The Spatial DNA of Distributed Work: Behaviors and Processes Planners and Policymakers Need to Know to Sustainably and Equitably Transform Local and Regional Built Environments for Digitalized Work and Living

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1 Introduction

Digital transformation and sustainable development are two interconnected concerns that contemporary planners and policymakers in the United States and worldwide face. In recent years, there has been a seismic shift in how economic, social, and cultural activities are organized in the United States and worldwide. We now seamlessly move from in-person to online modalities of engagement to fulfil our day-to-day tasks and obligations while working, relaxing, shopping, or accessing critical health and civic services. We commonly encounter people engaged in phone or video calls on their smartphones while walking on the streets, riding a bus, or dropping off their child at school, and people working at their laptops in coffee shops, parks, and at airports. This seamless and synergistic integration of the digital and the physical into the "phygital" (Sui & Shaw 2022), has altered the spatial and temporal structure of office-based work.

Office-based work is no longer restricted to centrally located office complexes and designated '9 to 5' work hours. Instead, it is spatially and temporally distributed, with employees working from multiple locations, such as their homes, offices, and third places, at any time of day or night. In hybrid work, a commonly encountered type of distributed work, employees spend some of their workdays at the office and others working from home or elsewhere. Another type of distributed work, remote work, is conducted fully away from the office at any location chosen by the worker. In offices, employees increasingly work at unassigned or non-territorial workspaces, such as hotdesks, which are available on a session-by-session basis and cleared of all possessions at the end of each work session.

Digital technological advances are one of many forces driving the widespread adoption of distributed work arrangements. Companies are embracing distributed work, including multi-local and non-territorial work, to optimize resources and minimize operational costs. Businesses that adopted remote and hybrid work to ensure service continuity during the COVID-19 pandemic are recalibrating their work practices for enduring post-COVID shifts to distributed work (Barrero et al. 2023).

The spatial and temporal restructuring of office-based work—the predominant economic activity of post-industrial United States and comparable Global North contexts—has wide-ranging consequences for the built environment. Distributed work, performed from anywhere and at any time, unsettles conventional land-use and transportation planning practices predicated on fixed times and places for work, regular journey-to-work patterns, and the segregation of activities into land-use zones. Spatiotemporally dispersed, nonterritorial, and phygital practices of distributed workers further reshape the urban and rural built environment. This calls for spatial plans and policies to sustainably and equitably transform local and regional built environments for distributed work and living (Hurtado et al. 2023, Zenkteler et al. 2022).

A conceptual understanding of how distributed work arrangements reshape the built environment is necessary for sustainably transforming neighborhoods, cities, and regions for digitalized work and living. But such a conceptual framework is not readily available. This paper, grounded in the research question, "how are distributed work arrangements reshaping the built environment?", contributes a much-needed conceptual framework that identifies and explains the key distributed work behaviors and processes driving the transformation of urban neighborhoods, cities, and regions in the Global North. In doing so, it empowers planners and policymakers to facilitate sustainable local and regional transformations for digitalized work and living.

2 Methods

The research workflow contains four stages. The first stage entailed a keyword search of research databases such as the Web of Science, ProQuest, and Scopus, and academic search engines such as Google Scholar and Semantic Scholar for traditional academic literature such as journal articles, books, doctoral dissertations, conference proceedings, master's theses, and archived documents, videos, audios, images, data, and newspapers (Table 1). Then, keyword searches were conducted on internet search engines such as Google and Bing to locate gray literature, including white papers, reports, preprints, podcasts, and blog posts. The time period ranged from 1990, when widespread networked communication became possible due to the invention of the World Wide Web and the Internet browser, through 2024, which is witnessing post-COVID intensification of remote and hybrid operations. The collected academic and gray literature (N = 271) spanned multiple spatial scales (workstations, offices, office complexes, commercial business districts, residential neighborhoods, cities, and metropolitan regions), social scales (individual workers, households, organizations, organizational fields, and society), and disciplines (urban planning, economic geography, corporate real estate, facilities management, organizational studies, urban anthropology, interior design, and work environmental psychology) pertinent to the built environment outcomes of distributed work in the US and comparable Global North contexts. The third stage involved a thematic analysis (Braun & Clarke 2006, 2022) of the literature database. The database was read and coded, and the codes were subsequently sorted into themes. Finally, the themes were structured into narratives, which were refined with expert interviews (N = 8). The narratives are presented in the Results section under the titles, "The Spatial DNA of Distributed Work" and "Built Environmental Outcomes of Distributed Work". In the fourth stage, the Spatial DNA of Distributed Work framework and the built environment outcomes serve as a lens for comparatively analyzing the comprehensive plans of three US cities experiencing varying levels of distributed work: Austin, TX, Boston, MA, and St. Louis, MO.

