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Doing the work: Locating labour in infrastructural geography

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Abstract

As the social sciences undergo an infrastructural turn, geographers have taken steps to broaden, disrupt, and reconceptualise understandings of infrastructure and its relationship to social, political, economic, and ecological processes. We contribute to this discussion by highlighting the emergence of a comparatively understudied yet crucial aspect within infrastructural geographies – infrastructural labour. We identify key theoretical anchors that guide contemporary analyses of infrastructural labour, which we query by focusing on five key areas of scholarly discussion. Building on these, we offer a working definition of infrastructural labour to help guide further engagement and point to questions meriting additional investigation.

Keywords

labour, work, infrastructure, geography, infrastructural labour

1 Introduction

How we understand infrastructure has changed dramatically through the social sciences' infrastructural turn (Buier, 2022; Fortun and Fortun, 2015). From focusing on physical infrastructures – nuts and bolts, pipes, and wires – analyses now conceptualise them as contested, relational, socio-technical configurations that shape environments and everyday life (Carse, 2016). This dynamic and growing body of scholarship has expanded notions of what infrastructures are and can be by making visible infrastructurally mediated and led processes, practices, and politics that underpin capitalism, colonialism, urbanisation, and everyday life. Geographies of infrastructure have highlighted infrastructural splintering, inequalities, and oppressions,

asking whom specific infrastructures serve and under what conditions (Batubara et al., 2018; Gandy, 2004; Graham and Marvin, 2001; Kooy and Bakker, 2008; McFarlane, 2018; Pamell and Pieterse, 2010).

As the infrastructural turn continues to unfold, conceptual precision and analytical distinctions have become increasingly important. Beyond providing added clarity, taking stock of emergent and converging discussions within this field of research can point to relations and processes meriting further

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attention. Here, we focus on the work that creates, sustains, and performs infrastructures – increasingly known as infrastructural labour (Gidwani, 2015). Scholarly attention to (and engagement with) infrastructural labour has lagged in the infrastructural moment and was ‘often not central to the conceptualization of infrastructure’ (Strauss, 2020: 1218). However, recent scholarship suggests a more fundamental engagement with these categories is underway (Addie, 2021), raising important questions not only around how we understand infrastructural labour, but also infrastructure in general.

Our objective for this article is two-fold: first, we critically review recent scholarly engagement with infrastructural labour, analysing prevailing interpretations of labour within infrastructural geographies to date, and pointing to ongoing discussions which are shaping how infrastructural labour is understood across geography and associated disciplines. In doing so, we wish to intervene in the growing field of infrastructural geography, while drawing connections to other subfields and disciplines, acknowledging that much can be gained from engaging with human geography more broadly. From this position, our second aim is to sharpen conceptualisations of infrastructural labour, in the hope that this can inform emerging research agendas and highlight its relevance beyond the academy. In particular, we offer – and explore the implications of – a working definition of infrastructural labour as intentional human work which is fundamental in sustaining collective life by enabling, mediating, maintaining, and modifying infrastructural assemblages.

We believe deeper engagement with infrastructural labour can do three things. First, it can clarify what labour and work do in the more-than-human associations and relations that constitute infrastructure, drawing attention not only to its necessity but also to its visibility and value. Second, it can function as a starting point to further refine not only what it meant by infrastructural labour, but also by infrastructure at large, which is particularly relevant given the liveliness of the infrastructural turn. Finally, engaging with infrastructural labour and how it is perceived, performed, and politicised can be a timely enterprise, engaging with a

contemporary moment characterised by intersecting ecological, economic, social, and political crises (Carr, 2022; Rose-Redwood et al., 2020).

Our intervention takes the following structure. We first consider how infrastructure and forms of labour and work associated with it have been described and theorised in recent scholarship. We build on these interpretations by engaging with five scholarly discussions that distinctly contribute to analyses of infrastructural labour: incremental, performed, and provisional infrastructures; maintenance and repair; social infrastructures, reproductive labour, and care; coloniality, racial capitalism, and unfree labour, and; infrastructural labour in the digital age. We contend that each of these five discussions provides a fruitful starting ground for interrogating the complexities and purchase of the notion of labour within infrastructural geographies, either in highlighting its essential role in making and maintaining infrastructural relations or in clarifying what distinguishes infrastructural labour from other forms of work. The final section puts forward a working definition of infrastructural labour and proposes several avenues for further reflection and investigation. While there are undoubtedly many possible directions to be taken, we emphasise those that can support (re)conceptualisations within infrastructural geographies, along with critical and propositional approaches for understanding and engaging with infrastructural labour in the contemporary moment (Baptista and Cirolia, 2022).

II What is (and isn't) infrastructure?

Before proceeding, we begin with a deceptively simple question: What do we mean by infrastructure? Over the last three decades, scholars have repositioned infrastructures as relational, political, lively and, consequently, as prime conceptual entry points into urban life, governance and environmental politics (cf. Amin, 2014; Doshi, 2017; Easterling, 2014; Furlong, 2014; Lawhon et al., 2014; McFarlane and Rutherford, 2008; Monstadt, 2009; Swyngedouw, 2006). This lively, political understanding has reconceptualised infrastructure as a political, socio-material assemblage of flows, rhythms, and relations (Carse, 2016; Graham and

McFarlane, 2015). However, this broadening has resulted in concerns over definitional looseness (Buier, 2022; Hesmondhalgh, 2022) and lack of attention to historical specificity (Schweitzer et al., 2017), which raises questions about the analytical purchase of infrastructure.

