alternative ground for interrogating work at margins, which is essential to the constitution of digitalized organizations. Theorizing invisible digi-work is in line with recent calls in organization studies to go beyond the visual and investigate the indirect and less visible implications of digitalization.

Keywords

invisible digi-work, invisible work, digitalized organization, digital work, feminist STS, automation, connectivity, AI

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Introduction

The ongoing comprehensive digitalization of society is affecting organizations in profound ways, giving rise to new ways of working and organizing. Constant connectivity (Kolb et al., 2020) has created growing interdependence between systems, technologies, data, people and organizations (Leonardi & Treem, 2020), which has spurred substantial reconfigurations of work relationships, processes and tasks. In most organizations, work today *is* digital (Orlikowski & Scott, 2016) because it is inextricably intertwined with digital technologies. This fundamental digitalization of contemporary organizations is an occasion to rethink our conceptualization of work, technology and organization (Bailey et al., 2022; Beyes et al., 2022; Faraj & Pachidi, 2021; Plesner et al., 2018) and develop new theoretical frameworks and analytical concepts that can help us better understand how digitalization changes work and organizations (Leonardi & Treem, 2020; Orlikowski & Scott, 2023).

Current theoretical accounts of the digitalized organization tend to revolve around the core of the organization and the enabling effects of digitalization. Emphasis is placed on the visible, understood as that which becomes realized in digitalized organizations, and we see a strong focus on the visibilities afforded by digital technologies (Leonardi & Treem, 2020) or the visible programmes of digitalization driving organizational changes on a larger scale (Orlikowski & Scott, 2023). More broadly, organization scholars have focused on the affordances of digital technologies and demonstrated how they enable key features, such as connectivity (Kolb et al., 2020), automation (Lammi, 2021) and visibility (Flyverbom, 2022). As such, evolving theorizations mostly contribute to an understanding of the positive consequences of digitalization even though these consequences may be normatively viewed as negative as in, for example, accounts of increased control and disempowerment (Kellogg et al., 2020; Manley & Williams, 2022) or mass surveillance (Zuboff, 2019,

2022). Even in clearly anti-deterministic approaches to technology and organization, in which technologies are considered relational and emerging (e.g. Bailey et al., 2022) and entangled with human agency (e.g. Orlikowski, 2007), the focus tends to be on the *outcomes* of introducing digital technologies or on the changes that follow from the entanglement of digital technologies and social or organizational aspects.

This strong emphasis on what digital technologies enable or make visible implies that less attention has been given to the work required to maintain digitalized organizations. Yet, as organizations become increasingly digitalized, this type of work also becomes increasingly significant both in practice and for organization studies. The aim of this paper is to develop a theoretical vocabulary that allows us to better understand not only the visible effects of digitalization on organizations but also the invisible work that arises in and around the digitalized organization to prepare, maintain and repair its key features. To do so, we problematize dominant root metaphor assumptions (Alvesson & Sandberg, 2011) underpinning main trends in research on digitalized organization. Organizational theorizing is intertwined with metaphors that guide our thinking and lines of inquiry as organizational scholars (e.g. Cornelissen, 2005). Hence, challenges to dominant root metaphors and proposed alternatives may spur our imagination, introduce new topics and perspectives and lead to resignifications of organizational phenomena (cf. Cornelissen et al., 2021). In some scholarly and much public discourse, implicit images of interconnected digital technologies constituting a productive space favour a conceptualization of organizations as already connected, automated and all-illuminated. This metaphoric precludes the possibility of theorizing the invisible work, which is an important constitutive element of the digital organization although it is relegated to its periphery in both theory and practice. To better understand this constitutive aspect of the digitalized organization and develop new analytical resources to account for it, we engage

with an alternative root metaphoric, taking inspiration from feminist science and technology studies (STS) (Haraway, 1988; Star, 1990, 1995; Star & Strauss, 1999; Suchman, 2007).

Feminist STS scholars have emphasized the importance of situatedness (Haraway, 1988), place, boundaries and the marginal in their attempts to understand lived experiences and everyday practices – including work and *invisible work* (Star, 1990; Star & Strauss, 1999; Suchman, 2007). Hence, the spatial metaphoric coming out of this scholarship stands in stark contrast to images of abstract digital space, as reflected in, for instance, ideas of cyberspace, the cloud and constant connectivity. As a corrective to the abstract images and accounts of digital spaces, the feminist STS vocabulary reminds us that digitalization and digital work always take place *somewhere* in concrete socio-material practices, and that the locations of digitalization are widely distributed.

On this backdrop, we propose to revisit and develop the concept of invisible work, originally coined by feminist scholars to account for unrecognized, undervalued and often underpaid work (Daniels, 1987). While feminism (Daniels, 1987), STS (Star, 1990; Star & Strauss, 1999) and the sociology of work (Hatton, 2017; Whiting & Symon, 2020) have maintained a sustained interest in invisible work, the concept has played a minor role in organization studies. This is surprising both because of the field's focus on work (Barley & Kunda, 2001) and growing interest in digital technologies, and because organization studies have had a long-standing focus on the visible and its opposites, as found in recent studies of organizational visibilities, transparency and opacity (Flyverbom, 2019, 2022; Leonardi & Treem, 2020; Ringel, 2019), as well as in classic organization theory where, for instance, discussions of the formal and informal organization (Dickson & Roethlisberger, 1939/2003) reflect an interest in the dynamics of visibility and invisibility. Making invisible work visible again (Schmidt, 2016) allows us to focus not only on the positive aspects of digitalized organization – on what is enabled, realized and made visible – but

also on the neglected aspects and the enablers of digitalized organizations.

This paper contributes to the literature on digitalization and organization by developing a theoretical framework that expands our understanding of digitalized organizations and digital work (Orlikowski & Scott, 2016, 2023) through the theorization of the multiple and marginal places of its establishment and maintenance. We develop the theoretical concept of *invisible digi-work* as a corollary to the already established concept of digital work (Orlikowski & Scott, 2016) and flesh out three types of work that we conceptualize as invisible *connecting*, *compensating* and *cleaning* work. This analytical vocabulary presents a theoretical alternative to abstracted imageries of established digital architectures leading to accounts that favour the affordances of new digital spaces, as it recognizes the located and lived experiences as well as aspects of work that tend to be out of sight and devalued in dominant accounts.

Digital Work and Digitalized Organizations – attention to the core and the enabled

Our current understanding of the enabling effects of digital technologies is growing. Recent decades have allowed us to follow how work becomes influenced by, or entangled with, digital technologies (Beane & Orlikowski, 2015; Orlikowski, 2007; Orlikowski & Scott, 2016). Insights into digital work are based on the implicit assumption that digital elements are used or infused into work processes or entangled with them. Accounts have revolved around the transformations of core tasks of organizations or changes affecting the most visible actors – be they professionals or service workers (e.g. Kellogg et al., 2020; Mazmanian et al., 2013; Petrakaki et al., 2016; Waardenburg et al., 2022).

The focus on how digital technologies are changing what is perceived as the core tasks of organizations and how core professionals experience such changes implies that attention is placed at the *centre of the organization*, whereas

the more peripheral work – both literally and metaphorically – has received much less attention, even though its scope seems to be expanding due to digitalization. As Orlikowski and Scott (2023) remark, the interest in digital transformation has revolved around visible innovations, whereas less attention has been given to indirect institutional changes occurring ‘at some temporal and spatial remove from the main events’ (p. 2). The restricted view of digital work – as work that is visibly changing as a result of the affordances of digital technologies – has been tentatively challenged in a research agenda proposing that work today always entails the digital (Orlikowski & Scott, 2016), paving the way for a more inclusive view of digital work as encompassing the invisible work involved in making the more visible entanglements of digital technologies and work possible. If the core tasks in the organization are becoming increasingly dependent on visible (and well-researched) dimensions of the digitalized organization (such as connectivity and automation, as we will argue below), the organization is also becoming increasingly dependent on the work required to support these dimensions. Adopting a spatial lens, this can be seen as work that takes place behind, beneath, or around what is considered the actual work, or at the periphery of some centre.