3 Results

3.1 The Spatial DNA of Distributed Work

Remote and hybrid employees work at variable times of day and night from diverse locations, including offices, homes, co-working spaces, third places, and

Keyword	n	Keyword	n
distributed working	8	polyfunctional spaces	3
telework, remote work	10	third places	3
telecommuting	9	office design	5
online communication	5	future of work	6
virtual work	4	distributed work	4
urban communication	6	mobilities	5
mobile communication technologies	3	fragmentation of activity	10
knowledge work	8	smart cities	2
ICT and urban form	6	urban innovation	4
ICT and travel	14	economic development	5
spatial behavior of firms	3	form-based planning	3
urban agglomeration	7	sustainable development	5
phygital	4	mixed-use, live-work-play	8
urban spatial structure,		15-minute neighborhood	5
post-industrial urban form	3	place attachment	2
multi-local working	4	Austin	13
nonterritorial working	8	Boston	14
post-pandemic real estate	12	St. Louis	15
co-working	7	Kendall Square	4
hotdesking	3	innovation districts	6
space-as-a-service	3	urban entrepreneurialism	3
organizational ecology	4	workspace psychology	5
new ways of working	6		

Table 1: Keywords and corresponding literature sample size

while commuting or traveling, either by choice, opportunity, or obligation (Felstead et al. 2005). Mobile ICT also provides employees with the mobility to move from one workstation to another within the office. Following the dot-com bust of 2000 and the collapse of Lehman Brothers in 2008, enterprises have adopted neoliberal, lean, agile, or just-in-time practices to optimize labor and facility costs in volatile economic conditions. For example, employees are increasingly recruited on a contingent and contractual basis, and no longer have assigned workspaces; instead, they have non-territorial or temporary workspaces available on a session-by-session or day-to-day basis. These technological, economic, and spatial shifts are changing office-based work along four dimensions:

1. **Dispersed** – workspaces are no longer centralized in an office, but are multi-local, dispersed within a distributed workspace ecosystem comprised of work and non-work-centric settings (Figure 1),

2. **Intensified** – nonterritorial workspaces such as hotdesking, where workers are allocated temporary workspaces on a "first come first served basis" and hoteling, where workers are allocated temporary workspaces upon prior reservation, intensify workspace usage by increasing the average number of users,
3. **Improvised** – real-time messaging and on-demand information about the built environment (e.g., road traffic, public transit, public health closures) facilitate improvised, 'on-the-fly' shifts in work schedules and arrangements according to emerging conditions, and
4. **Phygital** - Contemporary offices are neither solely physical nor digital but "phygital" (Sui & Shaw 2022: pp. 11:1–11:2), featuring a combination of physical and digital elements to maximize and optimize worker performance and connectivity. Phygital offices reflect the reliance of workers and organizations on both physical and virtual elements to conduct work.