We agree that infrastructure's growing popularity has risked eroding its conceptual precision, while also appreciating the debate around infrastructures' parameters and specificity. Bearing this in mind, we state plainly our current understanding of infrastructure as a premise for a more in-depth discussion of infrastructural labour. We understand infrastructures as being distinct socio-material assemblages which mediate the lively and repeated processes that underpin and sustain collective life, governance and power, and/or capital accumulation (Amin, 2014; Berlant, 2016; Graham and McFarlane, 2015). This definition seeks to balance materially centred interpretations of infrastructure, as per Larkin's interpretation of infrastructure as 'matter that enables the movement of other matter' (2013: 329), with more recent contributions that have highlighted the social, relational, and affective dimensions of infrastructure.

The 'contemporary infrastructure frenzy' (Cowen, 2018) has also led scholars to question possible gaps meriting further investigation. In her review of labour geographies of precarity, Strauss noted that the infrastructural turn has had a limited engagement with labour, concluding that greater attention to labour could yield new insights on social infrastructures, international infrastructural labour markets, and capitalist and colonial development of infrastructures (2020). Others have commented on this gap (Buckley, 2018), including those working on the relations between humans and non-humans in digitally mediated cities (Rose, 2017) and on characterising the emergence of a broader *posthuman* moment (Braidotti, 2013). While largely in agreement with these assessments, we also recognise the recent and growing body of infrastructural scholarship that centres its analysis around labour (Addie, 2021; De Coss-Corzo, 2021; Stokes and Lawhon, 2022) and infrastructural practice (Barnes, 2017; Denis and Pontille, 2014, 2015; Ramakrishnan et al., 2021).

We suggest this is an important moment for assessing the increasing, yet often dislocated engagement with labour within infrastructural geographies.

III Locating infrastructural labour

Our intention in this section is to locate infrastructural labour in recent geographic scholarship. While our primary focus is on infrastructural geographic scholarship, we occasionally reach out to adjacent fields, heeding calls to deepen engagements with other bodies of literature to refine our conceptual and theoretical approaches to infrastructure (Buier, 2022). We focus on what we identify as key contributions to this scholarship: the work of Vinay Gidwani and colleagues (Gidwani, 2015; Gidwani and Chari, 2004; Gidwani and Maringanti, 2016; Gidwani and Reddy, 2011) on matters of infrastructural labour, and the notion of 'people as infrastructure', as initially developed by AbdouMalik Simone (2004, 2021). We see these conceptual and theoretical approaches, as well as their tensions and points of coincidence, as fundamental for contemporary scholarship on infrastructures and work, labour, and other associated human practices. Clarifying what infrastructural labour and 'people as infrastructure' do can allow us to better understand the theoretical, conceptual, and practical implications of the growing body of literature that this paper engages with in detail.

As a concept, infrastructural labour first appears within the work of Gidwani and collaborators, grounded in their investigations and theorisations of waste infra-economies and the work underpinning such infrastructures (Gidwani and Chari, 2004; Gidwani and Maringanti, 2016; Gidwani and Reddy, 2011). This attention to waste work's infrastructural qualities emerges amidst a broader body of scholarship attending to the politics, economies, and performance of diverse forms of waste work across diverse contexts (cf. Gille and Lepawsky, 2022; Millington and Lawhon, 2019; Moore, 2012). Key is Gidwani's plenary lecture for *Transactions*, where the term 'infra-structural labour' is used to describe the informal work that transforms waste materials

within heterogeneous value chains of waste's informal infra-economies, which is 'continuously re-creating the conditions of possibility for urban life and capitalist enterprise' (2015: 576). Gidwani places infrastructural labour as a necessary element in the reproduction of capital, as it underpins processes of accumulation, urbanisation, and social reproduction, in ways that traverse and break down boundaries between waged and unwaged, formal and informal, and other binarily conceptualisations of labour.

Meanwhile, increased attention to human dimensions of infrastructural performance and functioning has generally emerged through some reference to or engagement with everyday practice. Of particular relevance is Simone's 'people as infrastructure' (2004), which pushed against technological/material interpretations of infrastructure by calling attention to people's activities, collaborations and relations as a veritable infrastructure or 'platform providing for and reproducing life in the city' (2004: 408), particularly in heterogeneous connectedness of majority urban worlds. Simone revisited 'people as infrastructure' in 2021 to clarify initial intentions and orientations two decades on. Within his *Ritornello*, Simone notes how describing people's collaborative relations and actions as infrastructures was meant to render them technical and generate 'possibilities of acting in concert beyond the explicit intention or planning of any individual or group' (2021: 1341).

This imagination harkens back to Simone's push against top-down, calculated, delineated, codified, and functional ways of seeing urban life and space. Instead, 'people as infrastructure' highlights the potentiality in everyday urban life in the majority world, a way of highlighting agency, fluidity, attunement, and change. Simone draws on Simondon to emphasise the blurring between human and technical life (2021: 1347), which is present in the radical openness of new constellations, configurations and ways of being and doing in the world. These ways of being are always enmeshed with others, both human and non-human, which Simone contends are overlooked by approaches that seek to taxonomise everyday urban life in the majority world. The concept of 'people as infrastructure',

then, also sheds light on spaces and practices that are often considered to be outside of and superfluous to contemporary urban life under capitalism, instead seeing them as underpinning sites where the technical, improvisational potential of collective life is forged contra capitalist accumulation and political rule (2021: 1348).

Taken alongside Gidwani and collaborators' approach, 'people as infrastructure' brings into focus the very different ontologies and orientations which coalesce on infrastructural labour. We take this ontological and epistemological plurality as an invitation to elucidate *what* human practices and efforts constitute labour within infrastructural processes and whether certain forms of work constitute a veritable infrastructure unto itself. In doing so, it is useful to consider Nelson and Bigger's (2022: 10) brief taxonomy of infrastructure and labour. There, they identify three key forms: (1) labour and infrastructure, or the ways in which infrastructures reproduce precarity and different valuations of labour; (2) labour of infrastructure, or the work that builds, maintains and repairs infrastructural systems; and (3) labour as infrastructure, or the work, such as care, which becomes an infrastructure in itself as it sustains social reproduction.

