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EDITORIAL

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Digital Transition and New Forms of Spatial Inequality

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Abstract

This thematic issue examines how digital transition reshapes spatial inequalities by reconfiguring relationships between people, places, and opportunities. We frame the contributions around three interrelated mechanisms—place attractiveness, access to opportunities, and the coordination of activities—that operate through housing and labour markets. Digital transition reshapes all three mechanisms, generating spatially uneven outcomes across the settlement system. Rather than producing a fundamental spatial shift or simply reproducing existing inequalities, it repositions people and places into more networked and multilocal arrangements. Suburban areas emerge as key beneficiaries, large cities retain their dominance in employment while facing intensifying housing pressures, and rural areas are increasingly reoriented towards residence and consumption, with amenity-rich localities gaining while more peripheral areas face compounding disadvantage. We identify three avenues for future research: the implications of remote work for residential mobility and immobility; unequal household capacities to coordinate activities across digital and physical space; and the need for a multi-scalar perspective to better understand the shift towards networked and multilocal spatial arrangements as everyday activities increasingly span physical and digital space.

Keywords

digital divide; digital transformation; housing market; labour market; multilocality; remote work; segregation; spatial inequality

1. Key Questions on Digital Transition and Spatial Change

Digital transition is reshaping the social and spatial organisation of societies. This article focuses on its impact on spatial inequality, understood as the uneven distribution of opportunities across people and places—shaped by the attractiveness of places, who can access opportunities within them, and how people coordinate everyday activities across physical and digital space (Galster, 2012; Harvey, 1973). Digital technologies have been celebrated as sources of flexibility, efficiency, and inclusion that may compensate for inequalities rooted in physical space by expanding digital access to opportunities (Moreno, 2024), yet they have also been seen as mechanisms that reproduce and often amplify existing divides in physical space (van Dijk, 2020). This tension has fundamental roots. Graham and Marvin (2001) showed that urban infrastructures—from transport to telecommunications—reinforce socio-spatial inequalities despite universal aims, producing "premium networked spaces" by selectively upgrading some places while bypassing others. Digital infrastructures now extend and intensify this logic across multiple spatial scales. Understanding how digital transition—defined as the ICT-enabled coupling of physical and digital space, encompassing digitalisation, platformisation, and the growing deployment of digital tools and AI—can simultaneously widen access to opportunities and reinforce spatial inequalities remains a key challenge for contemporary urban and regional research (Alfieri et al., 2025).

What is changing is not only where people live or work, but also how social and spatial relations in physical space are rearranged as many everyday activities partly shift into digital space, redistributing opportunities and constraints across people and places (Ash et al., 2018). To understand this change, we propose three mechanisms as an integrated analytical framework that builds on the fundamentals of central place theory (Christaller, 1933) for place attractiveness, accessibility theory (Hansen, 1959) for physical access to people, places, and services, and time-geography theory (Hägerstrand, 1970) for coordination of activities in physical space. In this framework, places are understood as relational spatial units linked to each other across interconnected spatial scales, from macro-level contexts within the settlement system—such as large cities, suburbs, smaller towns, and rural areas—to micro-level activity places of households, including homes, workplaces, schools, and service settings that structure everyday activities (Hägerstrand, 1970).

While rooted in relatively stable spatial structures, these three mechanisms are reshaped by digital transition through spatially and temporally uneven changes in place attractiveness, access to opportunities, and the coordination of activities (Figure 1). Attractiveness captures the degree to which places draw people, capital, attention, and activity through their spatial qualities—jobs, schools, services, and other opportunities, amenities, connectivity, density, and environmental characteristics—positioning them differently within physical settlement hierarchies from local service centres to large metropolitan regions (cf. Christaller, 1933). Digital transition reshapes place attractiveness through online visibility—how places are represented, prioritised, and manipulated through platforms, algorithms, and filters—directing attention unevenly towards them (Zook & Graham, 2007). This reflects the dynamics of an ordinal society in which hierarchical position in algorithms determines who and what gets seen (Fourcade & Healy, 2024). Access concerns who can reach opportunities such as jobs, housing, services, and digital infrastructure, and under what conditions, structured both by physical distance and infrastructure provision, and by digital divides in skills, motivation, and usage that determine whether and how people can participate in digitally mediated opportunities (Hansen, 1959). Digital transition reshapes access to opportunities as digital infrastructure is distributed unevenly across the settlement system and across various activity places, and a partial shift of activities

online unevenly relaxes, reinforces, and reconfigures place-based constraints (van Dijk, 2020). Coordination refers to how individuals and households organise activities across time and space, combining online activities with place-bound requirements related to housing, work, education, care, services, and leisure (Hägerstrand, 1970). Hägerstrand identified three types of constraints that structure this coordination of activities in physical space: capability constraints, which reflect individuals' skills, resources, and capacities to participate in activities across space; authority constraints, which reflect the rules set by institutions, markets, and organisations that govern where and when activities can take place; and coupling constraints, which reflect the impossibility of being in more than one place at a time.

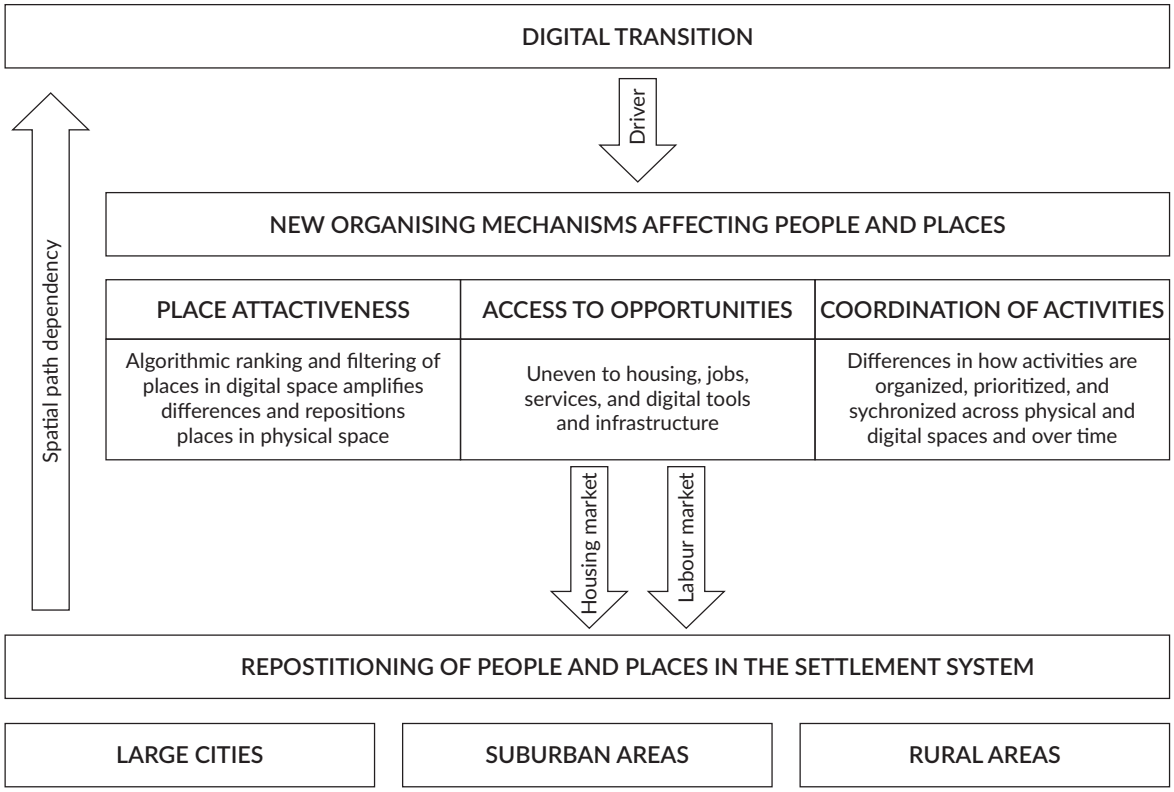

Figure 1. Digital transition reshapes people and places through three organising mechanisms.

While the expansion of remote working arrangements is the most visible manifestation of digital transition, its broader consequences for spatial inequality remain insufficiently understood (e.g., Reunamäki et al., 2026). Addressing these consequences requires recognising that the relationship between digital transition and the settlement system is inherently bidirectional: While digital transition repositions people and places within the settlement system, relatively stable spatial structures shape how it unfolds (cf. Massey, 2005). In turn, existing settlement structures influence where digital infrastructure is deployed, while the concentration of knowledge-intensive firms and start-ups in large cities further accelerates the digital transition. At the same time, these system-level dynamics translate into uneven impacts on households' capacity to rearrange everyday activities across digital and physical space, extending far beyond remote work itself. As digital tools become embedded in social relations and everyday activities, digital transition reshapes how opportunities and constraints operate across three interrelated mechanisms: place attractiveness, access to opportunities, and the coordination of activities. These mechanisms act via housing and labour markets as the principal channels linking digital transition to the repositioning of people and

places, with capability, authority, and coupling constraints shaping who can access and benefit from digitally mediated opportunities—and who remains excluded.

Capability constraints persist and deepen through an additional layer of digital divides between urban and rural areas, and between individuals with different levels of digital skills and access to infrastructure and tools (van Dijk, 2020). However, improvements in digital skills (Zālīte et al., 2025) and regional policy interventions (Aasa et al., 2026) may help to mitigate these constraints for both people and places. Authority constraints, ranging from housing and labour-market regulations to the opening hours of service providers, are also reshaped by digital transition, often becoming less restrictive in relation to residential decision-making (Galster, 2024), service use (Kousalová, 2026), and work arrangements (Leonardi et al., 2024). Most importantly, digital transition relaxes coupling constraints, as the partial shift of activities into digital space reduces the need to be physically present at a specific place and time—but does so unevenly, concentrating this flexibility among higher-educated, higher-income workers in knowledge-intensive occupations while leaving those in place-bound work largely unaffected (Dingel & Neiman, 2020). Digital transition, therefore, reorders spatial relations in complex and uneven ways, raising three interrelated questions that guide this thematic issue.

The first question concerns whether the digital transition produces a fundamental spatial shift, repositions people and places within existing spatial structures, or instead reproduces existing spatial inequalities. Digitalisation has the potential to generate disruptive changes in the spatial functioning of societies (van Wee & Witlox, 2021), most notably by reshaping housing demand through weakening the need to live near workplaces (McCue, 2022), while also enabling more flexible residential strategies such as multilocal living (Reunamäki et al., 2026). At the same time, recent research suggests that the digital transition often functions less as a disruptive force and more as an enabling mechanism, allowing selective, path-dependent residential reconfigurations rather than a systemic spatial transformation (Vilhelmson et al., 2026). These reconfigurations largely follow pre-existing spatial divides, reinforcing rather than reshuffling existing inequalities across the settlement system (McCollum, 2025). For instance, Reunamäki et al. (2026) show that movers often prefer to remain within the same urban region, highlighting that while proximity to workplaces has become less important, physical accessibility continues to matter because occasional commuting remains necessary. The core issue, therefore, is whether the digital transition fundamentally restructures spatial inequalities or instead reorders places within the existing settlement system, shifting their relative attractiveness, access to opportunities, and coordination of everyday activities.

The second question concerns how the gains and losses associated with the digital transition are distributed across cities, suburbs, smaller towns, and rural areas within the settlement system. As has been the case throughout history (Glaeser, 2012), large cities continue to concentrate high-skilled jobs, innovation, and digital infrastructure in the digitally transforming societies (Luca et al., 2025). This concentration has long been linked to rising urban inequality and segregation (Florida, 2018), and the digital transition appears to reinforce rather than weaken these tendencies. In particular, it intensifies housing-market pressures through digitalisation-driven commodification and platformisation (Galster, 2024), which contribute to rising housing prices. These pressures constrain the residential options of less affluent households and renters, while simultaneously generating capital gains for homeowners and investors. The core issue, therefore, is how the digital transition reshapes the relative attractiveness of places and redistributes access to opportunities across the settlement system.

The third question concerns how digital transition rearranges everyday spatial connections between people, their activity places, and—consequently—their access to opportunities, such as workplaces, schools, services, and leisure. As work, services, and social interaction partly shift online, lifestyles change, daily routines become less tied to proximity between home and specific activity places, mobility patterns evolve, and new forms of dependence emerge. Residential decisions—long structured around access to workplaces, schools, services, and leisure opportunities (Tammaru et al., 2021)—become more differentiated as households vary in their capacity to arrange activities across physical and digital spaces (Kährik et al., 2026). Likewise, the spatial configuration of activity spaces and the mobility patterns within them change, contributing to an expansion of multilocal living arrangements and increasing work–home distances. Still, everyday activities become more strongly anchored around the home (Vilhelmson et al., 2026) or multiple homes. This question is therefore fundamentally about how digital transition reshapes the coordination of everyday activities across physical and digital spaces, and what new forms of spatial inequality emerge as a result.