Hitherto, the literature on organization and digitalization has been disproportionately occupied with what is enabled or made visible in the digitalized organization, rather than with how the digitalized organization is enabled at all. The spatial root metaphors underlying the literature can partly explain this focus. Abstracted accounts of ubiquitous connectivity and extensive digital infrastructures leave us with an impression of a vast web of well-connected nodes in a network. From accounts of automation, we get images of frictionless infrastructures that allow data to flow freely. And in historical accounts of digitalized organizations, we encounter metaphors such as waves (e.g. Kolb et al., 2020), which indicate a development driven by external forces, or metaphors such as new territories (e.g. Rossiter & Zehle, 2013),

which point to a liberation from old constraints, to the potential of radically new modes of operating, and to the steady conquest of new terrain.

Seamless connectivity – the expansion and contraction of digitalized organizations

One of the typically highlighted features of the digitalized organization is connectivity (Kolb et al., 2020; Leonardi & Treem, 2020; Plesner & Husted, 2019), described on one level as a product of the internet, digital communication technologies, platforms, personalized apps and datafication (Kolb et al., 2020), and at another as creating the conditions for potential ‘dramatic shifts in processes of organizing’ (Leonardi & Treem, 2020, p. 1603). Connectivity is often conceptualized as an affordance (e.g. Leonardi & Treem, 2020), i.e. a property of digital technologies that can be used in a multitude of ways, with implications for practice. When connectivity is understood as an affordance, the emphasis is unsurprisingly placed on the visible use and consequences of connected digital technologies rather than on their establishment and maintenance.

Accounts of connectivity convey an implicit image of a vast space waiting to be conquered as still more dots become connected. In that sense, connectivity depicts an expanded digital organization, but also, at the same time, a contracted space where distance is gradually reduced. The notion of connectivity often seems to assume a frictionless space to explore via interconnected hardware and hyperlinks. Kolb et al. (2020) describe how connectivity has become increasingly ubiquitous as a result of subsequent innovation waves over the years, through which layers of connectivity have been added. This has resulted in extensive and intensive connectivity ‘underpinning’ personal and organizational activities and creating ‘a digital world’, from which it is difficult to disconnect or reconnect with ‘the place and present time in which we are living’ (p. 1594). This portrayal seems to assume an abstract space which has

grown as a result of socio-technical forces (waves) rather than as a result of *work* to connect algorithms, devices and sensors. Although there is indeed recognition of the fact that digital terrains are made up by entangled networks (Orlikowski, 2007), interconnecting algorithms (Orlikowski & Scott, 2016), or a wide range of devices and sensors which establish a comprehensive system held together by algorithms (Kellogg et al., 2020), these technological elements are often portrayed as operating in a relatively seamless manner and without much human intervention. They are sometimes granted strong agency, as when cameras record, algorithms monitor and platforms communicate (Kellogg et al., 2020), as if their operation did not require work by humans.

Digitalization is also portrayed as lessening material constraints, such as the limitations of space and location usually associated with work (Leonardi & Treem, 2020). Leonardi and Treem construct the digital as an underlying technical infrastructure connecting people where connective digital technologies seemingly allow data to flow freely and constitute illuminated spaces. The same assumptions about digital space having been established through the convergence of different ‘digital architectures’ can be found in Flyverbom’s (2022) portrayal of ‘overlit’ digitalized organizations. Here, although the metaphoric of architectures and built arrangements could point to the necessary activity of building and maintaining, references to the ‘inner workings’ (Flyverbom 2022, p. 4) of the technologies constituting the digital spaces precludes attention to how the technological elements constituting connected digital spaces require actual work in specific places. Instead, research on all-illuminated organizations directs the attention to affordances of visibility (Bernstein, 2017; Flyverbom, 2022; Leonardi & Treem, 2020), invoking an open space where the gaze can wander. Whereas some scholars have emphasized the extra work tied to visibility, e.g. how visibilities afforded by digital technologies must be organized or managed (Flyverbom et al., 2016; Justesen & Plesner, 2023), it is more common to identify the *conditions* of increased visibility

(for instance, connectivity) (Leonardi & Treem, 2020), or its *consequences* for work, and to ignore the digital work required to establish the conditions. Stretching our topographical imagination beyond the flat network of connected nodes offers a way of deepening our understanding of connectivity and hence theorizing important constitutive aspects of the digitalized organization.

Frictionless automation – enabling infrastructures

Automation is a second highly visible feature of digitalized organizations receiving considerable attention both in practice and in organization studies (e.g. Brynjolfsson & McAfee, 2014; Fleming, 2019; Lammi, 2021). As is the case with extant research on connectivity, accounts of automation focus chiefly on the visible changes in work that come with automation rather than the work required to maintain and make automation work in the first place. In particular, critical studies of automation portray digital technologies as operating more or less autonomously, where the ease and speed of, e.g. data flows, automated decision-making or automated tracing are implicitly portrayed as removing humans from the equation (O’Neil, 2016; Zuboff, 2022). Again, such accounts depict digital infrastructures as making up a type of extensive abstract space, which is different from the ‘real world’ (Zuboff, 2022). Although Zuboff criticizes the mythological ‘cyberspace’ (p. 16), she does portray digital information and communication spaces as being ‘an extra-societal zone in which norms and laws of *real world* democracies do not apply’ (p. 16, emphasis added), whereby it is made possible to generate and extract data on a large scale through automated systems.

Organization scholars do not portray automation as simply replacing work, but observe that automation is often linked to the efficiency goals of organization (Glaser et al., 2021; Trittin-Ulbrich et al., 2021). They describe how automation contributes to organizations’ expectations of frictionless digital services, such as automated

data capture (Newlands, 2021a), automated decision-making (Lange et al., 2019) or automated exchanges of resources and data across fields (Alaimo, 2022). A focus on automation affordances implies imaginaries of smooth and uninterrupted processes relying on seamless infrastructures, and we only rarely encounter examinations of the specific workplaces where humans struggle to make automation work (Lammi, 2021). There is an often implicit mechanical element in portrayals of automation, as they presuppose the smooth functioning ‘untouched by human hand’, as it is sometimes phrased, not unlike classic economic theory root metaphor assumptions of ‘the invisible hand’.

Towards a more expansive understanding of digital work

The scale and scope of changes associated with the digitalized organization invite us to rethink the work involved in the emergence of new organizational forms based on key features such as connectivity and automation. But combined, current accounts of these features contribute to the glossing over of new types of work that remain invisible. Our understanding of today’s organizations has been enriched with images of expanded spaces, but our understanding of embodied digital work and the specific places where this is conducted is still too narrow. This can partly be explained by how organization studies have hitherto directed our attention to the *visible*, the *positive* and the *core* features of the digitalized organization rather than being concerned with the *invisible*, the *negative* or the *peripheral* work that are elements in the constitution of the digitalized organization. Although digital infrastructures are recognized in both theory and practice as important technical issues or as central to organizational development and competitiveness, this significance is not mirrored in the attention given to all the work on which they depend. To identify, discuss and theorize such activities, we turn to feminist STS and, more specifically, the concept of invisible work.

A Feminist STS Perspective on the Digitalized Organization and Digital Work

Science and technology studies have presented us with a set of sensibilities and analytical apparatuses to capture how social and material phenomena are entangled and co-evolving (Hackett et al., 2008), inviting us to study the everyday practices of, e.g., technology design and use. Within this broad and interdisciplinary field, a feminist strand has criticized the tendency to focus on the empire building of strong actors (Amsterdamska, 1990; Star, 1990) and has, as an alternative, led our attention to the peripheral and theorized how space is always organized and how centres are established through boundary-drawing and marginalization. As Star (1995, p. 89) puts it, space is an ‘arrangement of priorities. Things that are more important are closer to the center; things less important farther away’. And she adds that ‘[th]e center is always defined with respect to a set of questions’ (p. 89). Hence, feminist STS represents an alternative to focusing on the core or accounts from the centre by paying attention to that which is marginalized and excluded from formal accounts (Star, 1990, 1995; Suchman, 2007). Such a line of thinking pushes us to consider the importance of concrete places rather than abstract spaces, just as it equips us with a fundamental scepticism in relation to the neutral gaze from nowhere (cf. Haraway, 1988) and the tendency to privilege the positive and powerful. A feminist STS perspective insists on situatedness, accounts of lived experiences and embodied perspectives as a point of departure for empirical work as well as for theorizing.