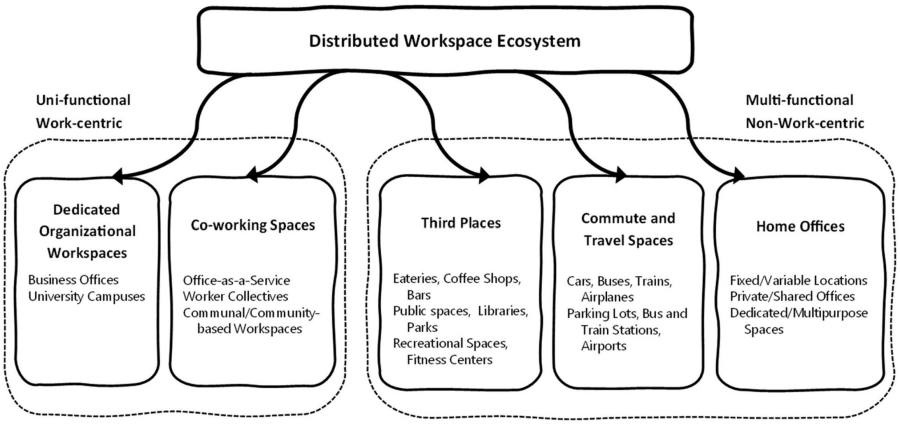

Figure 1: Distributed workspace ecosystem

The four attributes of distributed work—workspace dispersal, intensification, improvisation, and phygitality—together comprise the Spatial DNA of distributed work. Working in tandem, they reshape the built environment resulting in the outcomes discussed below.

3.2 The Built Environment Outcomes

The office is now spatially and temporally dispersed, intensified, improvised, and phygital. As a result, the spatial footprint of firms has shrunk by 30%. Workspaces

within buildings have been replaced by workscapes with a distributed workspace ecosystem, where land uses fluidly and contingently mingle as workers adopt any setting for office work. Consequently, workers have replaced regular work commutes with spatially and temporally fragmented work patterns (Alexander et al. 2010, Couclelis 2004). Technology entrepreneurs and designers are actively shaping phygital work environments, perhaps wielding even more influence than architects, planners, and civil engineers.

3.3 Comparative Analysis of Comprehensive Plans of Austin, TX, Boston, MA, and St. Louis, MO

Austin, Boston, and St. Louis are investing in distributed workscapes to support technology and innovation-driven economic growth and development in their respective regions. The comprehensive plans of the three cities aim to foster transit-oriented growth and increase the proportion of walkable neighborhoods within city limits. The planning agencies are also implementing equity-oriented place-based initiatives to facilitate access to high-paying tech jobs and urban amenities, and to offset historic inequities and underinvestment in communities of low-income individuals and people of color. These cases illustrate that planning for distributed work is relevant for all cities. Importantly, planners should shape and manage workscapes to minimize inequitable and exclusionary innovation and technology-driven growth and development. The enduring impact of historic development decisions on the demographic and socio-economic profile of the cities and their residents underscores the need to tailor spatial policies and plans to the local context, specifically the spatial, social, economic, and cultural dynamics embedded in people and places.

4 Discussion and Conclusion

Planning responses for the emerging geography of distributed work will entail multi-pronged and coordinated changes in planning education, research, and practice. This paper focuses on planning responses for sustainably and equitably transforming neighborhoods, cities, and regions for digitalized work and living. It reflects on the post-pandemic futures of polycentric regions, where hybrid workers divide their time between working from home and occasional visits to the office in an office park, innovation district, or a redeveloped mixed-use commercial district in the metropolitan or suburban city center. It offers visions of localized living in walkable or bikeable 15- or 20-min neighborhoods connected

by decentralized 24-hr public transit networks, and outlines key intersections between distributed work and smart cities, urban entrepreneurialism, walkable urbanism, and form-based planning. It identifies the need for equitable and inclusive versions of contemporary workscapes such as live-work-play neighborhoods, transit-oriented mixed-use developments, and innovation districts, and makes a case for moving beyond developing technological foresight and discernment to actively collaborating with technology entrepreneurs and designers to shape an increasingly phygital world. Finally, the paper discusses findings in the context of three US cities experiencing varying levels of tech-driven growth and development. The paper concludes by observing that although distributed work is experienced by a portion of the US workforce with the socioeconomic capacity to access amenity-rich built environments, its ripple effects on vulnerable and low-income communities make it worthy of planners' attention. Secondly, planning for distributed work is a precursor of planning for the digitalization of everything. The dimensions of change in the domain of work discussed in this article apply to learning, healthcare, and civic and retail services, as well. Planning for distributed work is thus a prelude to planning for the future of working and living in a phygital world.

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