2. Mechanisms of Spatial Change in Digitally Transforming Societies

Digital platforms, applications, and tools increasingly constitute the core infrastructure through which contemporary societies operate (Livingstone & Sefton-Green, 2025), reorganising how people and places are connected across different activity places, and structuring residential choice, economic activity, social relations, and everyday activities (Figure 2). Digital infrastructures and algorithmic governance do not act on space directly. Rather, they interact with existing spatial structures mainly through labour and housing markets, generating spatial differentiation through reconfigured place attractiveness, access to

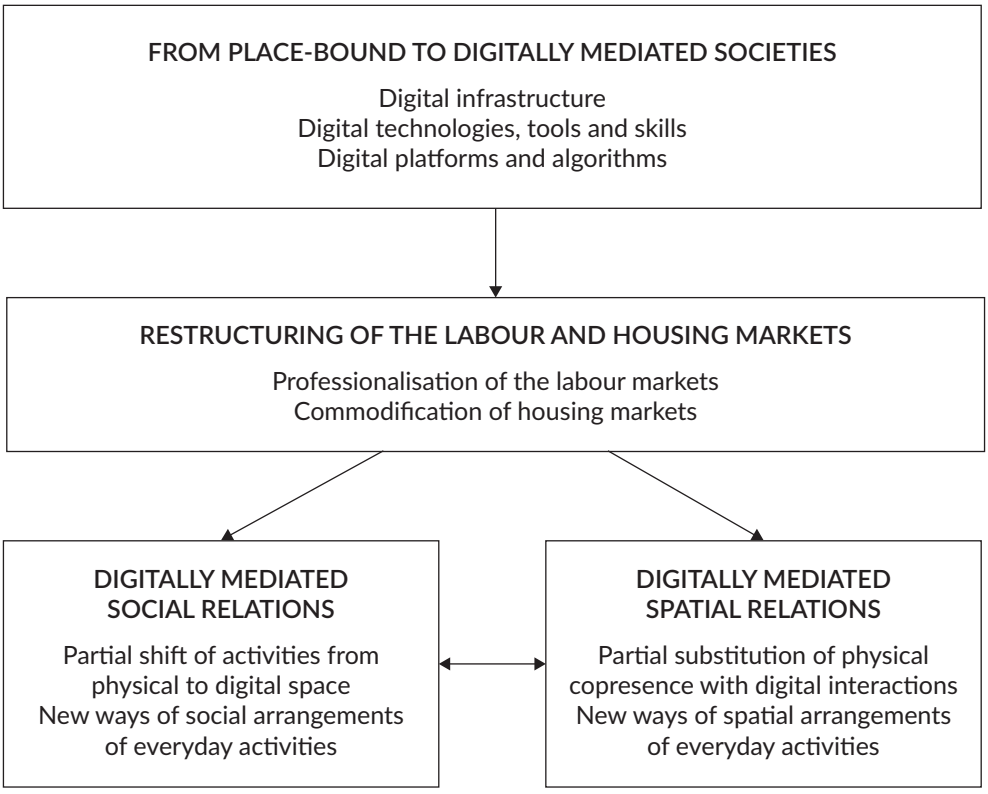

Figure 2. From place-bound to digitally mediated societies: new ways of social and spatial arrangements of everyday life.

opportunities, and the coordination of everyday activities. These three mechanisms do not operate independently or additively. Instead, advantages and disadvantages across place attractiveness, access to opportunities, and coordination of activities reinforce one another through a self-amplifying feedback logic. Higher online visibility attracts capital and talent, expanding access to opportunities and strengthening coordination capacity, which in turn further enhances attractiveness. This circular dynamic produces cumulative inequalities in which initial positional differences between people and places are progressively amplified, consistent with the Matthew effect (cf. Merton, 1968). It is through this same self-reinforcing logic that the long-term relative stability of the settlement system is reproduced.

Digital transition affects social and spatial relations by restructuring labour markets, reshaping access to employment, and the coordination of work (Figure 2). It contributes to the expansion of knowledge-intensive and highly skilled employment, reinforcing the long-term trend of labour-market professionalisation, especially in large cities (Ubarevičienė et al., 2025). Younger people are increasingly overrepresented in knowledge-intensive and digital occupations, such as those in the tech sector (Zālīte et al., 2025), supported by the expansion of higher education, intergenerational social mobility, and better digital skills. These opportunities are increasingly accessed through digital labour market platforms, where algorithmic recruitment systems shape which jobs, companies, and workers become visible (Fabris et al., 2025). Rising earnings among highly skilled workers expand residential choice (Hulchanski, 2010), further reinforced by opportunities to work from home (Leonardi et al., 2024). At the same time, the digital transition introduces new constraints and uncertainties. The extent to which AI will reduce labour demand across sectors and skill levels remains unclear (Brynjolfsson et al., 2025). It also expands precarious, platform-based forms of work, consistent with the social polarisation thesis (Sassen, 2001). Workers in such positions face more limited access to mortgage finance (Kalleberg, 2011) and, consequently, more restricted residential choice, particularly in high-priced urban housing markets.

Digital transition affects social and spatial relations by restructuring housing markets too, reconfiguring residential mobility through changing access to housing and growing demand for larger homes. Online platforms and their underlying logics further mediate the attractiveness and visibility of dwellings and neighbourhoods, access to housing, and the coordination of transactions across buying, selling, and renting (Galster, 2024). Platforms and algorithms govern as well as manipulate which dwellings and neighbourhoods are digitally visible in home-search, how rent applicants are screened, and how housing is segmented between homeowners, long-term renters, and short-term renters. As Zhang et al. (2026) show, this platform-based filtering of visibility is not neutral within the cities. Rather than simply reinforcing existing inequalities, platforms like TikTok generate new spatial patterns of online visibility in which lifestyle-oriented neighbourhoods gain prominence while large parts of the city remain digitally marginalised. By amplifying renter demand and short-term rental activity in already sought-after neighbourhoods, this reconfiguration accelerates gentrification pressures (García-López et al., 2020), while leaving less attractive areas invisible to potential residents and capital alike (Boeing, 2020). Platform-driven gentrification—the displacement of long-term residents from sought-after neighbourhoods through digitally mediated rental markets and short-term letting platforms—has emerged as a distinct urban dynamic, deepening housing inequality in high-demand cities (Sequera, 2025).

Digital visibility also varies across the settlement system. It is highest in large cities and tourist areas, where the concentration of listings on shared platforms enables landlords to benchmark prices upward, whereas

rural areas remain comparatively underrepresented (Mesa-Pedrazas et al., 2026). Digital platforms also broaden housing search for migrants, students, refugees, and digital nomads, enabling long-distance investment and inflows of capital into already attractive markets. This way, housing-market digitalisation intensifies commodification, most notably through short-term rental platforms that convert long-term housing into temporary accommodation, further tightening supply in high-demand areas. Together, these dynamics expand housing options for mobile and temporary users while constraining access to permanent housing for lower-income households and renters, thereby deepening the divide between owners and renters. At the same time, digital transition reshapes the meaning of home—from a physically bounded private space (Livingstone & Sefton-Green, 2025) to a node within digitally connected networks where work is also performed—thereby driving demand for more spacious dwellings that accommodate both living and working (Reunamäki et al., 2026).

3. Spatial Restructuring in Digitally Transforming Societies

The three mechanisms operating through housing and labour markets interact with the existing settlement system, while also contributing to changes within it, as different parts of the system unevenly gain or lose from the restructuring of housing and labour markets under digital transition (Figure 3). Large cities remain key nodes in the network society (cf. Castells, 1996), and the digital transition further strengthens their role as hubs coordinating both at global and national scales, thereby reinforcing metropolitan advantage (Aasa et al., 2026). Digitally intensive and knowledge-based employment, including remote work (Luca et al., 2025), continues to cluster in metropolitan regions, where agglomeration advantages—such as specialised labour pools, dense professional networks, institutional thickness, advanced infrastructure, and global connectivity—operate at global and national scales, supporting productivity, innovation, and knowledge exchange (Balland et al., 2020).

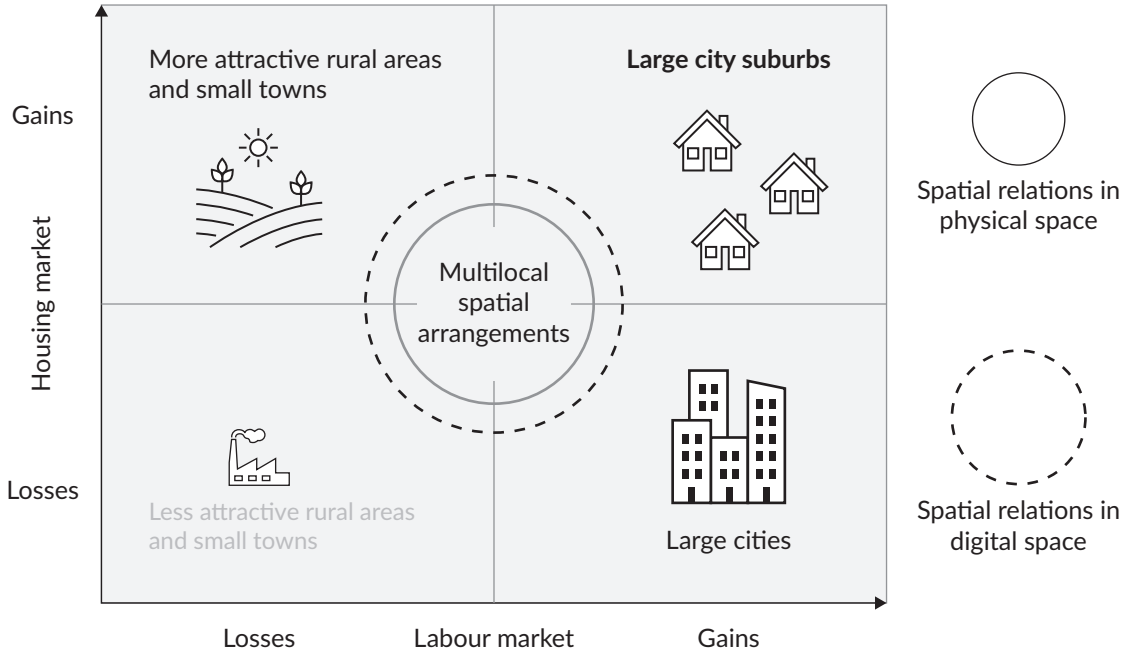

Figure 3. Digital transition induced gains and losses in the settlement system.

For workers, these metropolitan advantages translate into better career opportunities and upward social mobility, reinforcing the role of large cities as "escalator regions" (cf. Fielding, 1992). At the same time, these advantages are unevenly distributed within cities, clustering in city centres undergoing gentrification and thus contributing to socio-economic segregation (Ubarevičienė et al., 2025). Evidence from Riga illustrates this dynamic: creative and knowledge workers concentrate in historic inner-city and pre-war neighbourhoods, while leisure industry workers—whose jobs require physical presence—are more spatially dispersed across different neighbourhood types (Bērziņš et al., 2026). Digital transition also affects office spaces in multiple ways. While employers and businesses remain concentrated in large cities, the partial shift of work into digital space reduces demand for office space, raising concerns about a potential "urban doom loop"—a self-reinforcing cycle in which declining office use weakens urban revenues and local economies (van Nieuwerburgh, 2023). Yet the picture is more nuanced than simple office decline: Vibrant urban consumption spaces such as cafés and restaurants increasingly serve as attractive flexible work settings (Kousalová, 2026), while coworking spaces emerge alongside traditional offices in large cities (Sinitsyna & Alfieri, 2026).

These labour-market dynamics interact with housing-market dynamics, adding further complexity to the transformation of large cities under digital transition. Platform-mediated transactions, short-term rentals, and digitally coordinated investment intensify competition for housing in centrally located and amenity-rich neighbourhoods, which also attract workers engaged in flexible work arrangements. At the same time, a widening range of population groups—including domestic migrants, foreign workers, refugees, students, digital nomads, and tourists—adds demand to already tight urban housing markets. Many stays are temporary, yet digital tools enable these groups to maintain active connections to their countries of origin (Jauhiainen et, 2026). Together, the concentration of knowledge-intensive employment and intensifying housing competition increasingly restrict access to urban housing markets not only for lower-income but also for middle-income households, while concentrating agglomeration advantages among those able to remain (Hochstenbach & Musterd, 2018).

Suburban areas of large cities gain the most from housing and labour-market changes under the digital transition (Figure 3). Well-connected, low-density suburban environments emerge as spaces of triple access advantage, combining proximity to large-city labour markets and services, spacious dwellings in green environments, and access to high-quality digital infrastructure. Higher-income and higher-educated households benefit most from this advantage, as they are more likely to hold jobs that can be performed remotely (Luca et al., 2025) and experience a reduced commuting burden (de Menezes Amorim et al., 2026). Most relocations from large cities remain within metropolitan regions rather than beyond them, suggesting that occasional commuting still constrains residential choice (Sánchez-Moral et al., 2026). However, less frequent commuting also enables relocation further from large cities to environmentally attractive low-density locations—the so-called "donut effect" (Ramani et al., 2024)—increasing work–home distances (Coskun et al., 2026). As workplace proximity becomes less decisive, households can prioritise other factors, such as living closer to family to support intergenerational care and childcare (Kährik et al., 2026). Interestingly, the daily activity patterns of remote workers become more strongly anchored around the home, reducing everyday mobility distances (Vilhelmson et al., 2026) and concentrating social interaction within residential contexts. At the same time, new tensions emerge. First, this localisation of activity spaces is associated with higher levels of segregation, as people working from home and choosing nearby services experience more homogeneous daily environments than commuters in contexts of high residential

segregation, as shown in the Seattle metropolitan region (Cao et al., 2026). Second, among parents, working from home is associated with lower life satisfaction, reflecting the challenges of combining paid work and caregiving within the same space, as reported in a study from Belgium (Versigghel et al., 2026).

In rural areas and small towns outside urban regions, digital transition amplifies long-term job losses, as employment concentrates further in cities while nonmetropolitan areas reorient toward residence and consumption (Figure 3). Automation increases productivity in agriculture, forestry, and mining while reducing routine labour demand (Al-Amin et al., 2023), while high-skilled jobs generated by these changes partly relocate to cities (Berdegué et al., 2025). Disadvantages compound in former mining areas and agricultural centres that are least attractive for emerging consumption-based functions (Tammaru et al., 2023), leaving them excluded from the benefits of digital transition due to ageing populations, limited digital skills and access to high-quality digital infrastructure, and remoteness from urban opportunities (Leetmaa et al., 2025). Unlike cities with their vibrant cafés, restaurants, and social spaces that professional workers rely on for work, socialising, and leisure (Florida, 2018), rural areas offer less diverse opportunity structures for new consumption-oriented lifestyles. They also suffer from a digital visibility disadvantage. Low platform representation and sparse digital data trails make these areas less visible to capital, residents, and tourists alike (Mesa-Pedrazas et al., 2026), reinforcing their status as "forgotten spaces" (cf. Plüschke-Altof & Sept, 2023). Even where public investment has extended fast internet to underserved areas, IT companies and workers remain concentrated in already well-connected settlements, suggesting that digital infrastructure alone does not automatically translate into local economic activation (Aasa et al., 2026).