This has implications for our understanding of the digitalized organization and digital work. In addition to implying a conceptual expansion of what counts as digital work, it involves a novel theorization of the distributed agencies and delegated activities undertaken in a myriad of different places often viewed as being outside of the formal organization, or marginal to

core organizational tasks or professional purposes. In Suchman's (2007) terms, we need to expand our analytical frame and 'at once acknowledge the magic of the effects created while explicating the hidden labors and unruly contingencies that exceed its bounds' (pp. 283–284) and, as Suchman continues, '[a]t the same time, a full analysis needs to locate these entities and the sites and moments of their efficacy in *still more extended spatial and temporal relations*' (p. 284, emphasis added).

Inspired by this ambition, we can cultivate a novel spatial root metaphoric (Alvesson & Sandberg, 2011) that challenges current dominant root metaphors in the literature on digital organizations and provides the basis for a new understanding of how digital organizations are constituted, how they work, and how this is consequential in different ways. To do so, we need to develop different topographies of digital work and Crawford's (2021) metaphor of the atlas can be a source of inspiration because it highlights how digitalization consists of a plethora of situated sociomaterial practices. An atlas maps terrains and highlights places, positions, scales and boundaries. However, rather than seeing the atlas as fixed and two-dimensional, we can imagine an interactive, digital, three-dimensional atlas that allows us to zoom in and out and up and down, not only mapping well-known terrain, but also exploring subterrains and small and marginal sites. Looking outside taken-for-granted boundaries of the digitalized organization and digital work, interrogating new topographical layers, we can include the work that enables the connected and automated organization to exist at all. An outcome of a research programme inspired by feminist STS sensibilities represents an enhanced opportunity to recognize and value invisible work related to digitalization. This paves the way for the coining of the concept *invisible digi-work*.

Invisible work

The concept of invisible *digi-work* builds on the notion of invisible work, which has been a key

concept in feminist STS (Star, 1990; Suchman, 2007). Questioning widely held assumptions about what counts as real work, feminist scholars originally invented the term invisible work precisely to broaden the scope of the work concept to include activities in the household sphere, such as cleaning, cooking and childcare as well as care taking and emotional work supporting interpersonal relationships (Daniels, 1987; DeVault, 2014). Invisible work has been applied in studies of diverse areas such as the domestic and voluntary sectors (Daniels, 1987), the informal coordination and emotional work of care workers (Allen, 2014), repair and maintenance by technicians (Jackson, 2017), or the dirty and denigrated work of, for instance, cleaners, whose efforts remain invisible to those who perform what are often defined as the core tasks of an organization (Star & Strauss, 1999).

The concept of invisible work allows us to develop an analytical approach to the digital organization as constituted differently than by an abstracted and 'positive' space where connectivity reduces distance, automation works 'automatically' without much friction, and the digital organization becomes an illuminated space. Spatial metaphors were integral to the application of the invisible work concept from the outset, as its proponents directed their gaze to peripheries of the public sphere and formal organizations and to the lived experiences of people and activities at the margins. Across the fields mentioned above, a key issue was how to define the boundary between work and non-work – a task that has both analytical and normative dimensions. From the beginning, the research on invisible work had a clear critical agenda and suggested that we develop a more generous concept of work (DeVault, 2014). In a similar vein, we suggest that a more generous conceptualization of digital work needs to be developed.

The concept of invisible work has a dual meaning. First, some work is invisible because it is *unnoticed* by (often powerful) people in or around an organization and is typically also unaccounted for in formal representations of work (Star & Strauss, 1999). Second, it is

invisible in the sense that it is *undervalued* compared to other tasks that are deemed worthier by, for instance, managers or even employees themselves (Hatton, 2017; Whiting & Symon, 2020). This duality implies a methodological (and normative) commitment to expanding the boundaries of what counts as digital work and to including hitherto excluded and marginal places as objects of analysis to contribute to the mapping of work on the periphery. These sensibilities relating to boundary and place are of particular relevance to our aim of expanding our understanding of digital work and the digitalized organization.¹

We consider invisible work to be a thick concept, which Kornberger and Mantere (2020) define as concepts that are ‘both descriptive *and* evaluative’ (p. 12). In that sense, the term invisible implies taking a stance in the boundary discussion by defining work as precisely work, even if it is not commonly seen or (sufficiently) valued as such. For this paper, it is relevant to focus on the ways in which work is made invisible in the double and thick sense of the concept outlined above.

Out of sight

When certain activities are described as invisible work, an obvious question is for whom the work is invisible and in what sense it is out of sight. This is inherently a boundary question and visibility and invisibility are always dependent on embodiment and perspective (Star & Strauss, 1999). It is never possible to decide a priori what invisible work is, as it is always situated and grounded in specific practices. Rather than being dualistic, visibility and invisibility are dialectically inseparable (Star 1990, p. 265). This is why Star and Strauss (1999) refer to ecologies of visibility and invisibility rather than invisible work per se. For instance, whereas some work is invisible to certain people in the organization, e.g. the cleaning of offices at night or janitors’ work in the basement of the building, the same work is, of course, highly visible to the people who undertake it. It could be argued that the professionals

and managers who literally do not see the cleaners are also invisible to the cleaners because they, in turn, do not see the office workers. This question brings us closer to defining what is meant by work being invisible because it is out of sight. Invisible work is often background or infrastructure work, which supports the activities defined as key and core to the organization, which shows us that invisibility is intrinsically intertwined with power and privilege.

Work is rendered out of sight in a variety of ways and through various mechanisms. First, it may take place outside the physically and symbolically defined centre of the organization. Metaphorically, it is conducted backstage (Goffman, 1959) or underground, which literally means that the people who perform invisible work are sometimes stationed at peripheral physical locations, such as the maintenance workers in the basement, or as part of an outsourced mass of workers globally dispersed and geographically far away from the company’s headquarters. Domestic housekeeping is also out of sight in this sense because it takes place in the private sphere (Daniels, 1987). Hatton (2017) terms these diverse ways of keeping work out of sight sociospatial mechanisms. They reflect boundary drawing, whereby certain practices and skills become excluded simply because they do not occur in the right place, but in invisible places (Nardi & Engeström, 1999).

Second, work may also be rendered invisible by being unaccounted for in formal documents, such as organizational charts, formal job descriptions, budgets and business cases (Star, 1995; Suchman, 2007), or job contracts – what Hatton (2017) would describe as sociolegal mechanisms. Star and Strauss (1999) apply the concept of articulation work, which they define as ‘work that gets things back “on track”’ (p. 10). Articulation work connects things, but is, by definition, invisible to rationalized accounts of work (p. 10). It is background work that only becomes visible during breakdowns. Drawing on a spatial imagery, such types of invisibility hinge upon boundary drawing, whereby some activities are represented and

placed at the forefront in formal accounts while other, often time-consuming aspects of workers' everyday activities remain unaccounted for (Star & Strauss, 1999; Suchman, 2007). Finally, invisible work may also be out of sight, not because the activities are unseen, but because they are seen as something other than work. Housekeeping, voluntary work (Daniels, 1987) and emotional labour (Hochschild, 2016) are examples of this, and they can be considered invisible due to sociocultural mechanisms (Hatton, 2017).

Devalued work

Invisible work is not only out of sight, but also devalued economically, socially, or morally – three aspects that are often intertwined in practice. Originally, feminist scholars focused on the fact that housekeeping work in the domestic sphere, predominately performed by women, was unpaid (Daniels, 1987; Whiting & Symon, 2020) and economic devaluation continues to be a key aspect of the concept of invisible work. Hatton (2017) defines invisible work as 'labour that is economically devalued through cultural, legal and/or spatial dynamics' (p. 345). Economic devaluation also applies to invisible work conducted within formal employment relationships, where it has been associated with minimum-wage jobs and poorly paid sectors (Poster et al., 2016, p. 4), as well as precarious and unregulated labour. In addition to low-paid jobs, economic devaluation also pertains to different parts of, e.g., professional work such as the emotional and aesthetic work expected of service personnel (Hochschild, 2016), or the expectation of constant availability among some professionals (Mazmanian et al., 2013). Finally, there is also the issue of who bears the often-invisible transaction costs (Newlands, 2021a) of upholding employment.