In this framework, we see a useful preliminary approach for interrogating how infrastructures and labour come together and shape each other. At the same time, we see it as an invitation to further elaborate not only on what different forms of infrastructural labour are, but also how they can be defined in ways that allow for a critical exploration of the ontological, epistemological, and political implications of various forms of analysis and different forms of infrastructural practice. Below, we do so by engaging with five areas of infrastructural research that provide distinct empirical and theoretical entry points to query infrastructural labour. The identified areas of discussion stem from our respective sustained engagements with literature associated with geography's infrastructural turn and discussions and collaborations with other colleagues thinking about the place of labour in urban infrastructural research and geographies of infrastructure (De Coss-Corzo et al., 2019). As mentioned in the introduction, these areas also allow for an exploration of infrastructural

labour that can clarify its characteristics, practices, and relations to infrastructure and other forms of practice. We analyse them in light of the conceptual approaches reviewed thus far, identifying commonalities and differences that we then take on board to propose a working definition of infrastructural labour.

I Incremental, performed, and provisional infrastructures

While labour has largely loomed on the peripheries of infrastructural geographies, many urban scholars have examined the diverse roles and everyday practices which residents deploy in creating and maintaining urban heterogeneous infrastructures and metabolisms over the last two decades (Truelove, 2019). Increased attention to human dimensions of infrastructural performance and functioning have generally emerged through some reference to, or engagement with, everyday practices. This approach to ‘people as infrastructure’ (Simone, 2004, 2021) has been profoundly influential in urban studies and critical studies of infrastructure, where a growing number of scholars have sought to conceptualise infrastructures’ practised, performative, and relational dimensions, particularly in relation to urban infrastructural configurations across diverse contexts in the majority world. These works have highlighted the improvisations, rhythms, and tactics that marginalised urban inhabitants intentionally deploy to learn their environments to secure opportunities and, quite simply, exist (McFarlane, 2011). These collaborative social performances can be understood as ‘incremental infrastructures’ (Silver, 2014), which are ‘in-the-making, under constant adjustment and shifting technological and material configurations’ based on residents’ interactions, improvisations, and cooperation (2014: 789).

Human practices of metabolic transformation have become crucial to understanding diverse forms of infrastructural provision in majority worlds across diverse urban contexts (Alda-Vidal et al., 2018; Amankwaa and Gough, 2021; Anand, 2011; Munro, 2020; Neves Alves, 2021; Pilo’, 2020; Truelove, 2019). Analyses of these ways of doing have contributed greatly to scholarly conceptualisations of

infrastructure as being in flux and always unfinished (Baptista, 2019; Niranjana, 2021). This perspective has contributed to more heterogeneous (Lawhon et al., 2018), post-networked (Cirolia et al., 2021) and incomplete (Guma, 2020; Zapata Campos et al., 2022) interpretations of infrastructural practices and processes, which include so-called ‘formal’ systems and processes, but situate them within more diverse assemblages of relations, practices, and experiences. At the same time, this attention to heterogeneous and incomplete infrastructures has also highlighted the widespread splintering of infrastructures, which underpins, reinforces, and intensifies intersecting socio-economic, political, and spatial inequalities (Graham and Marvin, 2001, 2022; Jaglin, 2008; Kooy and Bakker, 2008; Smiley, 2020), along with the production of precarity surrounding infrastructural access and practices (Neimark et al., 2020; Phillips and Petrova, 2021).

Echoing Simone (2021), these works emphasise how agency and ingenuity are crucial in bringing together fluid materialities, sociabilities, and temporalities as ways of both making life possible today, and foreground other ways of being that are not quite present yet, and are placed in a future that cannot be fully grasped. By analysing how people perform or become infrastructure, this scholarship emphasises the potentiality that exists in everyday urban life, and the ways in which emerging infrastructural configurations, fleeting as they can sometimes be, prefigure other ways of being in the world that are not fully determined by hegemonic forms of power, domination, and economic organisation. In so doing, this body of work not only has drawn attention to the relevance of intentional human practice, but has theorised its relevance and role in analytical and conceptual frameworks that had before privileged the role of the non-human in the making of infrastructural relations and processes. An expanded attention to the specificity or role of the human meets concerns with matters of labour, as expressed in critical political economy, even if the conceptual apparatuses and tools deployed differ.

With this in mind, Addie (2021) has sought to reconcile dialectical tensions between Marxist conceptions of dead labour (Castree, 2002; Gareau, 2005; Kirsch and Mitchell, 2004; Mitchell, 2000,

2003), here understood as constituting infrastructures' materiality, with 'people as infrastructure'. His contribution highlights how practices of infrastructural maintenance, repair, adaptation, and improvisation, seen as 'living labour', are carried out 'in the shadow of infrastructural death', crystallised in the dead labour that constitutes infrastructures' materiality, and that links them to structural processes of capital accumulation and urbanisation. In looking at these forms of human practice, Addie suggests that dead labour 'may be dominant but it does not completely dominate living labor in reproducing city space and urban life' (2021: 1356), meaning that various practices of infrastructural work can not only foreground but enact diverse forms of socio-material transformation (Lawhon et al., 2014; Silver, 2014). Addie's approach sits with the possibility that labour might not necessarily be productive in the strictest sense, but might also be reproductive, reparative, adaptive, and incremental.