Digital transition brings a new wave of extended urbanisation in line with the concept of planetary urbanisation (Brenner & Schmid, 2014), reaching into rural areas by enabling residential preferences previously constrained by distance—through remote work and digitally mediated multilocal living arrangements. At the same time, it integrates rural areas more deeply into urban-origin flows of capital, knowledge, and opportunity. Amenity-rich rural areas with good accessibility and good digital infrastructure benefit through several interrelated pathways. Remote work eases distance constraints from urban labour markets, attracting new residents and enabling existing ones to avoid relocating to large cities by working from home (Reunamäki et al., 2026). This residential attraction is supported further by coworking spaces that offer professional infrastructure, reliable connectivity, and social interaction (Bosworth et al., 2023). Beyond facilitating remote work, multilocal arrangements enable families to raise children in more child-friendly environments and help slow population decline in rural areas while sustaining demand for local services (Reunamäki et al., 2026). New permanent and multilocal residents bring elements of urban lifestyle into rural areas (Tammaru et al., 2023), and households with green attitudes are particularly likely to seek out rural areas aligned with ecological lifestyles (Panori et al., 2026). The temporal rhythm of multilocal living is also changing as second homes get used more frequently and less seasonally, becoming settings for both residence and work rather than purely leisure (Hannonen et al., 2024). Amenity-rich rural areas also increase their role as places of consumption through tourism flows, gaining further attraction through enhanced visibility in digital booking systems and social media (Zainol & Roslan, 2025). Such changes strengthen the settlement system as a networked hierarchy of connectivity (Castells, 1996) and give rise to complex forms of multilocal belonging that connect individuals simultaneously to several places (cf. Schwanen et al., 2008).

Taken together, the contributions to this thematic issue show that digital transition is not a disruptive break with existing spatial structures, but a powerful force reshaping them through changes in residential decisions

and everyday activities. These dynamics unfold unevenly across the settlement system. Suburban areas emerge as the primary beneficiaries, while large cities retain their employment dominance while facing new housing market internal pressures. Rural areas and small towns outside urban regions experience the most polarised outcomes, with amenity-rich settlements gaining while peripheral areas face compounding disadvantage. At the core of these shifts lies the reorganisation of everyday activities, driven by unequal capacities of households to coordinate activities across physical and digital spaces. Digital transition thus neither eliminates distance nor diminishes the importance of place, consistent with Castells' (1996) insight that the space of flows does not dissolve the space of places but repositions them within existing settlement systems. It redefines how places matter by reshaping their attractiveness through the selective amplification of visibility within digital space, differentiating access to opportunities, and stratifying coordination capacity. The result is neither a fundamental spatial shift nor a simple reproduction of existing spatial inequalities, but a repositioning of people and places within existing spatial structures into more networked and multilocal social and spatial arrangements, mediated by digital transition-driven restructuring of labour and housing markets.

4. Avenues for Future Research

Building on these findings, we identify three avenues for future research that address the most pressing open questions in the field.

4.1. Remote Work and Changing Patterns of Spatial Mobility and Immobility

Future research should examine the extent to which the ability to work from home functions as a substitute for migration. This requires assessing how remote working arrangements enable people living outside major urban regions to access urban labour markets without relocating, potentially weakening the traditional links between migration, employment, and spatial inequality. Research should also pay greater attention to how the partial shift of activities from physical to digital spaces relates not only to mobility, but also to residential rootedness and immobility. A key question is whether digital transition reduces the need for migration or instead reconfigures it into more selective and spatially uneven flows across the settlement system.

4.2. Unequal Capacities of Households to Coordinate Activities Across Digital and Physical Spaces

Better knowledge is needed of how the capacity to coordinate everyday activities across digital and physical spaces varies across population groups, including age groups, life-course stages, and generations. While knowledge-intensive workers with better digital skills gain greater flexibility and benefit more from the opportunities provided by digital transition, diversifying residential choices and living further from workplaces, older generations and those in place-bound occupations remain more tightly constrained by physical proximity and fixed schedules. These differences intersect with education, income, and ethnicity, pointing to the need for more systematic research on how they jointly shape—at both individual and household levels—the capacity to coordinate everyday activities and, in turn, residential choices and spatial inequalities.

4.3. Differences Across Spatial Scales and Their Implications for Segregation

Future research also needs to address how digital transition reshapes spatial relations across scales, including the rise of multilocal living arrangements, and how both shape spatial inequality. While the uneven effects of digital transition across the settlement system are becoming better understood, important questions remain. In particular, from a household perspective, the expansion of residential choice alongside the contraction of daily activity spaces requires further attention. Intra-urban dynamics, including the uneven digital visibility of neighbourhoods, the role of digital platforms in shaping neighbourhood attractiveness, and their implications for community formation and social interaction, remain underexplored. A key question is whether and how the contraction of daily activity spaces around the home generates new vicious circles of segregation within already segregated residential contexts, potentially extending spatial inequality from places of residence to other activity places.

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ARTICLE

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The Impacts of Remote Work on Residential Space: A Review on Relocation, Multilocality, and Spatial Inequality

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Abstract

Remote work has emerged as one of the more consequential transformations in contemporary society, with far-reaching implications that extend beyond the organisation of work itself. One of its most profound, yet still insufficiently understood, consequences concerns residential space. By redefining the traditional spatial coupling between workplace and home, remote work offers many individuals greater freedom in choosing where to live, thereby having the potential to reshape residential location decisions. At the same time, remote work does not necessarily lead to permanent relocation; instead, it may encourage more flexible and fragmented residential strategies such as multilocal living—living and spending time in more than one dwelling. However, since remote work is not possible in every occupation, it can also potentially exacerbate socio-spatial inequalities, both temporary and permanent, in cities and rural regions. In this systematic literature review, based on 33 articles, we examine the impacts of remote work on residential space and its implications for spatial inequality. First, we provide a meta-analysis of where, when, and how the impacts of remote work on residential space have been studied over the past decade, focusing on three literature streams: residential relocation, multilocal living, and spatial inequality. We then summarise the main findings regarding these impacts, and through synthesising the existing literature, highlight issues that are currently missing from the three research streams. Finally, we suggest avenues for future research aimed at addressing the existing knowledge gaps at the nexus between remote work and residential space, which clearly remains understudied to date.

Keywords

multilocal living; remote work; residential relocation; residential space; spatial inequality; systematic literature review

1. Introduction

Remote work has emerged as one of the more consequential transformations in contemporary society, with far-reaching implications beyond the organisation of work itself. Accelerated by the Covid-19 pandemic, remote work is now widely regarded as a defining element of "the future of work" (e.g., Malhotra, 2021; Vuchkovski et al., 2023). Remote work arrangements (RWAs) offer flexibility in terms of location, timing, and frequency of work, thus allowing employees to operate outside conventional office settings for at least some of their working hours (Spreitzer et al., 2017). One of the most profound, yet still insufficiently understood, consequences of this flexibility concerns residential space—where people choose to live, whether they relocate, and how many places they inhabit as part of their everyday lives.

By redefining the traditional spatial coupling between workplace and home, remote work offers many individuals greater freedom in choosing where they live, when and where they work, and how they organise their daily lives (Pitkänen et al., 2020; Randall et al., 2022). Recent studies show that around 25% of all working days in the US are done remotely (Barrero et al., 2023), while in the EU, approximately 23% of the labour force works remotely at least occasionally (Taskinen, 2023). This growing prevalence of RWAs has the potential to reshape residential location decisions, enabling some workers to relocate to more affordable, spacious, or otherwise desirable neighbourhoods, including suburban, peri-urban, or rural areas (Stefaniec et al., 2022; Tan et al., 2023). At the same time, remote work does not necessarily lead to permanent relocation; instead, it may encourage more flexible and fragmented residential strategies.

One such strategy is multilocal living, defined as living and spending time in more than one dwelling (Randall et al., 2022). As remote work alters when and where work is performed, it can facilitate the maintenance of multiple residences for different purposes, such as combining urban employment with rural living, leisure-oriented second homes, or short-term city accommodation. While multilocal living is common in the Nordic countries (Müller, 2021), it is also increasingly recognised as a global phenomenon: 15% of households in the EU (Wind et al., 2020), 13% in the US (H.-S. Choi et al., 2014), and 20% of urban households in China (Huang et al., 2020) own multiple properties.

However, since RWAs are not an option in every occupation, they can potentially exacerbate socio-spatial inequalities, both temporary and permanent, in cities and rural regions. While residential relocation and multilocal living due to RWAs can provide opportunities for rural municipalities with a shrinking and aging population, an influx of temporary or permanent remote workers with diverse social backgrounds and lifestyles may increase socio-spatial inequalities within these municipalities and create social tensions between residents (Di Marino et al., 2023; Kiviaho & Toivonen, 2023; Schmidt-Thomé & Lilius, 2023). In cities, not everyone can afford a second home from which to work remotely or to relocate to more desirable suburban neighbourhoods, even if their jobs could be performed remotely. These economic disparities can amplify neighbourhood segregation and even lead to the "platformisation" of housing, including digital nomad communities taking over desirable urban locations from locals due to rent increases (Gil et al., 2023).

Despite long-standing research traditions on remote working (e.g., Bailey & Kurland, 2002; Nilles, 1975), residential relocation (e.g., Clark & Onaka, 1983; Rossi, 1955), spatial inequalities (e.g., Harvey, 1973), and a sharp increase in both remote work research and multilocality research since the pandemic (Figure 1), there

seems to be limited emphasis on how RWAs affect residential space. Studies have mostly focused on the social, economic, and sustainability implications of RWAs within the travel behaviour, work–life balance, office downsizing, and organisational culture contexts.

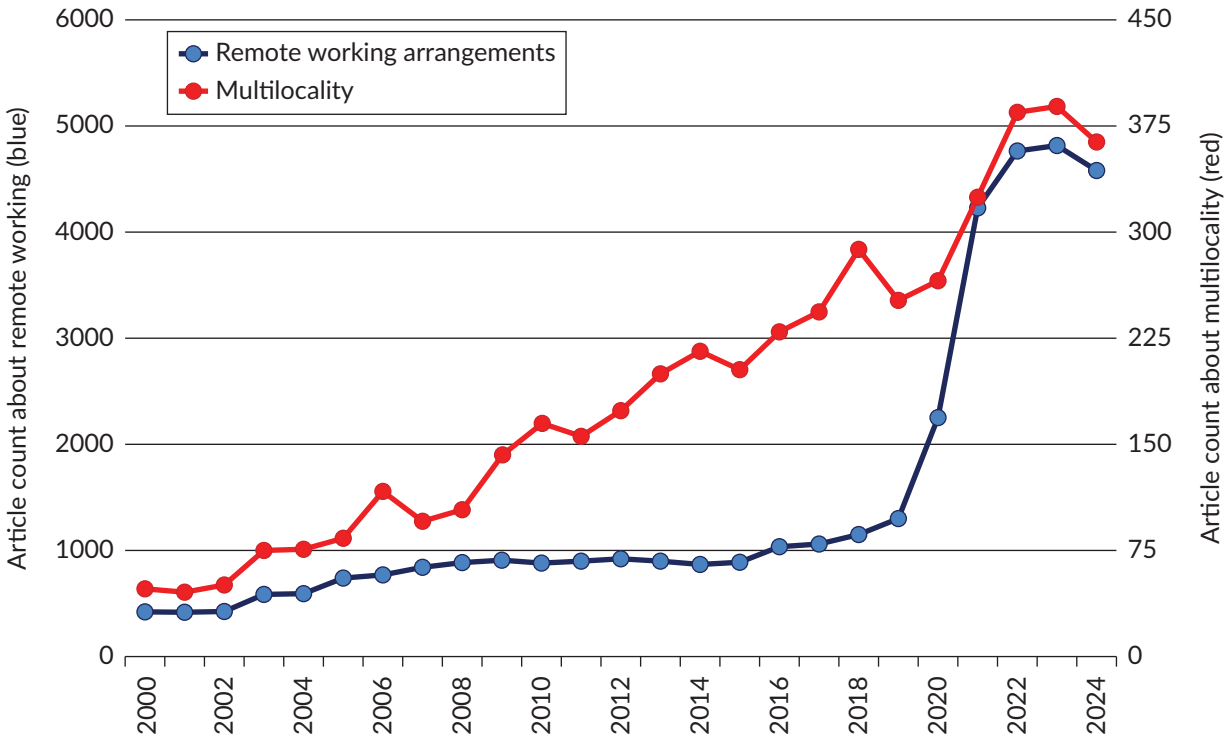

Figure 1. Number of published articles matching keyword searches for remote working arrangements (blue line) and multilocal living (red line) in the Scopus database (2000–2024).

In this article, we take stock of the existing literature and aim to provide a systematic overview of the impacts of remote work on residential space. Therefore, our first objective was to examine how the impacts of remote work on residential space have been empirically studied from three perspectives: residential relocation, multilocal living, and spatial inequality. We focused on when, where, and how the impacts of remote work have been examined, who has been studied, and the methods used for data collection and analysis. Our second objective was to map potential knowledge gaps—areas that have not yet been empirically studied—and propose avenues for future research on mitigating the gap at the nexus between remote work and residential space.

2. Methodology

2.1. Literature Search Strategy

2.1.1. Source Selection

For purposes of clarity, consistency, and reproducibility, we chose only one database for our article search, deeming Scopus the best option given that, compared to Web of Science, Scopus covers more scholarly journals from the social sciences, and approximately 99% of the journals indexed in Web of Science are

listed in Scopus (Singh et al., 2021). Google Scholar, as a crawler-based semantic search engine as opposed to bibliographic databases (such as Scopus), "does not support many of the features required for systematic searches" (Gusenbauer & Haddaway, 2020, p. 211), which is why we did not consider it to be appropriate for our study.

2.1.2. Literature Identification

We used three search queries, which consisted of two components: RWAs and their synonyms and impact categories. The former was the same for all three search queries and was used to scope our results based on the mode of work, whereas the latter was unique to each search query and was used to scope our results based on the effects we wanted to investigate. Thus, our search queries were formulated as:

(RWA keyword set) AND (IMPACT keyword set)

We used three impact categories: residential relocation, multilocal living, and spatial inequality. We jointly developed the keywords for RWAs and each impact category and then tested and refined them based on preliminary searches to achieve the optimal sets of keywords for our purposes (see the final keyword queries in the Supplementary File, Appendix 1).

We focused on two time periods: the post-Covid period (2020–2024) and the immediate pre-Covid period (2015–2019). Considering the recent impact of other societal developments in addition to the pandemic, such as technological advancement and digitalisation, we deemed it appropriate to limit the pre-Covid period to five years.

2.2. Article Selection Process

2.2.1. Initial Screening

We performed searches from the Scopus database using the three separate search queries on January 10, 2025. Our queries produced a total of 424 articles, from which we removed seven duplicates and one corrigendum, resulting in an initial set of 416 articles. We then manually screened whether each article was relevant or irrelevant for our review, excluding 301 articles as not relevant based on their abstracts (Figure 2).