Closely connected to economic devaluation is symbolic devaluation (Hatton, 2017; Poster et al., 2016), whereby some work is considered less worthy by, for instance, managers, colleagues with different functions in the organization, regulators, customers, or even by the

workers themselves, who might think that aspects of their work are not real work (Whiting & Symon, 2020). Finally, moral devaluation, where certain forms of work are considered illegitimate, unacceptable or dirty, represents a more radical type of social devaluation (Simpson et al., 2012).²

Invisible work and digitalized organizations

Recently, scholars have employed the concept of invisible work to account for what they refer to as digi-housekeeping (Whiting & Symon, 2020), post-digitalization work (Engesmo & Panteli, 2020), or the labour made invisible in the production of artificial intelligence (AI) services (Newlands, 2021b). These studies explore the analytical potential of the concept of invisible work in the context of digitalized organizations. They indicate how boundary issues concerning what counts as work, how it is rendered invisible or visible, and how it is valued have implications for our understanding of the digitalized organization in which the comprehensive – and attention grabbing – connectivity and automation afforded by digital technologies provide a new context for work, technology and organizing.

While this strand of research in digitalized organizations contributes to challenging myths of seamlessness and assumptions about the digital as an enabling space by showing how uncertainty and friction are dealt with in organizational everyday practices, we still need solid and systematically produced knowledge about the invisible work required to uphold, maintain and repair the connected and automated organization. We develop an analytical framework for such invisible digi-work by fleshing out important types of work that we conceptualize as connecting, compensating and cleaning. In the following sections, we define each type of work, provide illustrative empirical examples, and identify the ways in which these types of work are out of sight and devalued. Synthesizing the types of invisible work and exploring their dimensions from the perspective of a feminist

STS approach allows us to develop our theoretical contribution to the literature on digitalization and organization.

Invisible Connecting, Compensating and Cleaning Work

The distinction between three types of invisible digi-work – connecting, compensating and cleaning – is analytical and, in practice, there are considerable overlaps between them. We explore them in relation to different types of tasks, occupations and professions, and group them by invoking Star's (1995) idea of an arranged space, where some work and some workers are placed in the periphery. Notions such as centre and core are, of course, always a question of place, power and perspective (Star & Strauss, 1999), as well as boundary drawing, but those notions allow us to discuss how various kinds of digital work are rendered invisible in multiple ways, depending on both their symbolic and physical position.

Connecting

Connectivity is a visible consequence of advanced technologies that enables connection between employees, teams and organizations, and also with end users (Kolb et al., 2020). It has connotations of establishing an extended and unbounded space stretching out between nodes in a network. Yet, a strong focus on digital affordances tends to focus on the centred organization, thereby failing to grasp and theorize how constant connectivity (Leonardi & Treem, 2020) depends on workers who perform constant connecting work when connectivity breaks down. These workers may be on the margins of a formal organization or have a self-understanding of being peripheral in relation to what constitutes core tasks. Connecting work can be defined as concrete activities that involve the maintenance and repair of digitally afforded connections. Following a feminist STS approach, we propose to recognize the specific locations and embodied practices where this

connecting work takes place, with different costs and consequences. Such a mapping of connecting work allows us to theorize how core and peripheries of the digital organization are established through various mechanisms, and thereby challenge the ubiquitous image of ever-expanding smooth connectivity and frictionless automation.

Far from the core: Maintaining and repairing connectivity in the platform economy

Digital platforms are connective technologies (Kolb et al., 2020) par excellence, enabling contact and transactions between service providers and users. Highlighting their connecting potential, Davis and Sinha (2021) describe digital platforms as generating a new organizational form, which they call 'Uberization' and define as 'the creation of spot labor markets enabled by smartphones in which buyers and sellers can connect for the performance of specific tasks' (p. 7). However, the seemingly smooth connections and operations of digital platforms, such as Uber, depend on a growing labour force, whose work is often out of sight for users who enjoy their services and the easy connections (Cherry, 2016; Crawford, 2021; Gray & Suri, 2019; Irani, 2015; Newlands, 2021b). In Gray and Suri's (2019) words, platform users tend to 'assume that their purchases are made possible by the magic of technology alone' (p. xvii). In the opening pages of their book *Ghost Work*, they also use Uber as an example of a platform technology that conveniently connects driver and users:

Imagine a woman in her early twenties – let's call her Emily – standing on the curb in Chicago. Emily opens the Uber app on her smart phone and an Uber driver responds. Neither Emily nor the driver knows that their meeting hinges on another woman, two oceans away – perhaps her name is Ayesha. (Gray & Suri, 2019, p. xv)

In this little story Ayesha is the ghost worker whose everyday activities are geographically located far away from the Uber encounter on a

Chicago kerbside and are entirely invisible to both Uber customers and drivers. She ensures that connection between Emily and the driver is possible and maintained because, in this fictitious example, as is the case in one percent of Uber transactions according to Gray and Suri, the transaction needs to be vetted by a human who, for instance, verifies the driver's identity. This is connecting work that forges, maintains and repairs the connections that are part and parcel of the Uber business model and seemingly smooth experience. The digital platform economy abounds with examples like these in which the connectivity of digitalized organizations is supported by behind-the-scenes workers who perform connecting work (Newlands, 2021b; Tubaro et al., 2020), thereby enabling the connections in the first place, maintaining them on a regular basis, or repairing them when needed. Their very existence at the periphery presents a challenge to implicit assumptions underlying images of the digital organization as a connected one where still more territories are conquered as technologies connect hitherto distant people and places in a smooth manner.

Digital microwork is not only out of sight, but also devalued in various ways. The pay for digital microtasks on crowdsourcing platforms is generally low, but added to this are the transactions costs, which are displaced from employers to workers (Gray & Suri, 2019). Microworkers maintain not only the connectivity of platform end users, but also their own connectivity. Their livelihoods depend on being digitally connected, and if they experience technical problems, an unstable internet connection, or if their account is blocked, they often bear the costs alone both because they do not count as employees and because they often struggle to identify who to contact if they encounter connectivity problems (Walker et al., 2021).

In the core but far from the core task: Enabling professional and flexible work

While invisible connecting work is ubiquitous in the platform economy, it is not confined to

this sector. It is also found among groups of professionals who, in contrast to the microworkers described above, enjoy various privileges, such as a high degree of autonomy as well as higher social status and pay. For instance, self-employed social entrepreneurs can be considered autonomous and flexible because connectivity allows them to work anywhere and at any time (Whiting & Symon, 2020), not unlike the digital microworkers, but under much more privileged conditions and often closer to what we tend to consider the core of the digitalized organization.

Still, these professionals also spend a considerable amount of time and effort securing the connectivity that enables their flexible work life. They must prepare, charge and sync their devices and often troubleshoot when connections are not functioning. Comparing these activities to traditional household chores, Whiting and Symon (2020) call these activities *digi-housekeeping*, describing them as 'the inevitable price of achieving constant connectivity' (p. 1092). This kind of work is invisible because the employees symbolically devalue it themselves. While recurring and time-consuming, these tasks are not considered to be real work by the independent professionals who silently bear the full cost of the effort it takes to maintain the connectivity upon which their paid activities depend. This part of their job is largely marginalized by themselves as they do not 'see' it as real work. Herein lies a symbolic devaluation.

Supporting the core: Mediating and linking digital elements

A final position to consider is one that various types of support workers adopt. Here, Pallesen and Jacobsen's (2018) study of technicians in a large, smart grid demonstration project may serve as an example. This study shows how technicians become 'middlemen' who perform largely invisible work to ensure that users stay connected to the grid. They do so in a highly literal, concrete and material sense when they repair, e.g., broken devices, but Pallesen and Jacobsen also demonstrate how technicians

ensure connectivity by supporting, training and educating smart grid users to prevent them from, for instance, turning off their equipment by mistake. Much of this work is invisible, not least to smart grid designers who picture connectivity as well as automation as running much more smoothly than is, in fact, the case.