2 Maintenance and repair

The study of repair and maintenance practices has become an area of particular interest within social science and geographic studies of infrastructure (Barnes, 2017; Carr, 2022; Jambadu et al., 2023; Ramakrishnan et al., 2021; Velho and Ureta, 2019). These works have highlighted the relevance of labour in sustaining not only infrastructures but also the relations that they enable. Human labour has been explicit within these investigations, with repair and maintenance labour framed as necessary to 'keep modern societies going' as it is through such practices that 'the constant decay of the world is held off' (Graham and Thrift, 2007: 1). Whilst originally thought of as invisible (Star, 1999), the visibility of maintenance and repair (Anand, 2015), within and beyond breakdown, has been an object of increased attention. Here, scholars have highlighted how infrastructures 'require human communities to maintain them, even as they shape those (and other) communities. [...] Without maintenance, infrastructures crack, rust, and crumble and the political projects, promises, and aspirations that they carried dissipate' (Carse, 2014: 219).

While appreciating the role of maintenance and repair in sustaining infrastructures, the conceptual bearings that are present in this literature are varied, ranging from STS-informed works, to analyses more clearly rooted in critical political economy and ecology, including those that aim to bridge these perspectives, whether implicitly or explicitly. In conversation with STS scholarship, Denis and Pontille (2014, 2015) analyse how maintenance labour is crucial to understanding how the material order of things is maintained and cared for in the Paris subway, in an approach that draws from Puig De la Bellacasa (2012). Strelbel (2011) takes a similar perspective when analysing how public housing is maintained in Scotland amidst ongoing disrepair, focusing on how residents are key to sustaining material orderings through their everyday practices. In this scholarship, the focus on work is concerned with the very ontology of infrastructure, where human practices - and their coming together with non-human actants and materialities - is what makes infrastructural relations, spaces, and networks obdurate and lasting.

Other engagements with infrastructural repair and maintenance have emphasised how this labour is crucial in reproducing institutionalised relations of power, exclusion, and difference, and are a site of negotiation for state-society relations (Lemanski, 2020). In her analysis of maintenance practices in the case of irrigation infrastructures in Egypt, Barnes (2014, 2017) frames the maintenance of water infrastructures as a work of 'profound social, economic, and political significance' (2017: 147) which not only maintains infrastructural functioning but also reproduces state and community power and relations. Thinking with instances of infrastructural inadequacy, informality, and splintering, Wahby (2021) shows how repair work is also undertaken by residents and communities, reconfiguring relations between them and the state in contexts of privatisation and water governance transition. Equally, in studying police sweeps of homeless encampments, Gordon and Byron (2021) highlight how seemingly innocuous acts of urban maintenance are productive forms of power and exclusion in the governance of homelessness in North American cities. These works highlight the reproduction not only of material

orderings and infrastructural ontologies, but also of their politics, inexorably linked to those of the state and its contentions.

Recent approaches to repair and maintenance bridge concerns with the reproduction of technological relations and structures with matters of everyday practice. For example, Björkman (2015, 2018), has shown how the politics of hydraulic infrastructure in Mumbai are shaped by workers' and engineers' embodied knowledge and expertise, which remains crucial to mediating conflicts around water access in the city. Similarly, research on forms of engineering practice in Indian cities has shown that this work is essential in making hydraulic networks governable in face of excess, fragmentation, and unknowability (Anand, 2015; Niranjana, 2021). Looking at manual workers, De Coss-Corzo (2021) emphasises how repair work within Mexico City's water infrastructures is frequently ad-hoc, incremental, and improvised, relying not only on physically demanding practices but also creativity and ingenuity. In doing so, workers are contributing to the reassembly of urban fabrics and infrastructural forms in ways that are not only reproductive but adaptive. Such interventions are working through the tensions intrinsic to peopled approaches to infrastructures and emphasise the role of infrastructural labour in underpinning urbanisation and capital accumulation from a political economic and political ecological perspective.

Theoretical, methodological, and conceptual differences notwithstanding, growing scholarly interest in infrastructure maintenance and repair emphasises the importance and specificity of human labour amidst a broader set of infrastructural relations. This scholarship highlights the relevance of practice, and the links between everyday physical work - be that of repairing hydraulic infrastructures or maintaining signages in public transportation - and the reproduction and adaptation of material, political, economic, spatial, and ecological relations and orders. Working in through heterodox conceptual approaches that draw from STS, critical political economy and ecology, and postcolonial and feminist studies, among others, analyses of repair and maintenance point to a confluence between theorisations that derive from notions of 'people as

infrastructure', and those who are rooted in the analysis of infrastructural labour as discussed before. At the same time, this scholarship also highlights the role of practical knowledge, skill, expertise, and other embodied capacities. It begs the question of who does and can do infrastructural labour - not only to the everyday intricacies of practice, but also the abstract processes through which this form of labour becomes enrolled in processes of capital accumulation, urbanisation, and state-making.

In recent contributions, we observe emerging intersections between analyses of maintenance and repair, social reproduction, and racial capitalism. A key contribution is Corwin and Gidwani's recent intervention (2021), which argues that the work of maintaining and repairing socio-technical and socio-ecological systems constitutes a form of care. In their analysis, they note that within such work, which is frequently invisibilised and devalued, responsibility falls upon those facing the greatest burdens, exploitation, and vulnerabilities within racial capitalist systems (2021: 14). In doing so, they highlight how repair and maintenance work can reinforce and perpetuate extractive processes and reproduce oppressions and inequalities through the continuation of infrastructural processes as well as labour relations and conditions. Importantly, and building on Gidwani's earlier contributions, their argument distinguishes between infrastructural labour that works with and repurposes matter, and socially reproductive labour, which underpins human life, and individual care to make things work.