2.2.2. Final Selection

After performing this initial screening, we used a five-phase selection process (Figure 2) to identify the final set of articles following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement (Page et al., 2021). After excluding those that were published before 2015 ($n = 10$), those for which we had no access to full text ($n = 11$), and those that were not in English ($n = 8$), we first included 84 articles in the systematic review. After reading the full text of these articles, we excluded 21 as not empirical and 32 as irrelevant based on the full text. During the process of compiling our final set of articles, we noticed that two articles showed up in two separate impact categories. One was ultimately excluded from both categories due to not being empirical, whereas the other was included in one category as relevant but excluded from another

as not relevant. As a result, we ended up with a final set of 33 articles included in our systematic literature review (Figure 2). The full list of reviewed articles is in Supplementary File, Appendix 2.

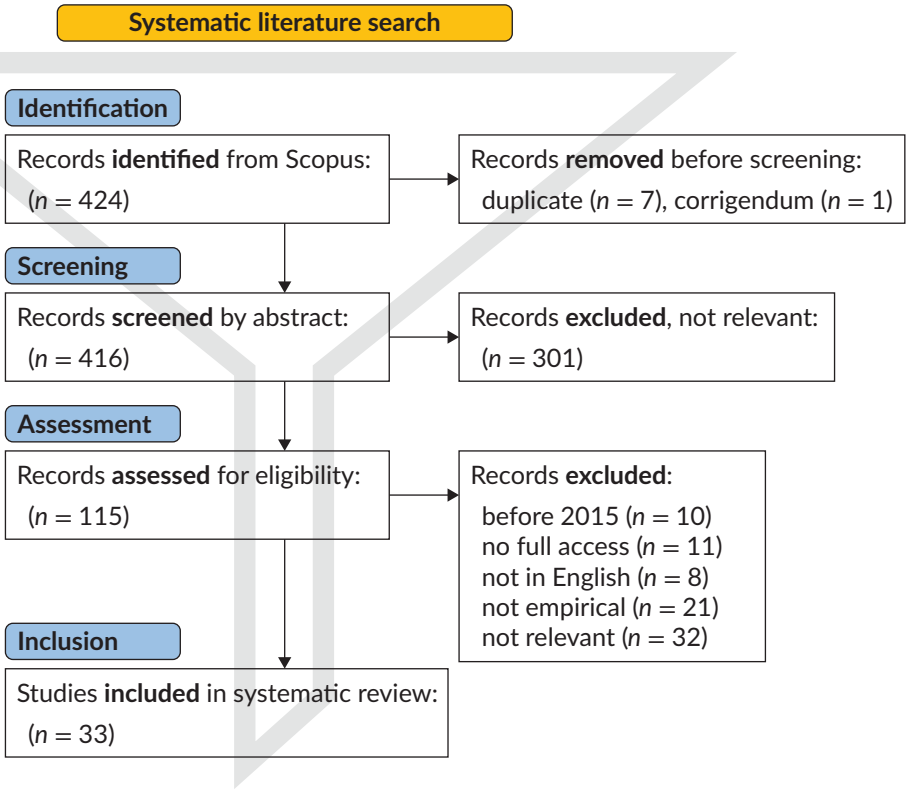

Figure 2. The systematic literature search process of this study.

3. Results

3.1. Meta-Analysis

Of the 33 articles reviewed, almost all were published during or after Covid-19, with a peak of 14 studies published in 2023 (Figure 3). Only two studies, both focusing on residential relocation, were published pre-pandemic. Regarding the timing of data collection in these studies, most (n = 22) employ data collected amid the Covid crisis (2020–2021), whereas data for 13 studies were collected wholly or partly before 2020 and for eight studies after 2021. Compared to the overall research trends (see Figure 1), the impacts of RWAs on residential space are clearly less addressed in remote work research.

The articles were published in journals across six broad research fields (Figure 3). They most frequently appeared in transport and travel behaviour journals (n = 8), primarily focusing on residential relocation, and in regional studies and planning journals (n = 6), which mainly addressed the multilocal living perspective. Interestingly, studies exploring residential relocation and spatial inequality were also published in economics journals (n = 5). Other articles were published in journals focusing on spatial and geographical research, and urban and sustainability issues.

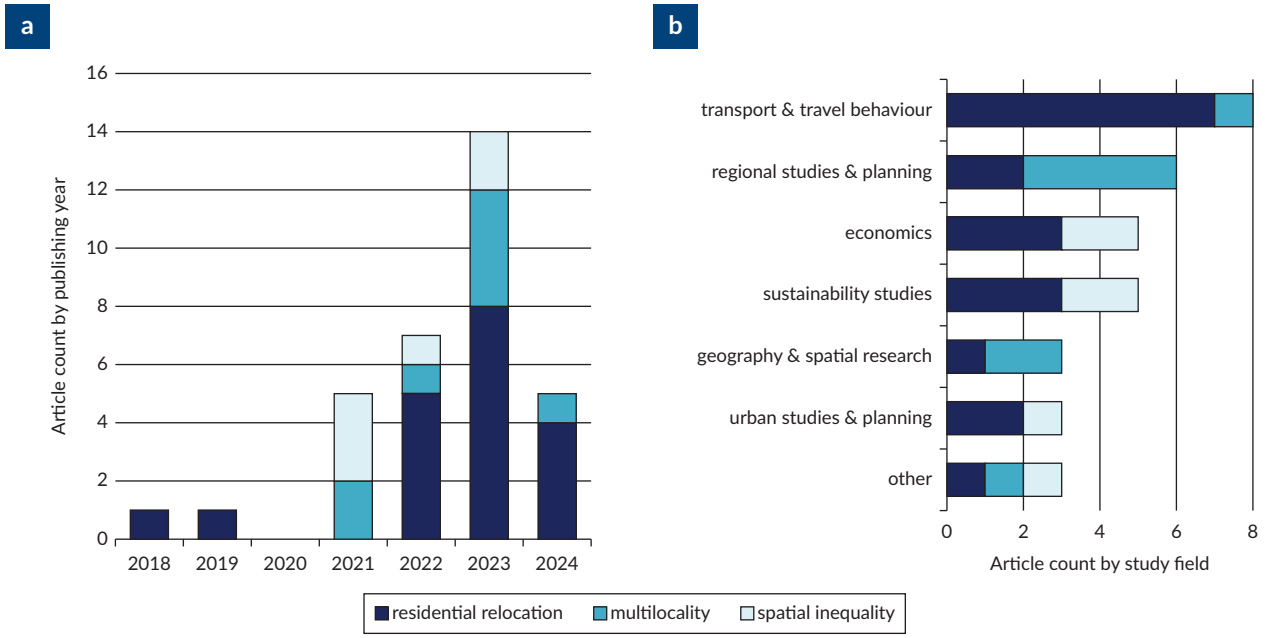

Figure 3. Articles reviewed by publishing year (A) and journal field (B).

From a geographical distribution perspective (Figure 4), most studies (n = 21) explored remote work impacts in the European context, although the US is the country with the highest number of studies (n = 6). Within Europe, four studies discuss RWAs in Germany, while six studies come from the Nordic countries. Only three studies have an international scope, with Braesemann et al. (2022) employing a global dataset, Burchell et al. (2021) utilising a survey conducted across EU28 member countries, and Garde (2021) comparing Germany and Italy. All other studies (n = 30) focus on a single country.

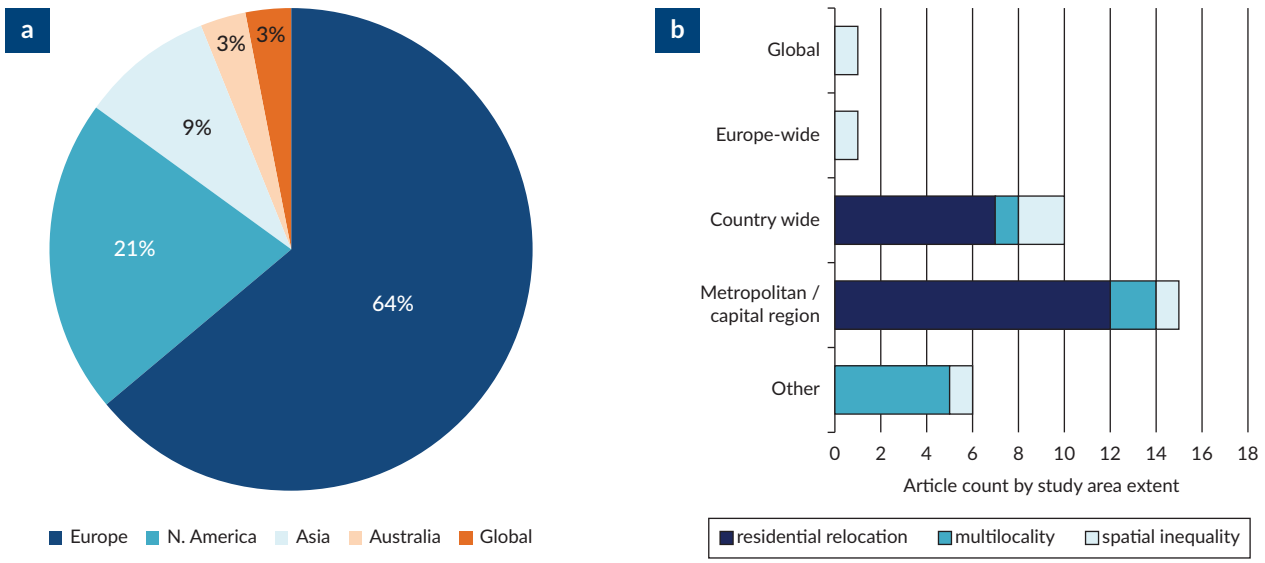

Figure 4. Articles reviewed by study area regarding the studied continent (A) and the extent of the studied region (B).

Regarding the geographical extent (Figure 4), 15 studies focused only on metropolitan or capital regions, and the vast majority of these (n = 12) were from the residential relocation category. Ten studies covered the whole study country, whereas six focused on rural regions and small cities—these were primarily investigating multilocal living. Only two had a larger scale: the global study by Braesemann et al. (2022) and the Europe-wide study by Burchell et al. (2021).

Two-thirds of the studies (n = 23) examined employees, with only five including all employees and the rest (n = 17) focusing on specific employee subgroups (Figure 5). Of these 17 studies, 13 had only one inclusion criterion: locational (work location, owning a second home, having moved), employment type (full-time, part-time, with or without RWA), or sector (ICT, white-collar, knowledge workers), with locational criteria the most often used. Five studies examined the whole population, and five other studies examined RWA impacts on residential space either by studying municipality statistics, public transit ridership, or real estate markets, or interviewing local authorities and coworking space managers.

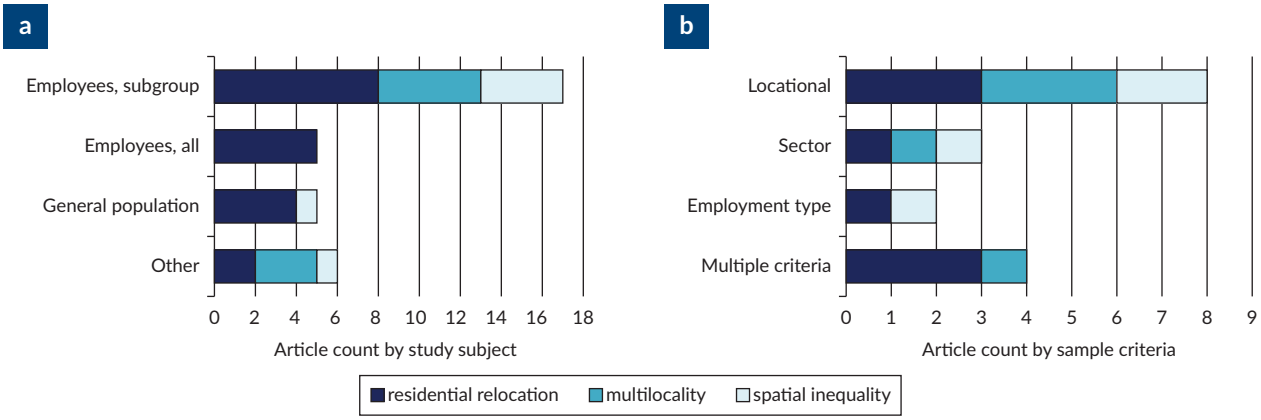

Figure 5. Articles reviewed by study subject (A) and the sample selection criteria for employee-based studies (n = 17) examining specific subgroups (B).

A clear majority of the studies (n = 24) used a quantitative approach, with the rest using either a qualitative approach (n = 5) or a mixed methodology (n = 7). Most of such studies (n = 7) examined multilocal living. Slightly more than half of the studies (n = 18) relied on one data source, which was usually a quantitative survey, whereas the rest combined multiple sources (Figure 6). The survey was the data collection method used most often, with 21 studies employing one. Eight studies used interviews and seven relied on some sort of transactional data (e.g., public transport use, real estate prices, and relocation events). Country-level register and census data and other types of databases were less used, as were various (stated preference) experiments.

Regarding the sample size in the quantitative studies, those using census or register data or other databases include all people: either the entire population or all employed persons. For survey studies, the variation was very large, ranging from 95 to 62,868 respondents, with a median sample size of 877. This variation is due to a few country-wide and Europe-wide studies with over 15,000 respondents; 12 studies had a sample size below 1,000.