The connecting work of supporters can also be identified in the new occupations that are emerging alongside – or in the shadows of – established and visible professions. For instance support work that involves taking care of underlying data structures is of growing importance. In their study of the emerging administrative occupation of clinical documentation integrity specialist in the health care sector, Pine and Bossen (2020) direct attention to the work this group performs through not only collecting and making data available for multiple purposes, but also doing translation work, which serves as ‘a connecting, buffering, and mediating bridge between multiple occupational boundaries’ (p. 10). Again, the point is that shared data does not automatically connect professional groups or organizations. Rather, data must be worked on to create coherence across professional and organizational boundaries. The people doing this work describe it as something clinicians should not bother with ‘because they should be left to do their core work’ (p. 10). We can think of it as social devaluation every time the significance of a given task is belittled with reference to it not being a core task, whereby it is constructed as being peripheral.

Compensating

Digital technologies are often introduced with the promise of replacing human work, and greater efficiency is expected to follow when data is easily accessible and work processes have been delegated to machines. However, efficiency gains are often smaller than expected because employees compensate by conducting several (often unexpected) new tasks that are entangled with automated digital solutions and are essential to making the solutions work in the first place. When emphasis is placed on how

digital technologies operate automatically, this (etymologically) implies that they function by themselves without human intervention and as if they worked magically in an abstract digital space (Crawford, 2021). This leads us to a second type of invisible digi-work, which we call *compensating work* and define as activities that compensate for errors, limitations, or other shortcomings related to digital technologies that promise more than they can deliver. In situated everyday practices, a myriad of such activities take place, and because they are unexpected and reactive rather than planned and proactive, they tend to be excluded from the promises attached to digital technologies (e.g. in strategies) and from formal accounts such as job descriptions. Once more, feminist STS sensibilities may help us to turn our gaze to peripheral locations, where a variety of people in various positions undertake invisible compensating work.

Far from the core: Upholding the automation illusion

To illustrate how compensating work takes place, let us again turn to the digital platform economy. Amazon Mechanical Turk, a digital platform where millions of workers around the globe perform digital microtasks such as tagging and text categorization, is often highlighted as an example of microworkers who compensate for the technological shortcomings of AI and other digital technologies (Cherry, 2016; Gray & Suri, 2019; Irani, 2015; Irani & Silberman, 2013). As we saw in the previous section, these workers conduct connecting work, but they also simultaneously compensate for the limitations of digital technologies that promise more than they can deliver.

They help maintain the automation illusion by compensating for the fact that AI is often less artificial and less intelligent than we tend to assume and many tech companies want us to think (Crawford, 2021). This situation has been described as ‘fauxtimation’ (Taylor, 2018), whereby ‘real workers remain out of sight in the service of an illusion that AI systems are

autonomous and magically intelligent’, as Crawford (2021, p. 68) puts it. Significant tasks are outsourced to a globally dispersed labour force that compensates for the fact that AI often fails to imitate human communicative and problem-solving skills to the extent hoped for and sometimes purported by companies. They are doing ‘AI impersonation’ because AI solutions are sold and marketed as though they were fully automated, even though human beings are operating them behind the scenes (Newlands, 2021b; Tubaro et al., 2020). Crawford (2021) provides the example of an allegedly digital personal assistant called Amy who schedules meetings and conducts other mundane daily tasks. However, a Bloomberg journalist called the bluff. It turned out that this digital assistant ‘wasn’t artificial intelligence at all. “Amy” was carefully being checked and rewritten by a team of contract workers pulling long shifts’ (p. 65). Faking automation is, according to Crawford, ‘an exhausting job’ (p. 65).³ As such, it also invisible emotional labour. The compensating work of microworkers far from the core and corporate headquarters contribute to the image of an abstract digital space where new technologies enable smooth operations for the digitalized organization.

In the core but far from the core task: Taking on new types of work

Automation and self-service solutions also entail new invisible work for people who occupy otherwise core and quite visible positions in organizations, and whose tasks should ideally become easier thanks to digital technologies. In the case of digital self-service solutions, the aim is to displace certain tasks from employees to users, who can order, apply, register and otherwise engage with an organization around the clock. However, compensation work is still needed when the encounter between the digital technology and the user is not frictionless. For instance, in a digitalized public sector context, many citizens need help with helping themselves, which is why frontline employees must spend time showing them how to navigate

digital systems (Pors, 2015). While the vision behind digital self-service for citizens presupposes seamless interaction in an abstract space where the citizen ideally can interact with the public sector from the personal digital device and from anywhere without a mediating case worker, research shows that case workers spend time as supporters, teachers and IT problem solvers, compensating for the shortcomings of the digital technology interfaces or the lack of digital skills among users (Pors, 2015). Such compensation work is carried out in workplaces such as service centres where public servants assist citizens in navigating the digital interfaces of the digitalized public sector. Whereas self-service solutions are in principle free from time and space constraints and the interaction with service providers, in practice they entail new types of work for the latter.

Managers also experience an extensification of their work due to the new visibilities that characterize digitalized organizations. Compensation work, in the case of managers, may comprise all the unintended but necessary work that ensues as a result of the introduction of digital technologies that were supposed to ease work processes, including managerial tasks. For instance, whereas the automated generation of – and easier access to – information is commonly considered conducive to efficient management, the explosion in visibilities also entails the emergence of new management tasks, such as working to protect cultures of trust despite the surveillance affordances of extensive digitalization, engaging in dialogue with employees about their digital behaviour and their performance traces, and so on (Justesen & Plesner, 2023). Being able to manage work via digital platforms results in an extensification of work ‘increasingly undertaken on an implicit, voluntary and contractually unpaid basis from spatio-temporal domains beyond the formal/physical parameters of the workplace’, as Hassard and Morris (2022, pp. 1649–1650) put it in their study of managerial work in the digital age. The general point is that digital technologies generate unforeseen new managerial work, and managers compensate for

this by increasing their workload in and outside both the spatial boundaries of the physical workplace and the temporal boundaries of normal work hours.

Supporting the core: Correcting mistakes to ensure flow

Advanced digital technologies introduced to reduce human error also bring about errors that are connected to their own functioning. As Barrett et al. (2012) demonstrated in their study of a hospital pharmacy, a robot was implemented with the aim of decreasing errors and thereby contributing to the smooth running of the professionals' work, but this led to new errors that had to be handled elsewhere in the organization and were, hence, out of sight for the professionals who benefitted from the robot. Automation allowed hospital pharmacists, i.e. higher status front-end employees, to go about their work more professionally. But at the same time, it rendered invisible indispensable behind-the-scenes work involving both troubleshooting and now more intense collaboration between the assistants who fed the robot and the technicians who had to calibrate it to minimize errors. As Barrett et al. (2012) describe it:

The disregard of assistants' 'pain' was facilitated by the pharmacists' won excitement over the role of dispensing robots in expanding their opportunities to do more research and clinical work and furthering their professionalization agenda. As pharmacists' attention focused on their expanding professional jurisdiction and status, the largely silent distress of the assistants was neglected. (pp. 1459–1460)

To keep up with the extra tasks resulting from the introduction of the robot, assistants had to work off-hours when it was not in such high demand. Furthermore, they were relegated to a small and cluttered 'back end' due to the robot's size, while the more highly ranked staff worked in a more spacious and appealing 'front end' (p. 1460). The assistants felt they had been demoted and that their working conditions were downgraded. Both temporal and

spatial marginalization brought about this situation.

A similarly often overlooked type of activity supporting professionals is data work. Although awareness of data work exists, planners and strategists fail to acknowledge the extent of additional tasks required beyond producing or using data for professional purposes, such as adding to and combining datasets, interacting with data, helping move data to different departments and contexts (Møller et al., 2020), engaging in detective work to search for missing or supporting data (Pine & Bossen, 2020), and curating data by compensating for data imperfections (Plantin, 2019). As Møller et al. (2020) state, 'practices of data work are often invisible to managers, and data-work tasks get neither the necessary resources nor the proper compensation' (p. 52). Such work compensates for the fact that data does not flow by itself and is not always in a state that allows analysts to use it unproblematically. Although data can be generated and captured automatically, human intervention and compensation are still required in the case of, e.g., poor interoperability or an absence of metadata. Although data is often portrayed as floating around in abstract digital spaces, sometimes envisioned as 'the cloud', the examples provided here illustrate how data flows are much more dependent on work conducted by people in specific physical places.