3 Social infrastructures, reproductive labour, and care

Geographic scholarship engaging with social infrastructures deploys the concept of social reproduction to highlight the myriad relations, networks, practices, and assemblages that sustain collective life. In doing so, this scholarship reconfigures what is understood as infrastructural by focusing not on materiality and its physical dimensions, but in the underpinning role that the delivery of social, emotion, and relational resources or support entails, including questions such as education, childcare, and care, along with more ad

hoc or multipurpose relational networks (Layton and Latham, 2022; van Melik and Merry, 2021). Key in this literature is the role of practice, which often overlaps and parallels conceptualisations of ‘people as infrastructure’, while drawing more clearly on feminist theorisations of care ethics and social reproduction. For instance, Latham and Layton (2019) build on Klinenberg (2018) by framing social infrastructures as promoting or facilitating sociality, emphasising ‘interacting across difference’ (2019: 3). Recalling social infrastructures as an often-overlooked part of urban space and life (2019: 5), Latham and Layton provide a framework for categorising urban social infrastructures and call for a broadened understanding of the socio-spatial scaffolding which underpins urban life. In doing so, they centre practices, socialities, and uses of social infrastructures, although these are not explicitly considered in terms of labour.

The scholarship engaging with social infrastructures has tended to address labour contributions and experiences predominantly through Marxist feminist framings of socially reproductive labour. Describing geographies of everyday life and social reproduction as a feminist project, Hall points out emerging literature on social infrastructures as a key realm in investigating geographies of social reproduction (Hall, 2020a, 2020b). Noting the underrepresentation of women’s lives and work, Hall recalls how gendered analysis must attend ‘to the ordinary, the unexceptional’ forms of differentiated and invisibilised labour underpinning collective life (2020a: 813, citing Rose, 1993: 22), echoing calls made by scholars analysing repair and maintenance work. This perspective helpfully proposes broadening Perce’s ‘infra-ordinary’ (1997, in Hall 2020a: 817) as a conceptual entry point for a labour-centred understanding of social infrastructures and differences of experience surrounding socially reproductive labour. This growing attention to everyday and ordinary work and relations has resulted in more recent interventions interpreting community-based actions and voluntary work as social infrastructure (Neves Alves, 2022), and infrastructural labour (Stokes and Lawhon, 2022).

Recent scholarship has furthermore focused on the dialectic relation between the subjective and embodied experiences of infrastructural labour, and

the material, spatial, and social experiences which surround such work. Recently, Power and Mee (2020) have suggested housing constitutes an infrastructure of care, which recognises the infrastructural quality of relational, reproductive, and care labour undertaken within the home and the domestication of care work through privatisation of social infrastructures. Conversely, scholars have argued for the infrastructural quality of socially reproductive and care labour (Alam and Houston, 2020), including several recent interventions that have argued for bodies to be considered infrastructure (Andueza et al., 2021) as, ‘these are the often unseen yet critical infrastructures and embodied practices that help neighbourhoods and cities to function, and also reflect social relations and hierarchies, slow violences, and unequal patterns of urban inclusion and exclusion’ (Truelove and Ruszczyk, 2022: 8).

Feminist perspectives of infrastructure have also returned to an embodied and vital understandings of infrastructures and differentiated experiences of such work on the basis of race, class, and gender, often intersected with critical recognition of infrastructures’ coloniality (Fredericks, 2014, 2018; Riedman, 2021; Siemiatycki et al., 2020; Strauss, 2020). Others have also sought to disrupt the perceived distinction between socially reproductive and productive labour by adopting translocal approaches (Green and Estes, 2022), highlighting labour refusals amidst the financialisation of social infrastructures (Horton 2022), and juxtaposing historical social infrastructures of unfree labour to the contemporary context (Mullings, 2021). Similarly, Cowan (2019) has sought to bridge understandings of social reproduction, infrastructure, and repair by arguing that urban villages can constitute social infrastructures by reproducing the labour which underpins collective urban life. This perspective seeks to ‘recast the devalued and concealed labours of cooking, cleaning, child-rearing, caring and loving as ‘infrastructural’: the precarious and concealed social practices which reproduce human life’ (Cowan, 2019: 740).

One question that emerges from this consideration of social infrastructure, social reproduction, and care is to what extent labour can be perceived as an infrastructure in its own right. Here, simply recognising diverse forms of infrastructural

labour – whether productive, distributional, socially reproductive, paid, devalued, stolen, free, or unfree – as constitutive of collective livelihoods is a starting point. The subsequent project appears to be understanding how this labour is experienced, governed, and politicised. For instance, scholars have emphasised the burdening of socially reproductive labour and shadow care infrastructures in response to state withdrawal and intensifying deprivation, often exacerbating broader inequalities (cf. Mullings, 2009; Power et al., 2022).

At the same time, this interrogation asks for a continuous engagement with conceptualisations of infrastructure discerning between their laboured aspects and those that are not immediately so. Perhaps here the notions of dead and living labour can be useful to clarify how these forms of practice are organised, building on and pushing Addie's (2021) work in relation to other approaches to embodiment and infrastructure. Similarly, approaches to social reproductive work as infrastructure can also point to ways in which the making of new relations of care can work through the cracks and failures of contemporary political economies, bring forth other forms of relating to each other, such as commoning (Anderson and Huron, 2021; Berlant, 2016).