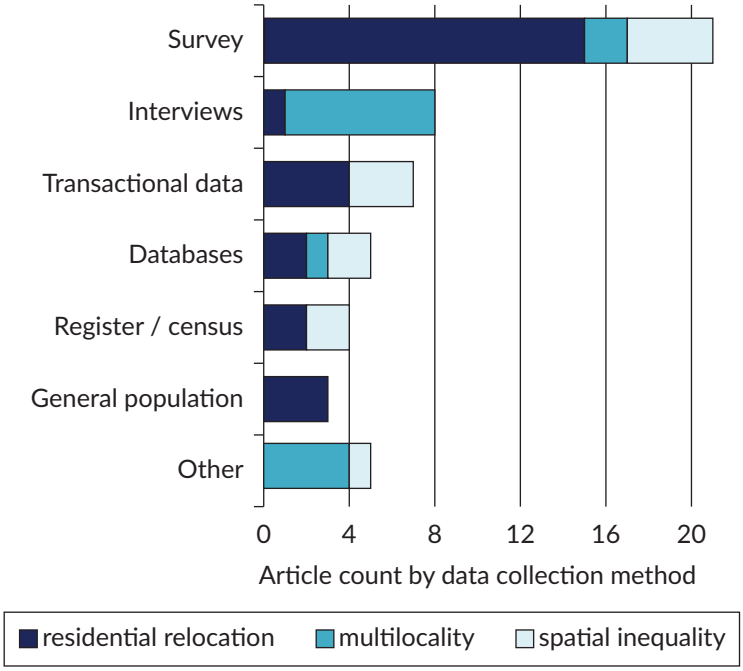

Figure 6. Articles reviewed by data collection method; articles with multiple sources are counted several times.

3.2. Findings on Residential Relocation

Our final selection of studies on RWAs and residential relocation included 19 articles, most of which referred to the situation during or shortly after the Covid-19 pandemic (2020–2022). During Covid-19, several studies reported how people moved away from urban areas and that this was partly due to the increase in remote work (e.g., Al-Akioui & Monzon, 2023; Rohit Kavikondala et al., 2022). Findings like this create the impression that RWAs indeed result in residential relocations away from urban areas. This is further corroborated by choice experiments in which respondents are presented with different RWA scenarios and asked whether they would prompt them to relocate (e.g., H.-Y. Choi, 2022). However, this proposed "urban exodus" deserves a more nuanced examination.

First, few studies (e.g., Al-Akioui & Monzon, 2023; Rohit Kavikondala et al., 2022) reported on actual moves during Covid-19. Instead, most empirical studies focused on the intention or the willingness to relocate because of remote work during the pandemic. Using data from an online survey in Ireland, Stefaniec et al. (2022) found that up to 42.5% of the white-collar respondents who could work remotely would consider moving. Tan et al. (2023) reached similar conclusions based on their online survey of tech workers in Silicon Valley, where almost half expressed an interest in relocating, and the majority (64%) cited remote work as a key factor. At first glance, the impact of RWAs on residential relocation seems significant, but there may still be a discrepancy between intentions and actual behaviour. Moreover, these studies reported only with descriptive statistics and merely an association between remote work and the intention to relocate, without further elaborating on the (causal) relationships between the two.

Second, although there might be signs that employees may have already moved away from their workplaces because of RWAs during Covid-19 or may do so in the future, many seem to prefer remaining within the same metropolitan region as before. For example, using data from U-Haul, the largest rental fleet for do-it-yourself

moving in North America, Rohit Kavikondala et al. (2022) found that, during the pandemic, most moves from cities like Austin, Chicago, New York, and San Diego stayed within their respective state. While metropolitan areas in the US are generally larger, similar trends were observed during Covid-19 in Madrid (Al-Akioui & Monzon, 2023), Istanbul (Paköz & Kaya, 2024), and Tokyo (Sharifi & Lee, 2024). Moreover, Paköz and Kaya (2024) also found that full-time remote workers during the pandemic were more willing to leave the city, while hybrid remote workers—who combine remote work with commuting to the workplace—were more willing to move to nearby regions without leaving the city.

Third, relocation studies during the pandemic often appeared to be driven by a need for extra space, including extra workspace, because of the increase in remote work—this was especially the case among those previously living in multi-family housing. However, access to a garden, proximity to nature, and quietness were important factors as well. Such location factors seem to have become more important to remote workers post-pandemic, with proximity to the workplace becoming less important (Sharifi & Lee, 2024; Stachura & Jagiełło-Kowalczyk, 2023; Thulin et al., 2023; Wolday & Böcker, 2023). Moreover, residential satisfaction and residential attachment might be important mediators in the link between remote work and the intention to relocate (Van Acker et al., 2024).

Based on these insights, simulation studies have suggested that the reduced need for commuting due to remote work may lead to an "outward relocation" trend away from central urban areas, even post-pandemic. Brueckner et al. (2023) and Brueckner and Sayantani (2023) observed how this could result in a decrease in housing prices and rents in high-productivity US regions where jobs are located. Moser et al. (2022) also observed a gradual yet discontinuous decay in additional residential demand from the core of Munich city to the fringes as the number of days working from home increased. This suggests a spatial preference for specific areas in the region, mainly secondary cities offering urban qualities while being more affordable compared to the main city of Munich. Also, these locations are easily accessible by public transport, as employees want to stay within an acceptable commuting distance from the conventional workplace. This shows again how proximity to a workplace has become less important to remote workers, but accessibility remains important to a certain extent, as they still need to commute to the workplace from time to time. This finding becomes even more important considering current debates about a return to the office. Remote workers may therefore still decide to move away from workplaces or cities in post-pandemic times, favouring locations that are accessible within a commutable distance or travel time from their workplace.

While most studies point towards a move away from city centres and workplaces to more suburban locations during the pandemic, a few studies found the opposite or found no clear pattern. For example, based on interviews with office workers in Sweden, Thulin et al. (2023) mostly found outward relocations, but also a few inward relocations nearer the workplace or city centre, mainly due to having experienced the burden of long-distance commuting during the pandemic. Shakib et al. (2024) found, based on a stated preference survey among residents in Greater Toronto, that RWAs tend to increase the utility of the current residence, but substantial heterogeneity exists among respondents, indicating that the impact of RWAs on the willingness to relocate varies.

Finally, some studies question the direction of causality in the relationship between RWAs and residential location choices. While the studies mentioned above assume that RWAs encourage residential relocation, some studies research the opposite relationship, namely, how the decision to work remotely is influenced by

where one lives. Studies like de Abreu e Silva (2022) have found that the willingness to work remotely and remote work frequency are indeed higher among those who already live further away from their workplace in suburban or rural locations and who have longer commuting distances or times. Interestingly, this debate about the direction of causality between remote work and residential location choices was already ongoing before the pandemic (Böhnen & Kuhnimhof, 2024; Ravalet & Rérat, 2019). Similarly, de Vos et al. (2018) found that remote work—even before the pandemic—was already associated with average commutes that are 5% longer.

3.3. Findings on Multilocal Living

We included eight studies in our final sample of articles about RWAs and multilocal living. One group of studies found that employees' multilocal living arrangements were not their first preference but rather they were a necessity based on their circumstances, made possible by RWAs. For example, Garde (2021) found diverse motivations for multilocal living: Some employees appreciated the social and environmental aspects of living in the countryside but could not find job opportunities there, leading them to stay at hotels or affordable rentals when working in the city at the main office. Others were in long-distance relationships, with their partner living and working in a different region, and the couples alternated living at each other's residences, typically on a weekly or fortnightly basis. The main reason for these arrangements was again a lack of job opportunities (near the partner's residence).

Similarly, J. Li and Xu (2023) investigated "dual-city dwelling" within a Chinese megaregion. They found that "job opportunities and career development are the primary reasons people make mobile-work and dual-city living arrangements" (p. 743), adding that the threat of unemployment and the need to provide for their families motivates (especially) parents to engage in multilocal living and working. These issues were echoed by Ciccarelli et al. (2025), who surveyed users of coworking spaces, shared communal workspaces which enable workplace-based multilocality, across Italy. According to them, multilocal living is sometimes a result of "forced flexibility," whereby employees may "find themselves compelled to adopt a multilocal lifestyle, for instance, to maintain family and other strong social ties" (Ciccarelli et al., 2025, p. 7). Their survey showed that multilocal living was negatively correlated with work–life balance, contradicting the more widespread discourse suggesting that RWAs allow for freedom, autonomy, and residential flexibility.

Another group of studies proposes that multilocal work can contribute to revitalising "shrinking cities" and rural municipalities with declining job opportunities and aging populations. These studies were conducted mostly in the Nordic context, where owning or renting a summer cottage in a rural area is popular. The integration of work into these leisure spaces has been on the rise, and this trend was particularly pronounced during Covid-19. For example, Di Marino et al. (2023) found that during the pandemic, summer cottages in Norway were used for 70–90 days per year compared to 40–50 days pre-pandemic, indicating a preference to work from there for longer periods.

Schmidt-Thomé and Lilius (2023) found that a local municipal government in Finland viewed multilocality as a potential solution to demographic challenges. Efforts were made to accommodate multilocals and integrate them into the community, reflecting hopes for leveraging remote work for local development. Similarly, Di Marino et al. (2023) suggest coworking spaces are beneficial for smaller cities and rural areas, because they attract second-home owners seeking better work–life balance, closer contact with nature, tighter communities, and more outdoor activities than what major cities can provide for them. Kiviaho and

Toivonen (2023) suggest that growing RWAs and multilocal living trends could offer opportunities for economic and social revitalisation in declining urban areas.

However, there are potential problems that need to be addressed in case a growing number of remote workers choose to move to smaller municipalities or stay in their summer cottages for extensive periods of time, including an increasing burden on the IT infrastructure, which is often not built for heavy use (Di Marino et al., 2023). Flipo et al. (2022), taking a more socially critical perspective, assessed the impacts of rural coworking spaces in France. The authors questioned the long-term demographic and sociological effects, pointing out the transient nature of multilocals' engagement with rural areas. They concluded that urban multilocals seemingly seeking a "simpler" and slower lifestyle in a rural area closer to nature may wish to do so only on a short-term basis, instead of a lasting change in attitudes towards rural living (Flipo et al., 2022).

Finally, Bürgin et al. (2021) studied the use of second homes as a strategic resource for certain work tasks. According to their findings, a "getaway" to the mountains provided knowledge workers with an opportunity for more focused and undistracted research and background work, and a chance to recharge mentally through nature activities, whereas working in the central workplace was reserved for teamwork and interaction with colleagues. In contrast to some previous studies, which have suggested that working remotely from peripheral regions fosters creative thinking, Bürgin et al. (2021) found that knowledge workers used the "peace and quiet" of a second home in the Swiss Alps more as a place for catching up on accumulated work tasks rather than for creative work.

As the opportunities for remote work have proliferated, multilocal living arrangements are also becoming more common. On the one hand, job opportunities are increasingly concentrated in large metropolitan areas, and on the other hand, companies expand their recruiting efforts geographically to find and hire the best employees (Garde, 2021). While there may be some potential for multilocal living and working to slow down urban agglomeration, the nature and magnitude of the impacts are still unclear. Accordingly, most of the articles on multilocal living examined the urban-rural divide in some form. These studies conclude that RWAs and multilocal living can help employees stay connected with their home regions (Ciccarelli et al., 2025), slow down population decline in rural areas (Di Marino et al., 2023), enable families to raise children in a more child-friendly environment (Schmidt-Thomé & Lilius, 2023), and provide welcome breaks from the hectic city life to work closer to nature (Bürgin et al., 2021). However, multilocal living can also increase strain on rural infrastructure and create tensions between locals and "part-time residents" who may use public services and resources without contributing taxes to the community (Di Marino et al., 2023; Flipo et al., 2022).

3.4. Findings on Spatial Inequality

By adopting a more flexible interpretation in selecting relevant studies on the impacts of remote work on spatial inequality in residential space, we found six relevant articles. A study by Braesemann et al. (2022), focusing specifically on digital online platform workers at a global scale, found that remote jobs are becoming more concentrated in larger cities, and rural regions are less attractive. This suggests that the existing concentration of human capital, ICTs, and urban opportunities pulls more remote workers and further increases spatial inequality between metropolitan and rural regions and between developed and developing countries. Similarly, Irlacher and Koch (2021) argue that remote work is drawn more to existing

urban centres, which offer greater opportunities, skills, and capital. This pull effect appears to be stronger than price differentials that might attract remote work to regions with lower living costs. Their claims are based on a study of employees in Germany, which found a clear positive relationship between working from home and average income levels at the regional level. Regions in eastern Germany tend to underperform, indicating that RWAs may exacerbate urban-rural imbalances within countries. These studies rely on data before 2020 and represent the pre-Covid era.

In contrast, a study conducted during the pandemic by Howard et al. (2023) examined how the short- and long-run effects of remote work on the US housing markets affected regional differences from 2020 until mid-2022. Their model predictions, based on housing supply and rental prices, suggest that people moved to more rural areas where housing costs were lower due to RWA opportunities, and not only due to temporary pandemic-related factors. In the long run, their predictions indicate that as RWA opportunities increase, people move away from high-density and high-price areas (like city centres) and the most expensive metropolitan areas toward lower-density, lower-price areas, including suburbs and rural regions. Similarly, a mixed-method study by Åberg and Tondelli (2021) conducted during Covid-19 in a rural region in Sweden argues that the pandemic generally increased interest in green spaces and rural living. The study found that the main motivations for relocation were quality of life and an existing second home in the countryside. While permanent and temporary in-migration to rural areas were seen primarily as positive developments by locals, they can cause both social and spatial inequality within the local community. From the spatial inequality perspective, local (younger) people might not afford increased property prices driven by in-migration, forcing them to move away to nearby cities with more affordable housing, thus contributing to spatial segregation by age groups.

Burchell et al. (2021), focusing on urban employees in 28 European countries, revealed gender inequality regarding the location of work: Women are more restricted to only work at the employer's premises (69%) compared to men (46%). For women, the potential to work elsewhere primarily means working from home, while men have more diverse and complex spatiotemporal patterns in their work locations. The study also found a clear regional difference: Nordic countries are markedly more flexible with (remote) working locations than other European countries. Finally, Owen et al. (2023) showed how RWAs and other neighbourhood factors affect public transport ridership in Chicago, and how its spatial variation can be seen as an indication of increasing urban inequalities.

However, none of the studies specifically focused on how residential relocation or temporary multilocal living due to RWAs affects spatial inequality regarding population composition at the neighbourhood and city levels.

4. Discussion and Future Outlook

One of the most important outcomes of this review is the fact that among thousands of studies focusing on remote work (Figure 1), only a handful of articles have focused on the impacts of RWAs on residential space (Figure 3). Unsurprisingly, most of these studies focus on residential relocation, whereas aspects of multilocal living and especially spatial inequality seem to have been neglected so far. From a societal viewpoint, this may significantly influence settlement patterns, urban and regional development, and social cohesion. Next, we discuss the knowledge gaps identified during the review process and propose ways forward in mitigating these gaps in future research.