Cleaning

The automation illusion described above is linked to the assumption that digitalized organizations can perform more tasks seamlessly. But ensuring seamless processes also requires work to establish clean digital spaces, whether these are social media platforms cleansed of disturbing content or a neat and tidy workspace made ready for what is seen as real work. This assumption leads us to propose a third type of invisible digi-work, which we conceptualize as cleaning work. This can be defined as modifying, purifying and removing what is perceived as waste, mess or dirt, sometimes signaled by terms such as e-waste (Stowell & Warren,

2018), robot waste or junk-mail (Whiting & Symon, 2020) that hamper the smooth functioning of the digital organization or the perceived appropriateness of digital content. As such, cleaning is dirty work (Simpson et al., 2012), sometimes in a metaphorical sense but also in quite a literal sense at times. Cleaning concerns boundary drawing in the sense that a clean digital space is established by removing items from it. Again, this type of tidying is less automatic than we are often led to believe, as it often involves invisible cleaning work performed by people who operate outside the boundary of the clean space they help create, placing them in a marginal position in relation to what goes on within the boundaries of the cleansed space.

Far from the core: Moderating content and moderating oneself

Once more, digital microworkers can serve as an example when they sort, tag and remove disturbing content from social media platforms (Gray & Suri, 2019). Among the dirtiest tasks is probably content moderation, labeling images as pornography or as violating terms of service (Irani & Silberman, 2013), or removing offensive or disturbing content (Gray & Suri, 2019). Shortly after the launch of the AI chatbot ChatGPT, an article in *Time* magazine reported how data labelers in Kenya were hired to make ChatGPT less toxic by tagging material pulled from the darkest internet to train the chatbot and prevent it from generating offensive content (Perrigo, 2023). Such tasks are performed by invisible workers, who are part of a massive, globally dispersed hidden industry (Roberts, 2019) and who apparently sometimes delegate tasks to workers who are even less visible, as in Gray and Suri's account of a woman in Bangalore who had her children doing tagging. As this microworker recounts, 'They help me keep the internet clean and safe for other families' (Gray & Suri, 2019, p. xi). The psychological cost of performing such work has only recently emerged in the debate about digital

labour, for instance in discussions of incentives to automate this kind of work:

These moderators are doing psychologically scarring work, in sometimes intolerable conditions, often under precarious labor arrangements. In fact, the strongest argument for the automation of content moderation may be that, given the human costs, there is simply no other ethical way to do it, even if it is done poorly. (Gillespie, 2020, p. 4)

Apart from the hopes for a technological fix expressed in this quote, it points to a type of invisible emotional labour that can be part of precarious jobs performed in various digital environments. Another example is related to algorithmic recommendation systems, which render organizations fragile because of the risks associated with negative reviews. Employees must perform extra work (Bucher et al., 2021) to 'swallow their negative emotions both during interactions with clients, but also in replying to negative reviews' (p. 57). Although this is not the terminology of Bucher and her colleagues, the negative reviews can be considered a pollution of a space that these workers need to keep positive and 'clean' to sustain their business. This is why they put in a significant 'cognitive, social and emotional effort that is intertwined with regular tasks and is aimed through direct and indirect practices at pacifying the algorithm' (p. 59). The emotional labour takes place not only in physical spaces that are out of sight but is also – obviously – intangible and rarely articulated.

In the core: Clearing the way for real work

In Whiting and Symon's (2020) study of self-employed entrepreneurs and other flexible workers, the authors identify cleaning work as being among the invisible tasks that take time and effort since they consist of 'clearing digital space' and getting rid of 'rubbish' such as 'junk mail' to prepare for that which is considered real work (p. 1085). According to Whiting and Symon, this aspect of

digi-housekeeping has obvious parallels to traditional housekeeping like washing up and doing the laundry (p. 1086). One of the self-employed entrepreneurs participating in their study recounts:

When I come into my work email. . .this is just annoying and a waste of time. I just have to go through and delete 34 emails. Most of it is just junk, kind of annoying, most of the time but there you go. (Whiting & Symon, 2020, p. 1085)

The devaluation is cloaked in a strong metaphorical and evaluative language as reflected by the words junk and waste of time. Yet, at the same time, this task is a necessary part of the job.

Supporting the core: Cleaning datasets

In organizations that seek to leverage the datafication processes discussed above, data work involves cleaning. The greater the dependence on data, the greater the need for data processors and data curators who ensure that datasets are pristine, according to Plantin (2019), who gives the example of the work involved in preparing datasets for research:

First, managers and peers verify that datasets are cleaned of all the flaws, irregularities, and other idiosyncrasies from the original data producers. This is the first level of cleaning [. . .] processors here remove elements of the original context and ensure that data sets can be used in future contexts without biases or difficulties. The second and equally important cleaning concerns the work of processors themselves. Data sets are deemed ready when no traces of their cleaning and repair remain in the final data set. (Plantin, 2019, p. 66)

Plantin, who highlights the distinction between inside the archive, where data work is highly visible, and outside the archive, where it must be invisible, problematizes the fact that data work is out of sight and undervalued:

as long as the institution will rely on such an erroneous conception of data [as raw] to organize data processing, it will reproduce the invisibility

of data processing staff instead of acknowledging how critical their intermediary function is to data sharing. (Plantin, 2019, p. 55)

Automation in digitalized organizations depend on data flows that are often pictured as relatively free-floating. Yet, data-intensive processes often require some manual cleaning of automatically generated data (Scroggins & Pasquetto, 2020, p. 123). This implies that even though automation may save labour, it may also result in additional labour (p. 123), often performed by technicians or juniors. Other decidedly unglamorous tasks are ‘new kinds of invisible labor in the form of authoring meta-data and preparing datasets for long-term access’ (p. 124). Ensuring that data archives are kept in order is fundamental, but it is socially undervalued work even though it supports the core work processes.

Invisible Digi-Work: Out of sight and devalued

Based on the accounts of connecting, compensating and cleaning work in digitalized organizations, we have substantiated what we see as key types of invisible digi-work. We can refine our understanding of these types of work by systematically examining what they comprise in work contexts that can be described as in the core, supporting the core, or far from the core. Each dimension of invisible work takes different forms and is shaped by different invisibility mechanisms (Hatton, 2017) depending on place and position in or around the digitalized organization. This allows us to explore other topographies than the abstracted and seamlessly functioning spaces of digital organizing centred around core tasks and professionals.

Invisible digi-work far from the centre

Far from any centre of a digitalized organization, we find a growing labour force that performs connecting work, compensating work and cleaning work, typically under highly precarious conditions. They maintain and repair the digital connections that are a prerequisite

for the constant connectivity highlighted as essential in digitalized organizations. They compensate for the shortcomings of intelligent digital technologies, and thus help to maintain the automation illusion (Crawford, 2021). Finally, they keep the internet clean by, for instance, moderating and removing disturbing content.

Organization studies have paid scant attention to these digital microworkers whose work is invisible in various ways. Physically dispersed, they are literally out of sight for users, who are often not aware of the contributions of microworkers to the operation of the platforms whose services the users enjoy. They are what Star and Strauss (1999) call non-persons, as also captured by the metaphor of *ghost* work (Gray & Suri, 2019). Not only their activities, but also their bodies and their very existence are rendered invisible because this kind of work occurs in invisible places (Nardi & Engeström, 1999), located outside the boundary of the formal organization and the spheres of users. Furthermore, digital platform workers are invisible not only to platform end users, but also to employers who, in many instances, do not know the identity of the platform microworkers who anonymously perform their tasks. Anonymity also implies that workers are invisible to each other, which makes it difficult to establish a collective identity that could serve as the basis for collective action (Gray & Suri, 2019).