4 Coloniality, racial capitalism, and unfree labour

Analyses of colonial infrastructures across different disciplines, including but not limited to history and geography, have highlighted how infrastructural development and provision structure racialised relations in and through labour (Davies, 2021; Kimari and Ernstson, 2020; Zeiderman, 2021). These discussions have challenged normative, positive, or depoliticised accounts of infrastructure as a modernising force, highlighting instead its role in the historical making of race, alongside class. In this literature, infrastructure is key to understanding how the international division of labour is always already racialised (Cowen, 2020), how the performance of everyday labour is too marked by racialised relations and dynamics (De Coss-Corzo, 2023), and how these forms of classification, difference, and domination

become themselves infrastructural (Nemser, 2017), supporting processes of urbanisation, capital accumulation, and state-making (Candiani, 2014; Salamanca and Silver, 2022). Here, infrastructure is understood as a techno-political device and analytical lens that allows scholars to untangle how race is produced, how it becomes obdurate, and how it is historically entangled with class both at a structural level and in the everyday practices that constitute infrastructural labour.

Colonial infrastructures are also crucial in the production of gender and gendering labouring bodies in a process that unfolds entwined with that of racialisation (Lugones, 2008). This means that the production of socio-spatial relations through infrastructure entails the making of race and gender as constitutive of colonial relations of power, which in turn shape labour relations across colonial space and time (Davies, 2021). Put simply, gender – and race – are not by-products of colonial relations but constitutive of them, made material and enduring through infrastructures. This means that the present making of labouring bodies, and labour relations and structures, exist as a racialised and 'gendered afterlife of slavery and global capitalism' (Hartman, 2016: 167). Crucially, these colonial relations are not only confined to the past, but also continue to exist as afterlives or endurances of previous colonial and imperial projects, and as constitutive of colonial presents and futures (Aalders, 2021; Bernards, 2022; Distretti, 2021; Enns and Bersaglio, 2020; Mbembe, 2003; Salamanca and Silver, 2022; Sizek, 2021; Stoler, 2016).

The endurance of coloniality and imperialism concerns not only infrastructures but also various forms of infrastructural labour. Building on the widespread recognition that social, political, material, and legal infrastructures have underpinned colonial expansion and extraction, scholars engaging with settler-colonial relations have emphasised how unfree and enslaved labour underpin infrastructural development for the benefit of settler-colonial populations by providing cheap labour which is governed through racialised migration, mobility, and employment practices and regimes (Cowen 2020; Crosby, 2021; Carpio et al., 2022). An important area of investigation in this regard concerns analyses of

urban history and urbanisation. There, feminist scholars have shown how unfree and unwaged labour has been crucial not only for the production of capitalist accumulation and urban space in the past, but underlined possibilities of urban life in (and beyond) contemporary contexts of precarity and marginalisation (cf. McKittrick, 2006; Fuentes, 2010, 2016; Buckley, 2018).

On the question of labour and racial capitalism, Beverley Mullings has recently suggested (2021) that attending to how life was made possible in contexts of slavery and indentureship in the Caribbean can offer lessons for global presents and futures characterised by the growing abandonment of surplus populations and institutionalised precarity. Key in her contribution is the notion of 'life-work', which points to the ways in which unfree labourers construct social infrastructures to sustain themselves individually and collectively 'in conditions of extreme uncertainty and precarity across different historical periods' (2021: 151). We see this notion as resonating with that of 'people as infrastructure', insofar as both illustrate how productive and re-productive work become blurred, while also pointing to other ways of being can be essayed within relations of domination and power in (racial) capitalism. Importantly, this approach suggests that people might perform an infrastructural role in underpinning capitalist and colonial relations, whilst also becoming an infrastructure in themselves in the margins and interstices of these forms of political economic organisation and domination. This, beyond being useful to clarify what infrastructural labour is, also resonates with contemporary analyses of work in the digital age.

5 Infrastructural labour in the digital age

Alongside the infrastructural turn in geography, scholars have identified an adjacent, and at times overlapping, digital turn (Ash et al., 2018). Within it, there are calls to pay further attention to the specific infrastructural dimensions of the digital (Furlong, 2021), its materiality (Kinsley, 2014), and digital labour (Graham and Anwar, 2017). Building on this, we suggest that engagements with infrastructural labour can be further developed through more

explicit engagement with analyses of the gig economy and emerging works that focus on the role of labour in sustaining the operation of digital infrastructures. An example of the latter is Mahmoudi and Levenda's (2016) analysis of the labour that underpins data centres in the Northwest United States. There, they argue that understanding how digital platforms structure and mediate urban life and capital accumulation requires careful consideration of what labour does. More specifically, they show how digital labour is needed to increase 'the circulation velocity (or rate) of capital' (2016: 100), enabling an accelerated realisation of profit. In doing so, digital labour also allows for an expansion of urban relations beyond the confines of the city, linking urban spaces to rural areas through the socio-environmental relations that underpin data management and production as part of a broader process of urbanisation.

Just as digital infrastructures are sustained by infrastructural labour, digital platforms and technologies also transform how labour is carried out and organised (Richardson, 2020). Scholars have distinguished between various modes of digital labour: remote work, such as data processing and remote intermediated work (Mahmoudi et al., 2020; Tubaro et al., 2020); platform-enabled transport and logistical services (Pollio, 2021; Rosenblat and Stark, 2016); crowd-working for artificial intelligence (Altenried, 2020); and services which rely upon deregulated labour arrangements, including the emotional labour of Airbnb hosting (Spangler, 2020). For instance, Graham and collaborators have undertaken extensive research to understand digital labour within platform urbanism and the gig economy (Anwar and Graham, 2020a, 2020; Graham, Hjorth, et al., 2017; Graham, Lehdonvirta, et al., 2017). Here, platform and digital labour are characterised as a form of precarisation, alienation, and everyday life reorganisation that can be read as a manifestation of digitally intermediated globalised labour markets.