4.1. Mapped Knowledge Gaps: What Is Missing?

4.1.1. Meta-Analysis

We identified several knowledge gaps based on our meta-analysis. First, the vast majority of the studies we identified were conducted in either Europe or North America, so we still know little about RWA impacts on residential space in other parts of the world, even though remote work is a global phenomenon (albeit less prominent outside Europe and North America; see Aksoy et al., 2025). Second, existing studies primarily focus on single metropolitan regions rather than covering entire countries, and more importantly, the country-comparative perspective based on a common methodology is almost entirely missing—only two studies examined two or more countries.

Third, many studies investigating employees focus only on certain employee subgroups, such as knowledge workers or full-time employees. This excludes a broader comparative view on how RWAs impact residential space based on employment sector and type, as well as the overall impact on society. Fourth, regarding research domains, the impacts of RWAs on residential space are not extensively discussed within the fields of urban studies, demography, and population research. Having fewer articles published in fields such as urban studies and urban planning reflects a clear research gap in understanding how spatial inequality in residential space (i.e., residential segregation) is shaped by residential relocation due to RWAs.

Fifth, methodologically speaking, there has been a notable lack of qualitative research, especially within the categories of residential relocation and spatial inequality. In contrast, studies on multilocal living predominantly use qualitative methods and lack quantitative research. Surprisingly, current quantitative research relies heavily on survey data, whereas the potential of national register databases as well as promising big data sources (see, e.g., Müürisepp et al., 2022; Willberg et al., 2021) seems to be overlooked. Further, we see a clear need for innovative mixed methods approaches in future research.

4.1.2. Residential Relocation

The understanding of how RWAs influence employees' residential location choices has expanded since the pandemic, yet significant gaps remain. First, existing evidence suggests remote work is associated with moving away from the workplace, but it remains unclear whether this also implies a move away from cities. Most studies do not clearly specify how far remote workers are willing to relocate or to which types of spatial environments. Consequently, "moving away" is often implicitly assumed to mean moving from urban to suburban or rural areas. However, the heterogeneity of findings suggests this assumption may be too strong. Given that some employers ask remote workers to remain within a reasonable commuting distance from their conventional workplaces (as documented by Šmite et al., 2023) or increasingly request a return to the office, it is becoming increasingly important to better understand how far remote workers wish to relocate and to what types of environment. While commuting distance as a factor in location choice may have diminished in importance, it has likely not disappeared entirely, with "proximity" potentially being replaced by "accessibility."

Second, this also calls for more research on the importance of remote work as a relocation decision factor against other considerations like housing characteristics (e.g., size, cost, type) and neighbourhood attributes

(e.g., proximity to workplace, public transport, natural spaces). Stated preference experiments, like in Shakib et al. (2024) or Sharifi and Lee (2024), could shed light on these dynamics. Additionally, most empirical studies focus on the intention to relocate and how this is influenced by RWAs, but offer no insights into actual relocation decisions. In-depth interviews (e.g., Thulin et al., 2023) or surveys with clients of moving companies (e.g., Rohit Kavikondala et al., 2022) or real estate developers who are in contact with people considering moving can be useful for this purpose.

Third, the causality between remote work and residential choices remains unclear. It is uncertain whether remote work drives changes in residential location or if the choice of residence influences the extent of remote work. This requires more research based on longitudinal data, as used by de Vos et al. (2018) or Ravalet and Rérat (2019).

4.1.3. Multilocal Living

The literature recognises that RWAs make multilocal living possible, but there is uncertainty regarding individual and regional outcomes. First, although RWAs and multilocal living hold potential for reducing the need for families to relocate to larger cities and enabling them to live in smaller communities despite a lack of local job opportunities (Schmidt-Thomé & Lilius, 2023), studies like those by Garde (2021) and Ciccarelli et al. (2025) contradict the mainstream RWA narrative of increased freedom and flexibility and suggest that multilocality is often more a necessity than a deliberate choice. Where and for whom this is the case, and what can be done about it, needs more research attention.

Second, there are knowledge gaps concerning whether remote work and multilocal living can revitalise rural municipalities and how. Studies like those by Kiviaho and Toivonen (2023) and Schmidt-Thomé and Lilius (2023) have employed future-oriented qualitative methods to explore the hopes and doubts of locals and decision-makers, but complementing quantitative and longitudinal studies is needed to find out what the long-term impacts of RWAs and multilocal living are on the development of rural areas and peripheral cities.

Third, RWAs encourage more people to work from their second homes for extended periods (Di Marino et al., 2023; Kiviaho & Toivonen, 2023). One question, especially in the Nordic summer cottage context (see Müller, 2021), is how RWAs are transforming rural second homes from places of leisure and relaxation into places for mixing work and holiday use. Although Bürgin et al. (2021) provided interesting insights on the strategic use of a peripheral holiday home for work, they relied on only six individuals, leaving room for further studies on the interplay of different places for work and multiple homes.

4.1.4. Spatial Inequality

There is limited (indirect) knowledge about how the increasing adoption of RWAs influences residential relocation and multilocal living, and its subsequent effects on societal structures, particularly concerning spatial segregation and social inequality. This issue stems largely from the structural inequalities linked to the potential to work remotely, which vary by job type and industry (H. Li & Wei, 2023), as well as by country, due to national RWA policies (Luca et al., 2025). Thus, it raises critical questions about how RWA-induced residential relocations are reshaping population compositions from the neighbourhood level to a global scale.

Despite the significance of these questions, none of the studies reviewed specifically addresses these issues. Certainly, similarly to Howard et al. (2023), economists have started to estimate the impact of RWAs on residential real-estate property and rental markets since the Covid-19 pandemic (e.g., Althoff et al., 2022), but their focus is solely on economic aspects and not on social implications: how it affects the social fabric of neighbourhoods and how it potentially fosters spatial inequalities and segregation in cities. Regarding multilocal living, we lack understanding of how temporary living in second homes for certain population groups affects the social fabric in areas where primary homes are left empty for weeks and months, and the social dynamics in areas where second homes are occupied by temporary residents.

A few discursive articles (not included in the review) touch on potential changes in urban spaces and spatial inequality, offering predictions for future developments in residential space. For example, Florida et al. (2023) predict only minor long-term impacts of RWAs on urban fabric and settlement structure, arguing that employees with high RWA potential still want urban amenities and opportunities in attractive metropolitan cities. They further predict that if densely populated urban centres lose population, people will relocate to nearby suburbs and small towns, and medium-sized cities and remote rural areas will continue to lose economic attractiveness and residents. These predictions are supported by two of the empirical studies we reviewed, conducted on global and regional scales, respectively (Braesemann et al., 2022; Irlacher & Koch, 2021). In contrast, initial studies on spatial inequality conducted during Covid-19 indicate significant structural changes in people's daily lives and society (H. Li & Wei, 2023; Müürisepp et al., 2023), although these studies do not examine the role of RWAs. These somewhat conflicting results underscore the need for more comprehensive research that delves into the implications of remote work for spatial inequalities in residential space at neighbourhood, city, regional, and global levels.

4.2. Synthesis and Avenues for Future Research

Remote work is here to stay, and it has enormous impacts on where people live and how they go about their daily lives. Our review of the existing research on the impacts of remote work on residential space shows that the flexibility offered by RWAs regarding work locations sometimes enables residential relocation, multilocal living, and greater work–life balance. Additionally, RWAs can and will also significantly affect socio-spatial inequalities and potentially contribute to segregation, making them highly relevant for urban and regional planning and policy.

The review revealed that the impact of remote work on residential space has largely been overlooked, especially in the urban research context. Most importantly, the existing literature is primarily focused on Europe and North America, is often case-specific, and tends to concentrate on only certain population sub-groups; thus, one must exercise caution in drawing any universal conclusions on the topic based on the current literature. Additionally, the underlying economic, social, and cultural mechanisms by which remote work impacts residential space remain unclear and require further research.

Above, we have addressed several aspects aimed at mitigating the existing knowledge gaps in understanding the impacts of RWAs on residential space. We now highlight four avenues for further research that can provide new insights and contribute to the discourse on RWAs and residential space.

First, we urge scholars in the social sciences to better acknowledge the impacts of RWAs on the social and spatial functioning of society. RWAs affect more than daily practices, health and well-being, organisational changes, job relocations, and office downsizing. They also alter socio-spatial structure and the urban-rural nexus, which can have long-term impacts on residential location decisions, multilocal living arrangements, and spatial inequalities in residential space. It is essential that scholars pay more attention to these impacts.

Second, almost all empirical studies were cross-sectional or compared changes over two consecutive years, which captured short-term changes related to the social disruptions caused by the pandemic. However, the knowledge gaps we identified in all three studied perspectives clearly require more longitudinal studies to understand the relationships between RWAs and residential space better, to not only see beyond the Covid-19 disruption but also to enable a more detailed examination of the pre-Covid period to distinguish long-term trends.

Third, a more diverse methodological toolbox is needed, especially to capture the missing longitudinal perspective. For example, qualitative research could employ innovative remote or hybrid ethnographic approaches (e.g., Reunamäki, 2025) or study employees' biographies, whereas quantitative research could leverage the potential of national register databases and census data. In particular, national registers enable researchers to link individual information (such as place of residence, education, and income) with employment information (such as location, job type, and sector) at the micro-level annually to reveal residential and work relocation linked with the remotability of jobs over several years or even decades. Many countries (e.g., the Nordic and Baltic countries) maintain such national register databases, but to date, this information remains underexamined.

Finally, it is surprising that no big data sources (e.g., mobile phone and social media data) have been utilised in this research field at all, especially given their widespread use in academia for understanding societal processes, including capturing daily activity locations (e.g., Poorthuis et al., 2024), dynamic population presence (Willberg et al., 2021), and spatial inequality (Müürisepp et al., 2025). For instance, studies based on mobile phone data from operators during the pandemic revealed how the spatial segregation increased between socioeconomic and ethnic groups regarding their daily use of urban space (Müürisepp et al., 2023), as well as patterns of individuals with access to second homes escaping larger cities for less dense rural areas (Willberg et al., 2021). Similarly, data from Facebook indicated that people stayed in their homes and avoided dense urban centres (Rowe et al., 2023). These promising novel data sources capturing dynamic population presence and mobility flows, combined with conventional data, could shed some light on the impacts of RWAs on residential space, especially regarding multilocal living.

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Conflict of Interests

The authors declare no conflict of interests.

LLMs Disclosure

ChatGPT was used solely for language polishing. All outputs generated were critically reviewed, revised, and approved by the authors.

Supplementary Material

Supplementary material for this article is available online in the format provided by the author (unedited).

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Which Regions Gain the Most From Digital Transition: Urban, Suburban, or Rural?

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Abstract

Since the outbreak of Covid-19, the digital transition has intensified globally. This study examines its spatial dynamics by focusing on the distribution of fast internet across settlements and how it relates to the location of IT companies and the residential patterns of IT workers. While existing research often emphasizes the urban–rural divide, we go beyond this by adopting a full-country approach at a fine spatial scale and by distinguishing between urban, suburban, and rural contexts. The study focuses on Estonia, a digitally advanced country known for its e-governance and digital public services. Using multiple data sources—including fast internet availability, business registry data to map IT company locations, and individual-level census microdata to trace the residences of IT workers—we conduct a detailed spatial analysis at the settlement level. Our findings show that telecom companies provide fast internet primarily in urban areas, while public subsidies have aimed to address market failures in less urbanized regions. Areas with fast internet host nearly four times as many IT companies and three to four times as many IT workers as unconnected regions. IT companies are highly concentrated in Estonia's two main cities, while IT workers are more dispersed, extending into suburban and exurban areas. Settlements with fast internet and higher shares of IT workers also report significantly higher income levels. The Estonian case highlights the importance of targeted public policy to address the cumulative and spatially uneven effects of digital transition. Expanding fast internet access to underserved regions is essential for inclusive and balanced regional development.

Keywords

digital transition; high-speed internet infrastructure; IT companies; IT workers; regional divides

1. Introduction

Growing regional divides between economically vibrant cities and peripheral areas have become a defining challenge of regional development. While large cities thrive—attracting capital, talent, and innovation—many rural areas face stagnation or decline (Rodríguez-Pose et al., 2024). Cities serve as magnets for businesses and people, hosting universities, generating knowledge spillovers, and functioning as hubs of global networking and innovation (Bathelt et al., 2024). The divide between major cities and peripheral areas is deepening (Rodríguez-Pose, 2018).

Digital transition—the integration of digital technologies into the economy and society—has emerged as a potential game-changer in redefining regional divides (European Commission, 2022). Accelerated by the Covid-19 pandemic, the shift from physical to digital space has transformed how people and places connect to opportunities (Lythreatis et al., 2022). The interplay between centralizing and decentralizing forces lies at the heart of debates on spatial consequences (Fu et al., 2024). Two trajectories are emerging: one deepening existing divides, another reducing them.

Cumulative advantage explains how regional inequalities reinforce over time. The "Matthew effect" (Merton, 1968) describes how initial advantages accumulate, further benefiting prosperous areas. Major cities attract talent and strengthen their role as control centers of the world economy (Sassen, 1991), with digital tools potentially consolidating this dominance. Fielding's escalator regions concept (Fielding, 1989, 1992) highlights how certain areas offer enhanced opportunities that draw skilled labor and facilitate upward mobility.

In contrast, Hägerstrand's (1967) contagious diffusion concept suggests innovations spread outward from urban centers, extending opportunities beyond major cities. Moss (1987) argued that while telecommunications facilitate business clustering in large cities, rural areas could benefit from remote work and digital businesses with appropriate infrastructure and policies. The IT sector has become one of the fastest-growing parts of modern economies. The spatial distribution of IT companies and their workforce is strongly influenced by digital infrastructure availability (van Dijk, 2020). By driving innovation and productivity, the IT sector can serve as both an indicator and a catalyst for both more balanced regional (Zālīte et al., 2025) and urban (Tammaru et al., 2021) development.

Despite growing recognition of digital infrastructure as critical for regional development, knowledge gaps remain in understanding how it influences regional change (Bathelt et al., 2024). This study examines whether digital transition reinforces existing regional inequalities or creates new opportunities by analyzing the interplay between digital infrastructure availability, IT company locations, and IT worker residential choices. We go beyond the urban–rural dichotomy to understand how the digital transition affects different settlement types—urban, suburban, and rural. More specifically, our analysis seeks to answer three interrelated research questions:

1. Does the location of digital infrastructure, specifically fast internet, follow existing regional divides?
2. How does the availability of fast internet relate to the spatial distribution of companies, particularly those in the IT sector, relative to other companies?
3. How does the availability of fast internet correlate with the residential distribution of IT sector employees compared to employees in other sectors?