Various mechanisms contribute to making these workers and their work invisible. In Hatton's (2017) terms, they are marginalized and kept out of sight due to sociospatial and sociolegal mechanisms. Geographically remote from corporate headquarters and end users, digital microworkers are also physically isolated, typically working alone from home (Gray & Suri, 2019). Since it is outsourced, digital microwork is unaccounted for in the sense that it is absent from formal company descriptions and legal documents, such as employment contracts, which is a socio-legal mechanism that contributes further to their invisibility.

Digital microwork is often devalued economically by being systematically underpaid,

but also because microworkers bear considerable transaction costs and find themselves in vulnerable situations in that not only is their source of income often precarious (late payment, if at all, and nobody to complain to) but also their employment can be terminated without explanation (Gray & Suri, 2019). At the same time, their work is devalued socially, for instance, when deliberately hidden or when fake automation is demanded to compensate for technological shortcomings (Crawford, 2021; Newlands, 2021b; Tubaro et al. 2020). This dynamic can be seen as symbolic devaluation but also as moral denigration. The cleaning of disturbing content, which may be considered dirty work in a digitalized context, involves the emotional costs that the workers endure.

Invisible digi-work in and around the core

While the workers and the activities described in the previous section can be seen as an extreme case of invisible digi-work, we see similar examples, patterns and mechanisms closer to what is typically considered the core of organizations. Here, we find professionals, self-employed entrepreneurs and managers. In contrast to digital microworkers, these groups enjoy various privileges and typically much greater social recognition. So, in what sense is their work out of sight and devalued? Like the digital microworkers, they too perform connecting work because the constant connectivity upon which their livelihoods depend is less stable than anticipated – as in the case of self-employed entrepreneurs (Whiting & Symon, 2020). Professionals in different organizations also compensate for the fact that self-service solutions are less intuitive for users than anticipated, which pushes them into new roles as helpers and facilitators (Pors, 2015). Additionally, they need to spend time cleaning their digital work spaces (Whiting & Symon, 2020).

Yet, rather than being hidden away and devalued by others through exclusionary

sociospatial and sociolegal mechanisms (Hatton, 2017), the activities described above are symbolically discounted as not real work by the professionals or managers themselves, even though these activities are recurrent and take considerable time and effort to perform. Some professionals consider their new roles a reduction in professional status and lament what they perceive as a loss of authority and a move away from their core professional competencies (Pors, 2015), hence socially devaluing elements of their new work practices in the digitalized organization. Whereas microworkers are placed in peripheral positions in relation to more obvious organizational centres, counting as non-persons in non-places, different boundaries are in play concerning people located at what is considered the centre of formal organizations. Here, tasks that are key to the maintenance of the digital organization are excluded because they are marginal to the self-understanding and perception of the real work of those concerned.

Invisible work supporting the core

Supporting the operating core of organizations, we find employees in a variety of administrative functions. It is nothing new to say that they support the work of others, but increased datafication, in particular, leads to new kinds of invisible digi-work. Data workers connect professional groups by connecting data, they compensate for the fact that data is less readily available and often of poorer quality than assumed, and they clean data to prepare it for the professionals or managers whose work depends on datafication. These groups of employees are not geographically dispersed and isolated like digital microworkers, but at the same time, they do not enjoy the same privileges as professionals and managers positioned at the core of the formal organization. They may work side by side with the professionals they support, as in Barrett et al.'s (2012) study, but like Pallesen and Jacobsen's (2018) technicians, they may also be invisible to scientists and designers who assume that connectivity

and automation almost work by themselves, with little need for more than the occasional technical repair. Unlike the professionals and self-employed entrepreneurs described above who disregard their own supporting work as not real work, we see no evidence that supporters, technicians and data workers do not recognize what they do as work. However, those who are considered to be at the core of the organization seem to undervalue and underestimate their work, such as the designers in Pallesen and Jacobsen's (2018) study, and resource allocation is not always adequately reflecting the extent to which this work is necessary to make the core tasks of organizations possible.

Based on the above, we summarize in Table 1 the main characteristics of invisible digi-work.

Invisibility and devaluation mechanisms are, as previously argued, dynamic and depending on power and perspective. But by highlighting some main characteristics of invisible digi-work, we are able to draw contours of how specific positionings and boundaries make up the arranged spaces (Star, 1995) of work in and around the digitalized organization, bearing in mind that this picture is not static, that defining a centre depends on the questions posed (Star, 1995), and that more devaluations mechanisms could be identified and problematized. Yet, depending on place and position (in relation to a given organizational core) invisible work is chiefly about handling problems for distant others, about handling immediate problems that prevent one's own core work, or about handling fundamental problems for others, facilitating their core work. The closer to the core, the fewer devaluation mechanisms, and the further from the core, the more devaluation mechanisms. The invisible digi-work carried out in different places (relative to the given organizational core) are types of work that challenge assumptions about digitalized organizations being well-connected spaces afforded by smooth infrastructures. Rather, digitalized organizations are made up by fragile elements; their constitutive elements produce frictions, which is why they must be repaired and maintained.

Table 1. Characteristics of invisible digi-work.

	Far from the core	In and around the core	Supporting the core
Connecting work	Ensuring connectivity for others and upholding own connectedness	Upholding own connectedness	Ensuring connectivity for others
Compensating work	Upholding automation illusions	Performing unexpected tasks generated by digital technologies	Troubleshooting unexpected problems to make digital technologies function
Cleaning work	Moderating content and moderating oneself	Clearing the digital work space to allow for one's own (core) tasks	Cleaning data to ensure the functioning of digitalized organizations
The position of invisible work in relation to organizational core	At a physical and symbolic distance from the formal organization	At a symbolic and emotional distance from one's core tasks	At a socio-hierarchical distance from the organization's defined core tasks
Primary type of devaluation of work	Economic: underpaid, precarious Social: anonymous, isolated Moral: degrading and deliberately hidden	Social: elements of work marginalized and not acknowledged by professionals themselves	Social: not acknowledged by core professionals Economic: not being allocated sufficient resources

Invisible Digi-Work: New topographies of digitalized organizations

In this paper, we discussed the invisible work involved in establishing and maintaining digitalized organizations. We proposed to conceptualize this as invisible digi-work consisting of connecting, compensation and cleaning work. The theorization of invisible digi-work responds to recent calls for new theoretical concepts to better describe and understand the comprehensive digitalization currently transforming work and organizations (Leonardi & Treem, 2020; Orlikowski & Scott, 2023). The three types of invisible digi-work we propose cut across different job functions and professions and they are relevant to understanding the changing work of precarious labour performed outside of formal organizational contexts but also to aspects of more prestigious professional and managerial work and various administrative and technical support functions closer to what is often conceived as the centre of the organization and to its core tasks.

With the invisible digi-work concept, we elaborate on the notion of digital work at a crucial moment when digitalized organizations are becoming ubiquitous and work, as Orlikowski and Scott (2016) put it, always entails the digital. If all work requires the digital, and if the digital is dependent on invisible work, as argued above, we propose that invisible digi-work is a corollary to Orlikowski and Scott's (2016) concept of digital work, making it an integral aspect of the digitalized organization. This organizational focus mobilizes the potential of the invisible work concept in theorizations of new organizational developments and expands its application beyond specific spheres. When examining invisible digi-work, we see how it is a consequential phenomenon, essential to the constitution of the digitalized organization.

Our agenda contributes to advancing our present knowledge of the digitalized organization. We have a good grasp of key features of the digitalized organization, such as connectivity, automation and visibility (Flyverbom, 2022; Kellogg et al., 2020; Kolb et al., 2020), but the time has come to pay attention to and

develop novel theoretical tools to understand digitalization phenomena that are at a distance from the visible organizational changes that are entangled with technological affordances (cf. Orlikowski & Scott, 2023). If we only focus on changes to the work that is placed at the *centre of the organization*, the more peripheral work – both literally and metaphorically – is in danger of being forgotten, even though its scope seems to be expanding due to digitalization, as illustrated throughout this paper. If the core tasks in the organization are becoming increasingly dependent on the key dimensions of the digitalized organization, the organization is also becoming increasingly dependent on the work required to support these dimensions. And the work in the core itself is also digital, and hence not spared from the need to perform invisible digi-work.