Attention to labour within and through digital platforms and 'smart' urban paradigms highlights intensifying displacements, exploitation, and precarisation of labour (Attoh et al., 2019). At the same time, such scholarship also points to profound re-configurations in power relations (Veen et al., 2020),

as well as worker agency and organising potential (Wells et al., 2021). According to Bissell (2020), while platform urbanism has contributed to labour precarity and exploitation, its infrastructures have also made certain resources (such as food or accommodation) more convenient or accessible thereby creating at once enhancing and depleting changes to social reproduction and consumption habits. More fundamentally, attention to the inter-sections of human labour and digital technology suggests that new forms of being in digitally mediated cities might be afoot (Rose, 2017). These forms of posthuman agency imply the simultaneous re-articulation of the relations between humans and digital tools, machines and platforms, the deepening of previously existing forms of inequality and exploitation, and indeed the emergence of new practices and processes of domination and power (Braidotti, 2013).

Acknowledging the profound implications of digital technologies and infrastructures for human action and agency at large, we contend that the growing focus on labour within these discussions can be particularly relevant for theorisations of infrastructural labour. For example, considering digital work through a feminist lens calls for a broadened definition work to include emotional labour and extend understandings of how and where such work takes place (Richardson, 2018). This engagement could lead to reconsidering the current conceptualisation not of digital infrastructural labour, but also of infrastructures more generally.

Another area of potential cross-fertilisation concerns the infrastructural role of labour underpinning the work that so-called artificial intelligence does (Altenried, 2020). There, labour is rendered invisible and is taken for granted, even if its performance is that which enables these forms of digital mediation and production, and indeed other techniques, tools, and technologies of platform capitalism. Meanwhile, attention to infrastructural labour can advance understandings of the maintenance, repair, and disposability of digital urbanism's infrastructures, ranging from e-waste to micro-mobility platform services (Corwin, 2019; Jai Singh Rathore, 2020; Pickren, 2014; Stehlin and Payne, 2022). Further attention to how digital labour is made

infrastructural, and how these processes and practices compare with other experiences and forms of labour could signal relevant new avenues for research and action.

Finally, while much attention has been on consumer-focused platforms or urbanism dimensions, increasing attention to the implications of less visible, or arguably regulated or centralised, digital infrastructures are likely to merit further interest from an empirical and conceptual standpoint. For instance, Rosales has recently engaged with the precarious labour underpinning cryptocurrency mining in Venezuela (2021), showing how these novel technologies require not only energy and expanding material infrastructures to proliferate, but also labour, itself shaped by broader political economic processes and practices. Increased attention to labour can be helpful when engaging with these, and indeed other spaces where human practices, infrastructure and the digital come together – both how infrastructures enrol, shape, and organise human labour, and how human labour is required to sustain infrastructure and the relations they sustain and enable. Following Richardson's proposal for a feminist understanding of work be applied to digital technologies (2018), a double movement is required, where a renewed attention to digital infrastructural labour is matched by an expanded notion of digital infrastructures.

IV Working towards an infrastructural labour research agenda

While starting from different empirical contexts and theoretical positions, our review sees varied but complementary efforts that make infrastructural labour visible; push conceptualisations of what labour is and does to include collective intentional practices that make contemporary life possible; and call for rethinking of how we understand not only infrastructural labour but infrastructures themselves. Taking these bodies of literature as coalescing entry points to query what infrastructural labour is, we reintroduce our working definition of infrastructural labour as intentional human work, whether waged or unwaged, which is fundamental in sustaining

collective life by enabling, mediating, maintaining, and modifying infrastructural assemblages. This definition can account for the incremental, prefigurative potentiality of infrastructural practices as discussed in literature that draws on *peopled* and incremental notions of infrastructure. It also captures the centrality of labour in the reproduction of collective life, as highlighted in the formulations made by Gidwani and colleagues (Gidwani and Maringanti, 2016), and which resonate throughout the bodies of scholarship that we have reviewed here, particularly when considered in light of notions of dead infrastructural labour (Addie, 2021; Sizek, 2021). By considering these diverse work practices as labour, we directly draw on literature that emphasises the metabolic capacities of human practice, whether reproductive, adaptive, or potentially emancipatory.

At the same time, we suggest that this definition, and the bodies of literature it dialogues with, raises important questions around what kind of infrastructures are desirable based not only on their techno-political promises (Anand et al., 2018), but also on the kinds of labour they enable and require. In doing so, attention to infrastructural labour can also create intellectual space for imagining how infrastructures could become more just and sustainable, and centre labour in the process. Growing attention to labour within infrastructural scholarship is proving to be a generative space for bridging broader disciplinary discussions surrounding racial capital, social reproduction, political economies and ecologies, along with digital and labour geographies. We anticipate scholarly interest in infrastructural labour will persist, and emerging discussions will continue to be crucial for infrastructural scholarship. This section offers several topics and questions that we suggest merit further engagement, which stem from the review above. These topics and questions are overlapping, yet sometimes pull in different directions. We clarify this below, suggesting new spaces for cross-fertilisation and further reflection.

First, we affirm the continued importance in fleshing out definitions and parameters for studying infrastructural labour. We place our own intervention in this conversation. Amidst proliferating conceptualisations and emerging theorisations, there are a range of

ontological concerns surrounding infrastructural labour, including questions over non-human agency and work, the specificity of the human and human labour (Barua, 2021; De Coss-Corzo, 2021; Gandy, 2022). While this concern is not exclusive to infrastructural labour, asking about the specificity of the human and implications of calling any form of practice labour raises questions about infrastructural forms, processes, and modes of being. Is looking at infrastructural labour a way to query how the world is built anew through immanent practices and associations of commoning (Anderson and Huron, 2021; Berlant, 2016)? Is it a way to understand what forms of labour are required to sustain already existing forms of power and domination, processes of capital accumulation and urbanisation (Addie, 2021; Corwin 2019; Gidwani and Reddy, 2011)? Is it a way of theorising not only what is specific to human practice, but also what reconstituted notion of the human might look like in posthuman times (Braidotti, 2013)?