This study focuses on Estonia, a country with a market-driven economy and limited regional policy interventions (Raagmaa, 2023). Its digital infrastructure development combines market-driven investments with public initiatives: Private telecommunication companies target profitable urban and suburban areas, while the state focuses on peripheral and rural regions. This dual approach creates a complex spatial landscape where high-speed internet access is shaped by both market forces and public interventions. Public investment has proven effective in narrowing urban–rural digital divides (Briglauer et al., 2019). This article analyzes digital transition's spatial footprint in this market-based context, examining how effects manifest across the settlement system.

The article proceeds as follows: The next section presents the conceptual framework for understanding how digital infrastructure relates to regional divides, followed by a literature review synthesizing key empirical findings. The data and methods section outlines sources and analytical techniques. The results section examines the spatial clustering of IT companies, IT workers, and income distribution across areas with varying digital infrastructure. The discussion interprets findings through the lens of spatial divides and regional inequalities. The article concludes by summarizing key findings and outlining directions for future research.

2. Conceptual Approach: Effects of Digital Transition in Urban, Suburban, and Rural Areas

Urbanization, suburbanization, and counterurbanization have long shaped regional development (van den Berg et al., 1982). Digital technologies now transcend physical boundaries, reshaping where people can live and work and blurring lines between urban, suburban, and rural areas. The Covid-19 pandemic accelerated this transformation, bringing remote work and online services into everyday life across the settlement system (Ciccarelli & Mariotti, 2024; Oleaga, 2025). However, little is known about how these shifts redistribute opportunities—including employment access, flexible work arrangements, and housing options—across different spatial contexts. In this section, we propose a conceptual framework for understanding how the digital transition is driving change across urban, suburban, and rural contexts (Figure 1).

Following our conceptual framework, we focus on how the digital transition affects urban, suburban, and rural areas through labor and housing market changes. The digital transition affects labor market change in two key ways. First, it enables automation and information economy expansion, which increases demand for highly skilled workers in sectors like IT (Hamnett, 2024). Second, remote and hybrid work arrangements have become mainstream among professionals, decoupling work from physical proximity to employers. This gives workers greater flexibility in residential location based on lifestyle preferences, family needs, or housing affordability.

Growing professionalization and work flexibility are reshaping housing markets. As professionals cluster in major cities, housing demand and prices rise, displacing lower-income groups (Van Ham et al., 2021) and pushing even some professionals beyond core employment areas (Ramani et al., 2024). Digital transition has accelerated housing financialization through online real estate platforms and short-term rental services (Cocola-Gant et al., 2021). These tools enable local and international investors to easily buy, manage, and monetize housing. Apartments in high-demand urban and touristic locations increasingly serve as investment assets rather than homes for long-term residents (Barron et al., 2019; Pettas et al., 2024).

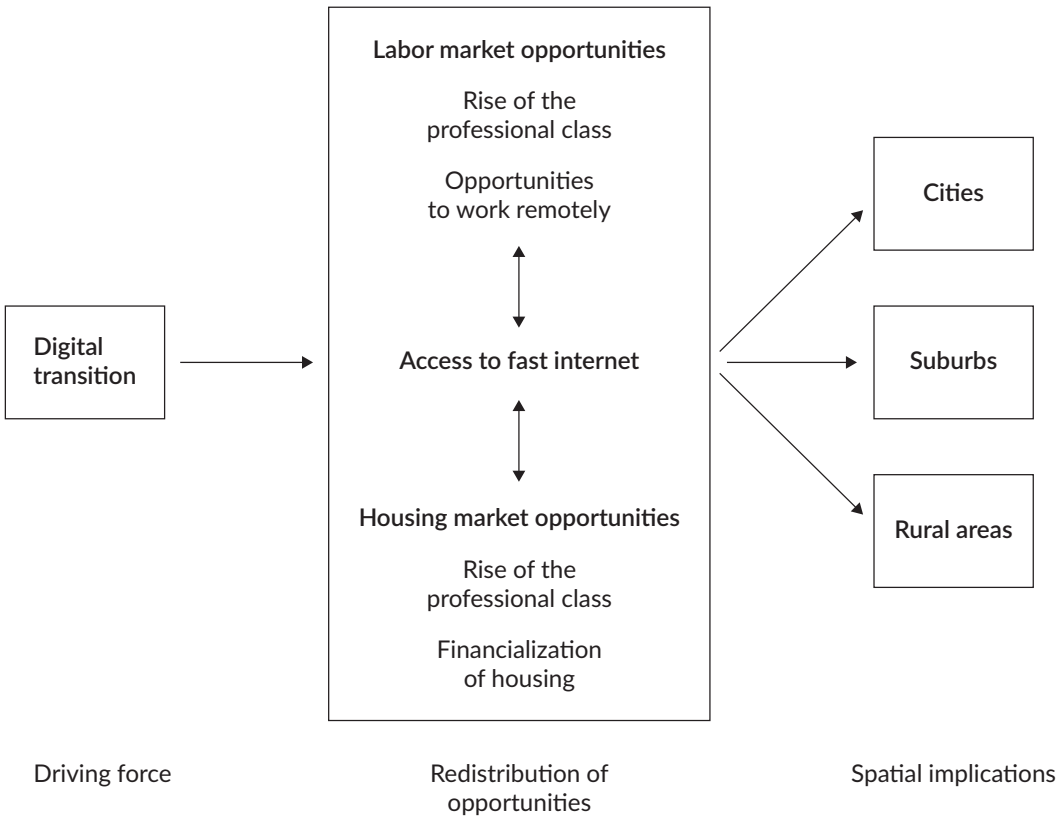

Figure 1. Digital transition as a driver of urban, suburban, and rural change.

High-speed internet drives change across work and housing domains. By enabling remote work and transforming housing markets, digital connectivity reshapes the context in which people decide where to live and businesses where to operate. Large cities continue attracting investment, skilled workers, and high-paying jobs, reinforcing their economic dominance (Althoff et al., 2022; Luca et al., 2025). Simultaneously, rising prices displace long-term residents (Wolf & Irwin, 2024), unlocking opportunities for digitally connected non-metropolitan areas as destinations for remote workers and lifestyle migrants seeking affordability and quality of life (Malecki, 2003; Mießner & Naumann, 2024). In some cases, this rural gentrification helps reverse population decline by bringing capital, skills, and new economic activity (Bogason et al., 2024).

Our approach goes beyond the urban–rural binary by explicitly incorporating suburban areas, which are becoming ideal grounds for the opportunities arising from the digital transition. Suburban areas are increasingly seen as compromise locations for high-skill workers seeking both proximity to urban job markets and improved housing affordability or quality of life. With better internet access than rural areas, suburbs support remote work and family needs, enabling a shift from central cities to more spacious, affordable suburban living—even as companies and IT jobs remain city-centered (McArthur & Hong, 2023; Tan et al., 2023).

While digital transition may deepen regional divides by concentrating employers in central areas, it also holds potential to bridge divides through residential decisions. Rising housing costs push residents outward, while remote work makes suburban and rural living feasible. Fast internet investments enhance appeal of

non-metropolitan areas, enabling smaller businesses to reach broader markets, create jobs, and attract skilled workers (Deller et al., 2022; Fu et al., 2024). Even where local job markets remain limited, improved connectivity supports remote employment and digital inclusion (Ciccarelli & Mariotti, 2024; Li et al., 2024; Peng & Dan, 2023). However, unequal access to digital technologies—the digital divide—remains a pressing social justice issue. Digital exclusion exacerbates marginalization among vulnerable populations, making equitable connectivity investments critical for inclusive regional development (Ragnedda et al., 2022; van Dijk, 2020).

3. Digital Transition and Spatial Inequality: Existing Evidence and Knowledge Gaps

The digital transition is transforming spatial development patterns through multiple channels, such as improved access to digital infrastructure, expanded opportunities for remote work, and the consequent shifts in residential location choices (Hostettler Macias et al., 2022). Research reveals pronounced concentration of IT sector employees and companies in major cities, reinforcing existing regional divides and supporting the escalator region concept (Ali et al., 2019; Keuschnigg et al., 2019). However, patterns vary: While some cities concentrate IT workers in urban cores, others show more dispersed distributions (Bauer, 2018; Foley et al., 2022). At the local scale, significant intra-city disparities emerge, with tech workers clustering in well-connected and attractive neighborhoods, amplifying gentrification (Foley et al., 2022; Francis & Weller, 2022; Zālīte et al., 2025). Tech-related activities remain concentrated in and around urban centers (Gallardo et al., 2021), deepening the metropolitan-non-metropolitan divide.

The adoption and use of digital services does not, thus, take place at the same pace in urban and rural environments, with rural areas lagging behind (Gallardo et al., 2021; Lengyel et al., 2020; Rodríguez-Pose, 2018). Nevertheless, Fu et al. (2024) demonstrate that rural areas may benefit from the digital transition, too, as innovations spill over from large cities to other regions. For instance, Deller et al. (2022) found a positive association between increased startup activity in IT-related sectors and higher access to fast internet in rural USA counties, suggesting that digital transition can support the decentralization of IT sector companies and employees if the infrastructure enables it. Other studies further suggest that tailored digital development strategies can help mitigate existing disparities and empower rural areas, even when initial inequalities are pronounced (Fu et al., 2024; Rodríguez-Pose, 2018).

According to McArthur and Hong (2023), residing in areas with fast internet leads to increased remote work, suggesting that digital infrastructure plays an important role in enabling its adoption. Hostettler Macias et al. (2022) further link this trend to shifts in the residential redistribution of workers toward both rural and suburban areas. Covid-19 sparked counter-urbanization patterns, with migration toward holiday villages, peri-urban coastal areas, and some remote regions (Argent & Plummer, 2024; González-Leonardo et al., 2022). However, debate persists over whether these patterns reflect genuine counter-urbanization or merely extended suburban sprawl into metropolitan hinterlands (Denham, 2021), and whether they represent only a short-term response to the health crisis or a more structural shift enabled by new opportunities to decouple home and work brought about by the digital transition. The spatial character of these movements remains uncertain, too, with some scholars pointing to extended suburbanization rather than genuine counter-urbanization to more remote rural settlements (González-Leonardo et al., 2022), labelled as a “donut effect” by Ramani and Bloom (2021). Emerging research highlights that suburbs may, indeed, be the long-term key beneficiaries of digital transition (Hostettler Macias et al., 2022). Hybrid work

arrangements enable workers to live further from workplaces while maintaining periodic commuting, limiting relocation to distant rural areas, and instead driving suburbanization and urban sprawl (Ramani et al., 2024; Tan et al., 2023).

While research increasingly examines digital transition's spatial impacts, most studies focus on urban–rural divides, largely overlooking suburbs as distinct and dynamically changing spaces. Moreover, infrastructure distribution, company location, and worker residence are rarely analyzed together, and the role of public investment in mitigating market-driven inequalities in developing digital infrastructure. This study contributes to addressing these gaps by examining how the digital transition unfolds across urban, suburban, and rural Estonia, analyzing jointly the spatial distribution of digital infrastructure, IT companies, and IT workers, and distinguishing between market-led and state-supported connectivity in the development of digital infrastructure.

4. Case Study Context: Regional Development and Digital Infrastructure in Estonia

Estonia provides a valuable context to study how digitalization influences spatial development. With minimal regional policy intervention (Raagmaa, 2023), Estonia offers insights into how digital infrastructure and IT-related sectors evolve within a market-driven society. However, digital infrastructure development follows a more complex trajectory, combining market and public investments. Market forces strongly influence labor and housing markets (Aalbers, 2017; Çelik, 2024) as well as digital infrastructure access.

Private providers concentrate high-speed internet investments in affluent, densely populated areas, leaving rural regions behind (Galperin et al., 2021). This pattern is evident in Estonia. Private telecommunication companies prioritize economically viable urban and suburban areas with higher returns. However, the Estonian state has supported infrastructure expansion in peripheral and rural areas through targeted programs led by the Estonian Broadband Development Foundation (ELASA). Consequently, high-speed internet access, particularly 1 Gbps fiber optic connectivity, has become both a market-driven commodity and a state-facilitated public good. Established in 2009, ELASA has implemented the EstWin project, building over 6,000 km of backbone network by 2018 and expanding since 2021 to construct last-mile access networks in underserved rural areas using national and EU funding (ELASA, 2025; Majandus- ja Kommunikatsiooniministeerium, 2024).

This article explores how digital transition progresses across Estonia's settlement system, focusing on major urban centers (Tallinn and Tartu), suburban areas, and rural regions. Tallinn serves as the economic hub, while Tartu is the center of education and innovation. Suburban areas are the functional urban regions of Tallinn and Tartu, characterized by intense commuting and ongoing urban sprawl that extends almost 100 km from the city in Tallinn and 50 km in Tartu, offering attractive living environments, fast internet, and close access to jobs (Majandus- ja Kommunikatsiooniministeerium, 2025). Beyond these urban regions, smaller towns and rural areas face uneven development trajectories. Although Estonia is recognized for early e-governance adoption and widespread online services, significant spatial disparities in digital access persist. Income inequality is relatively low by OECD standards (OECD, 2025), yet it intersects with digital divides, potentially reinforcing unequal access to labor and housing markets (Kalmus et al., 2013; van Dijk, 2020). This study analyzes how digital transition affects urban, suburban, and rural settlements through the spatial distribution of digital infrastructure, IT companies, and workers.

5. Data and Methods

5.1. Data

This study integrates multiple data sources to provide a comprehensive analysis of how the digital transition intersects with spatial development along three key dimensions: the availability of fast internet infrastructure, the business location of IT companies, and the residential location patterns of IT workers. These dimensions reflect the technological, economic, and demographic aspects of digital transformation. To enable consistent comparison across data types, all datasets were harmonized and aggregated at the settlement level, even in cases where more granular, address-level data were available. This approach ensures analytical coherence while maintaining statistical robustness. In accordance with data protection and anonymity requirements, all settlements with a population below three were excluded from the analysis to prevent potential identification of individuals in very small communities.