The feminist STS tradition and its classic concept of invisible work offers three important kinds of inspiration for challenging some of the dominant spatial root metaphor assumptions (Alvesson & Sandberg, 2011) in current research and for developing an alternative metaphoric of digital work and the digitalized organization.

First, the focus in feminist STS on boundaries sensitizes us to what is at the periphery or outside the boundary of what we understand as work. Deploying invisible digi-work as a thick concept (Kornberger & Mantere, 2020) with both descriptive and evaluative dimensions helps us direct attention to overlooked and undervalued tasks, integrating the recognition that their invisibility is interwoven with place, power and privilege (Star, 1990). Approached in this way, the invisible is not just an absence or that which resides in the dark. Instead, it acquires a normative dimension, rendering work that is otherwise excluded from accounts, left out of sight and devalued an object of analysis. This may bestow recognition on the workers and the work, which is devalued economically and/or symbolically (Hatton, 2017). It is also consequential for our understanding of digitalized organizations since it problematizes current ways of drawing boundaries around them.

Our accounts of types of invisible digi-work problematize spatial root metaphor assumptions about the digitalized organization as a ‘positive’ and enabling space and it problematizes a restricted understanding of work in the digitalized organization. The inclusion of excluded work practices that make the digitalized organization function brings about a richer understanding of organizations today – which is called for since we do not only witness an expansion of the digitalized organization due to the affordances of the digital, we also witness the emergence of new types of work and must engage in expanding what we think of as digital work. Combining the capacity of the invisible digi-work concept to include many types of work with an interest in the specificities of how connecting, compensating and cleaning work are conducted differently in different places results in a theoretical vocabulary that facilitates nuanced, detailed, systematic and – as a result – generous accounts of changing work in digitalized organizations.

Second, while spatial images already abound in discourses on digitalization, a feminist STS-inspired lens and the concept of invisible digi-work bring the analysis down to earth and offer heuristic alternatives to abstract digital spaces of clouds and disembodied digital platforms. Crawford’s (2021) metaphor of an atlas is useful in this regard. An atlas brings our attention not only to places, but also to scale, connections and boundaries. The various accounts of invisible digi-work presented in this study can be considered elements in a preliminary mapping of the specific places where the digitalized organization is maintained and repaired through connecting, compensating and cleaning work. The atlas metaphor should not be understood as a suggestion to look from afar on aggregated or abstracted phenomena, but rather to be assembled by moving through landscapes, following traces, zooming in and out, and taking notes in a slow and conscientious fashion. As Crawford (2021, p. 10) suggests, ‘an atlas offers us the possibility of rereading the world, linking disparate pieces differently’, but without succumbing to the belief that these mappings add up.

Rather, they are partial views dependent on shifting positions, power and perspectives. As Haraway (1988) reminds us, vision is always situated and embodied.

Third, a focus on invisible work supplements recent calls in organization studies to go 'beyond the visual' (Quattrone et al., 2021) and investigate indirect and less visible (Orlikowski & Scott, 2023) implications of digitalization. Much research in the field of organization and digitalization has focused on the explosion in visibilities (Flyverbom, 2022; Justesen & Plesner, 2023; Leonardi & Treem, 2020; Zuboff, 2019) made possible by connectivity and automation, and on the way this changes the insight of organizations into human patterns of behaviour, in general, and work processes and performances in particular. While it is widely acknowledged that visibility is connected to opacity (e.g. Flyverbom et al., 2016) there is great potential in further developing our understanding of the invisible in the digitalized organization in a particular sense, namely as a type of work that is distributed, practical and embodied. Such an approach to invisible digi-work adds to the organizational literature on visibilities and invisibilities, formal and informal work, and openness and opaqueness. It also encourages an expansion of the analytical sensitivity of many studies of digitalized organizations and digital work and goes beyond the attention given to work afforded by and entangled with digital technologies to theorize the work that makes digital affordances and entanglements possible at all. Thereby, the attention to invisible digi-work also plays a part in problematizing portrayals of the digitalized organization as one that operates seamlessly and without frictions.

Future research: Some suggestions

Our paper has observed invisible digi-work through a spatial lens and fostered metaphors aligned with this imagery, but we suggest that future research could supplement this approach with a temporal perspective, conceptualization and metaphors. In addition to being in different

places, the various manifestations of invisible work also possess biographies (Glaser et al., 2021) and career trajectories that are worth exploring further. Since invisible digi-work is not a static phenomenon, a temporal analysis could fruitfully be used in empirical studies of the work required to establish and maintain connectivity and automation. Another possible way of observing the examples of invisible digi-work discussed throughout the paper is to look at how work *prepares* the digital execution of core tasks and the features of the digitalized organization, and how work *repairs* the features. As the terms *prepare* and *repair* indicate, it may be helpful to approach digital work as that which takes place before and after what is considered the actual work.

We believe that invisible digi-work requires not only new ways of theorizing the digitalized organization but also novel methods, and possibly even new methodologies. This ambition resonates with the broader question of how to examine phenomena defined as being invisible and thereby, as mentioned above, go beyond the visible (Quattrone et al., 2021) that has dominated the field of organization studies. Studying what is not there seems inherently paradoxical, but feminist STS scholars remind us that the invisibility–visibility interplay is a dynamic one that depends on context, power and perspective. So, what methods will be appropriate to study work that is out of sight as well as devalued? How might we empirically capture and describe the mechanisms that render these activities invisible in the double and thick sense suggested in this paper? As much invisible digi-work partly takes places on online platforms, how might netnographies (Kozinets, 2002) and other digital methods supplement more traditional ethnographic work to better access, understand and describe aspects of invisible digi-work – in a nuanced way that bears in mind that invisible digi-work is also always physically embodied and located *somewhere* (Haraway, 1988) and never merely takes place in an abstract digital space? Can we devise methods to describe this hybrid presence and its consequences? How might time studies give

new insights regarding the amount of unobtrusive daily tasks of connecting, compensating and cleaning that sneaks into all types of work practices? How might document studies, in combination with other qualitative organizational studies, offer insights into the invisibilities produced in accounts of digitalization?

While invisible digi-work is essential for the operation of the digitalized organization, it is overlooked and undervalued in practice and neither systematically analysed nor theorized in the organizational literature on digitalization. Since the cost and indirect consequences of digital affordances are poorly understood, more empirical studies are needed to shed light on the various lived experiences of people engaged with invisible digi-work in practice (cf. Morgan et al., 2023). Such studies could teach us more about the implications of digitalization for employment relations, professional relationships, management and the conditions for collective action related to work conditions. Finally, we could account more fully for the emotional costs, mental loads and unintended tasks associated with digitalization.

Acknowledgements

We wish to thank a number of people for offering excellent feedback on this paper along the way. Thanks to our editor, Joep Cornelissen, for highly developmental advice, and to our anonymous reviewers for insightful and helpful comments. Thanks to the participants in the OT Winter Workshop 2023, in particular Christian Fieseler and Frank den Hond, for engaging with our manuscript in a most useful way. Thanks also to Tammar Zilber for very inspiring comments at an early stage in the process at an IOA seminar at CBS as well as to the participants in a research seminar at the Wirtschaftsuniversität Wien, June, 2023. And finally, thanks to our colleagues in the Work, Expertise, Technology and Organization research cluster at IOA, CBS for – as always – informed and inspiring comments on our work in progress.

Author Contributions

The authors are listed alphabetically and contributed equally to the paper.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This research is funded by The Independent Research Fund Denmark (Grant number 9130-00011B).

Notes

1. The definition implies that the hidden operations of big tech companies, intelligence services and other secretive organizations are not invisible work in the sense that we understand it.
2. While invisibility often implies social and economic devaluation, scholars have also emphasized that, in some situations, a certain degree of invisibility is the precondition for professional autonomy and learning (Star & Strauss, 1999; Suchman, 2007). When work is visualized, standardized or formalized, professionals often feel that their discretionary space is drastically diminished and their expertise devalued.
3. For a first-hand account of fauxtomation, see this piece in *The Guardian*. https://www.theguardian.com/technology/2022/dec/13/becoming-a-chatbot-my-life-as-a-real-estate-ais-human-backup?CMP=longread_email (Thanks to Frank den Hond for bringing this article to our attention).

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