Linked to these ontological matters is the political-economic question of value. This concern is present in Gidwani and colleagues' foundational work (Corwin and Gidwani, 2022; Gidwani, 2015; Gidwani and Chari, 2004; Gidwani and Maringanti, 2016), and remains relevant across many of the themes we've discussed above. A key question remains: is infrastructural labour is productive of value in a classical Marxist sense, or does it occupy a different relational position in the process of capital accumulation and the structure of a capitalist society? In other words, further discussion is needed to ascertain whether forms of labour that sustain infrastructures are themselves value-making, or whether they create the conditions for the production of value, particularly when occurring in spaces of liminality, informality, and illegality. This concern with value is present in recent work that interrogates the relations between repair and finance, where empirical attention has been brought to how finance reconfigures repair (Hilbrandt and Grafe, 2023), or how finance can sustain repair in climate changed geographies (Bigger and Millington, 2020; García-Lamarca et al., 2022; Webber et al., 2022). These contributions point out how infrastructural labour is enrolled in value-making processes, but also question whether forms of value-making are amenable with other ways of

producing socio-environmental relations through infrastructure.

In calling for a more thoughtful and careful account of labour within infrastructural research, we must also be cautious not to fall into fetishized or heroic accounts of infrastructural labour. Responding to the strong critiques surrounding settler-colonial and colonial dimensions of infrastructure (De Coss-Corzo, 2023), growing scholarly attention to infrastructure (and labour) must avoid becoming overly positive or fetishising of infrastructural labour. Indeed, a simplistic view can perpetuate a moralising or romanticising view of work while disregarding the ways in which work has been disciplining, exploitative, oppressive, and violent. We are supportive of ongoing efforts that call into question the merits of work and, in some cases, make compelling arguments in favour of an anti-work ethic (Chatterton and Pusey, 2020; Weeks, 2011). Adopting such frameworks into ongoing accounts of infrastructure and its associated labour could further existing critiques of unfree, exploited, and devalued infrastructure. It might also offer another imaginary for analysing recent politics advocating for infrastructural development, and depoliticised logics proclaiming associated job creation as an inherent good.

This is particularly salient at this moment, as political projects worldwide have only intensified their interest in so-called essential and infrastructural work in response to the Covid-19 global pandemic, and intensifying climate, economic, and care crises. Having witnessed previously invisibilised forms of so-called 'essential' or 'key' work become briefly visibilised and, at times, revered during the Covid-19 global pandemic, scholarly interventions have already taken note of the shifts in public and political discourse, and surrounding labour relations (Brickell et al., 2022; De Souza Santos, 2022; Lin, 2022; Rogaly and Schling 2020; Rose-Redwood et al., 2020). These discussions highlight the need for more critical discussion of what work (infrastructural or otherwise) is considered essential for collective life, and what expectations and conditions surround its performance and governance.

Furthermore, attention to infrastructural labour can critically inform analyses of the climate crisis and associated green recoveries and sustainable

transitions. Infrastructural development and provision associated with these supposedly transformative policies will require distinct forms of infrastructural labour, or indirectly impact others. For instance, recent scholarship has considered labour configurations within infrastructure-led development projects (Apostolopoulou, 2021; Fischer, 2020; Schindler and Kanai, 2021). We see great potential for scholarly attention to infrastructural labour to engage with parallel discussions surrounding repair and care labours in service of, and resulting from, climate crisis and emerging transitions (cf. Carr, 2022; Carr, 2023, and accompanying dialogues). How might the lens of infrastructural labour contribute to recognising labours' skills, capacities, and knowledge, recognising spatial, subjective, and scalar differences, while also weighing up calls for deepened understandings of complexity with the urgent need for rapid transition amidst climate crisis (Stein, 2022: 4)? Moreover, critically querying promises of green infrastructures and decent work might be extended to question the premise of work as the primary or sole basis for achieving a decent life (cf. Lawhon and McCreary, 2020, 2023).

Finally, we emphasise the need to reconsider methods and clarify objectives for undertaking such scholarship. Moving from rendering infrastructural labour visible to reframing and consolidating the claims, experience, and perspectives of people conducting infrastructural labour is already underway. Here, scholarship carried in solidarity and close collaboration with workers might signal a way forward. At the same time, we observe a plural problematization of the very category of labour, ranging from feminist calls to seriously consider reproductive labour theoretically and empirically, to approaches that query the coming together of humans and non-humans in the performance of infrastructural labour. Beyond being of conceptual importance, these questions will continue to shape how infrastructural research empirically engages with labour; how scholars observe and account for its performance and role in making, reproducing, and remaking the world through infrastructures; and how these issues come to shape the politics of infrastructural labour.

V Conclusion

This article has analysed how labour has been accounted for in infrastructural geographies, responding to widespread acknowledgement that the topic has been comparatively under-theorised within this scholarship. To analyse these bodies of literature, and highlight how they contribute to critical understandings and studies of infrastructural labour, we have first outlined what we consider to be key contributions within and adjacent to infrastructural geographies. We then reviewed five scholarly discussions that have engaged with infrastructural work or labour, pointing to the ways these discussions are contributing to a sharpened and deepened understanding of infrastructural labour. Proposing a working definition of infrastructural labour that considers the confluences and differences between these bodies of work, we conclude by discussing possible avenues for further investigation. Through this, we suggest this closer engagement with diverse aspects of labour engagement can expand and revitalise infrastructure studies.

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