First, we use cable internet access data from the Consumer Protection and Technical Regulatory Authority. We focus exclusively on fiber optic cable internet because, in the Estonian context, a 1 Gbps fiber optic connection is widely regarded as a proxy for stable and high-speed internet access. Our analysis examines the availability of such connections at two points in time: 2019 and 2023, corresponding to the period before and after the global Covid-19 pandemic, which markedly accelerated digital transitions worldwide. Importantly, the data allow us to distinguish between networks developed commercially by private telecom operators in response to market demand, and those established through public sector initiatives (including EU funds and national government support) intended to address market failures in less profitable areas for telecom companies. To capture variation access across settlements, we classify connections into three categories: fast internet (1 Gbps), slow internet (less than 1 Gbps), and no cable internet connection.

Second, we utilize data from the Estonian Business Registry, which contains detailed information on company addresses and fields of economic activity for the year 2023. The location data is provided both for headquarters as well as actual operation units for larger companies. While digital technologies permeate virtually all sectors of the economy, this study adopts a narrow operational definition of IT companies to ensure analytical clarity. Using the official Classification of Economic Activities in the European Community (NACE codes), we identify and extract companies whose primary activities fall within core information technology fields. The specific activity codes included in our classification are presented in the Supplementary File, Table 1. This approach allows us to distinguish IT companies from other types of businesses and to map their spatial distribution across Estonian settlements.

Third, we incorporate individual-level data from the 2021 Estonian Population and Housing Census, which provides detailed information on residents' employment sectors and home locations. This dataset enables us to identify individuals working in the IT sector and analyze their residential patterns in relation to broader spatial development and digital infrastructure dynamics.

Our analysis compares IT sector workers and companies to all other sectors combined. While 'other sectors' encompasses a diverse range of industries, this broad comparison serves our analytical purpose of identifying the distinctive spatial concentration patterns of the IT sector. IT workers constitute a clearly defined occupational group with sector-specific characteristics—high salaries, remote work capability, and

digital infrastructure dependency—making them analytically distinct from the general workforce. This approach allows us to assess whether IT sector spatial patterns differ fundamentally from overall employment distributions across the settlement system.

5.2. Methods

The spatial unit of analysis in this study is the settlement, which represents the most granular territorial division in the official Classification of Estonian Administrative Units and Settlements (Eesti Statistika, 2025). This approach allows for a high level of spatial precision and comparability across datasets. In total, data were obtained for 4,715 settlement units, although this number may vary slightly between data sources and over time due to administrative updates and reclassifications within the national settlement system. Special analytical focus is placed on Estonia's two largest urban centers—capital city Tallinn and second-largest city Tartu, hosting the main university of the country—and the suburbs surrounding them, as these are two main hubs of digital transition in Estonia. These two urban regions are delineated based on functional relationships, specifically by identifying areas where at least 50% of the employed population commutes to the urban core. This commuting-based definition captures broader urban influence zones and better reflects contemporary patterns of residential location and economic integration. In the accompanying maps, place names correspond to the central settlements of these functional city-regions (Hägerstrand, 1967).

Our analysis starts with a ranking-based assessment of spatial patterns of economic activity, which is particularly suited to Estonia's highly uneven spatial structure—characterized by a small number of dominant urban centers and a large number of sparsely populated small towns and rural settlements. While Location Quotient (LQ) analysis (Isard, 1960) is commonly used for evaluating relative concentration of economic activity, its effectiveness can be limited in contexts with significant spatial inequality, making rank-based approaches more appropriate for our case. This methodological choice reduces the distorting effect of extreme disparities in absolute values and facilitates more meaningful comparisons across settlements of different sizes. To evaluate the distribution of IT-related activity, we rank settlements along two dimensions: the share of IT companies relative to all companies located in a settlement, and the share of IT workers relative to the total employed population residing in each settlement. These two sets of rankings will then be compared by calculating rank differences for the top 500 settlements in each category. By focusing on this subset, we minimize the statistical noise associated with very small settlements where IT activity is negligible, allowing for a more robust comparison. In a nutshell, the resulting rank differences reveal the relative over- or under-representation of IT companies operating and IT workers residing in each settlement. This ranking approach addresses a key statistical challenge visible in our data: In settlements with very few IT workers or companies (typically fewer than five), small absolute numbers create high variance that obscures underlying spatial patterns. By focusing on the top 500 settlements, we capture areas where IT activity is sufficient for reliable statistical comparison, while avoiding spurious patterns driven by random variation in very small settlements.

Next, Ripley's K function is employed to analyze the spatial clustering and interaction between fast internet access and the locations of IT companies and IT workers (Baddeley & Turner, 2005). This method is well-established in spatial economics for detecting agglomeration effects and identifying the geographic extent of business clustering. As a second-order spatial statistic, Ripley's K function evaluates point pattern distributions across a range of distances, enabling us to detect spatial clustering or dispersion beyond what

would be expected under complete spatial randomness. In particular, the bivariate (or cross) K function is used to assess whether two different types of spatial features—such as internet access points and IT company locations—tend to occur near each other (indicating attraction or clustering) or farther apart (suggesting repulsion or dispersion). When the empirical $K(r)$ values lie above the theoretical expectation under spatial randomness, this indicates clustering at distance r; values below suggest spatial avoidance or dispersion. Results are presented as curves that plot $K(r)$ against distance r, accompanied by confidence envelopes derived from Monte Carlo simulations. These envelopes provide a statistical benchmark, helping to determine whether the observed spatial patterns significantly deviate from randomness. For visualization, we used Ripley's L function, which is just a transformation of Ripley's K that makes it easier to interpret. Both measure spatial clustering identically, but L centers around zero under complete spatial randomness: Values of $L(r) > 0$ indicate clustering at distance r, while $L(r) = 0$ corresponds to random distribution. This approach enables a nuanced understanding of spatial dependencies and synergies between digital infrastructure and the geography of IT businesses and IT workers.

A spatial lag model is then employed to examine potential spatial spillover effects in the residential locations of IT workers (Bivand & Piras, 2015). This model captures how neighbouring settlements influence one another, recognizing that IT workers might cluster not only due to characteristics of individual settlements but also because of broader regional dynamics around each settlement. Such spillover effects may arise from agglomeration economies, knowledge diffusion, or shared infrastructure, which together foster the formation of spatially connected housing and labor markets. We use spatial lag regression because IT worker distribution shows spatial autocorrelation—nearby settlements influence each other. Standard regression would miss these neighborhood effects and produce biased results.

To further explore how the digital infrastructure and the spatial concentration of IT workers relate to income disparities across settlements, we apply analysis of variance (ANOVA) to test for statistically significant differences in mean income levels among settlement groups characterized by varying degrees of internet access and IT employment share. Where ANOVA assumptions, such as homogeneity of variances, were not satisfied, the Kruskal-Wallis test, a non-parametric counterpart, was used to ensure robustness of results. Post-hoc comparisons are conducted using the Duncan multiple range test, which allows for pairwise group comparisons while controlling for type I error. This multi-method approach enables a more nuanced understanding of how digital transition evolves at the settlement level.

Several methodological limitations warrant acknowledgment. Rank-difference analysis reveals relative patterns but does not capture absolute magnitudes or test statistical significance. Ripley's K assumes uniform spatial distribution under the null hypothesis, which may oversimplify Estonia's transport networks and geographic barriers. Spatial lag models capture average spillover effects but assume these are constant across all locations, potentially masking regional variations between metropolitan and peripheral areas.

6. Results

To test our conceptual framework (see Figure 1), we examine three key indicators. First, we map high-speed internet infrastructure to see whether it follows existing urban hierarchies or reaches peripheral areas through public investment. Second, we analyze where IT companies locate to assess whether digital transition concentrates jobs in cities or enables spatial dispersion. Third, we examine where IT workers live

to understand how remote work flexibility affects residential choices. These three measures allow us to assess the impacts of digital transition on urban, suburban, and rural areas.

6.1. Spatial Distribution of Digital Infrastructure in Estonia

Estonia's digital infrastructure shows significant spatial disparities. In 2023, 5.4% of residents (71,280 people) lived in settlements without cable internet, despite these areas covering 46.3% of the country's territory (Maa- ja Ruumiamet, 2025). Although cable networks reach 46.8% of all buildings, only 27.2% are connected to high-speed fiber-optic networks (1 Gbps). This mismatch highlights a persistent digital divide across Estonian settlements, as shown in Figure 2, with consequences for remote work access and regional competitiveness.

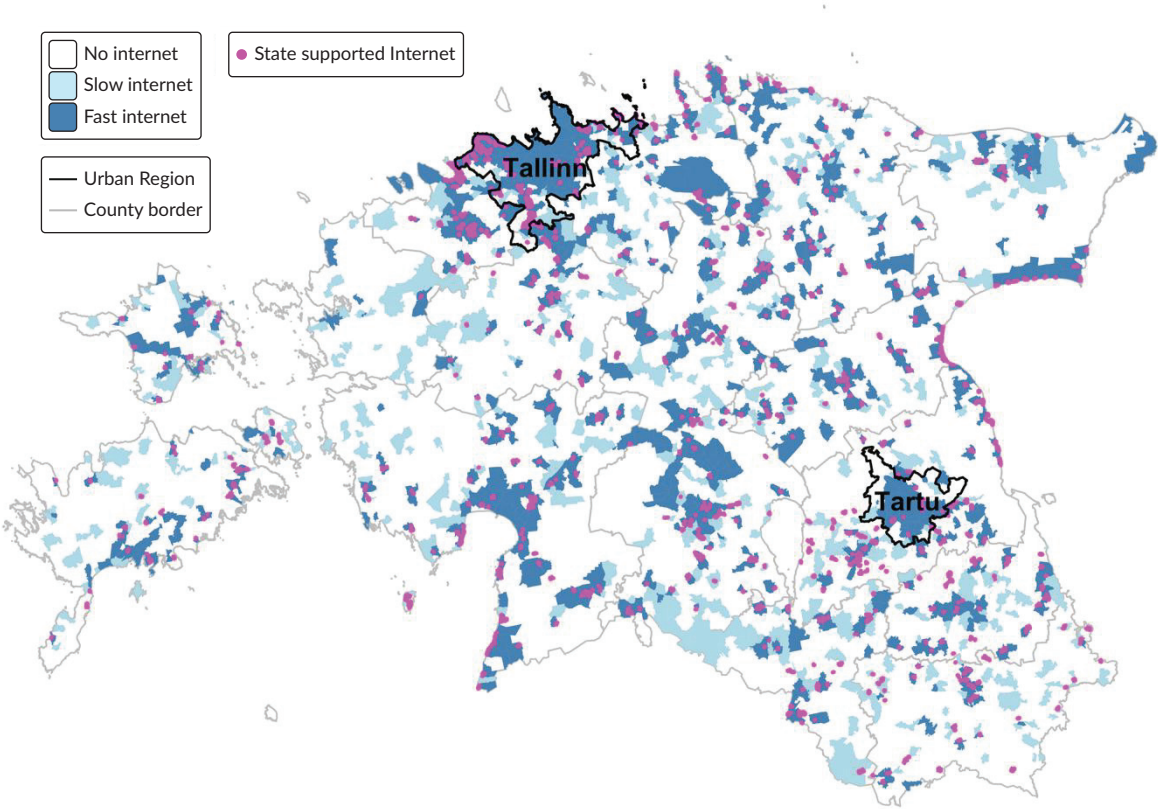

Figure 2. Availability of fiber optic and other cable Internet in settlement units (2023).

The spatial distribution of fast internet in Estonia reveals a pronounced urban–suburban–rural gradient. Urban settlements exhibit near-universal connectivity, whereas rural areas continue to face substantial service gaps. To address delays in the development of digital infrastructure in rural areas, Estonia has adopted a dual-track strategy that combines market-led investments with targeted public interventions. The ELASA has played a key role in addressing market failures by extending broadband infrastructure to peripheral and sparsely populated areas. Through its targeted efforts, the foundation has supported the development of fast internet in 691 settlement units (representing 14.7% of all settlements in the country), which are home to 16.2% of Estonia's population. This complementary approach has yielded varying results, depending on the type of actor involved. While private sector providers tend to concentrate their efforts on

densely populated and commercially viable areas—often excluding more remote rural areas—public infrastructure projects are more likely to ensure access to fast internet even in sparsely populated settlements, thereby helping to reduce spatial digital inequalities. As a result, public-sector-built fast internet networks now span a larger share of Estonia's territory—59.8% of all settlements—despite serving a smaller share of the population (Table 1). These patterns underscore the magnitude of remaining infrastructure challenges, with an estimated EUR 828 million in additional investment required to achieve universal high-speed coverage in rural areas (Majandus- ja Kommunikatsiooniministeerium, 2024).

Table 1. Internet availability in settlements.

	Fast	Slow
Private sector providers	40.2%	89.1%
State-supported infrastructure	59.8%	10.9%

6.2. Spatial Distribution of IT Companies

6.2.1. Distribution Patterns

IT companies are heavily concentrated in areas with high-speed internet. In settlements with 1 Gbps connectivity, IT companies account for 7.8% of all enterprises, compared with just 2% in areas with slow or no cable internet (Table 2). This difference is statistically significant ($\chi^2 = 529.56$, $p < 2.2e\text{-}16$), showing regional variation that public infrastructure investments only partly reduce.

Table 2. Distribution of IT and other companies by internet availability.

	Fast	Slow	No Internet
IT companies	7.8%	2.1%	1.9%
Other companies	92.2%	97.9%	98.1%

Spatial clustering of IT companies has resulted in higher concentrations in the two main cities of Tallinn and Tartu and their surrounding suburbs (Figure 3). Statistical analysis confirms IT workers are not randomly distributed across settlements (χ^2 test, $p < 2.2e\text{-}16$). Notably, IT workers are markedly overrepresented—by a factor of three to four—in areas equipped with high-speed internet (1 Gbps) compared to settlements with slow or no cable internet access. This overrepresentation reinforces the interpretation that fast digital infrastructure is not merely an enabling condition for IT business operations, but also a key factor influencing where IT companies are located. The concentration of IT companies in well-connected areas underscores the emergence of spatially selective digital ecosystems.

Ripley's *L* function analysis confirms pronounced spatial clustering of IT companies, strongly correlated with access to high-speed internet infrastructure (Figure 4). *L* values consistently exceed zero across all connectivity zones but rise most steeply in high-speed (1 Gbps) areas, indicating dense agglomerations. This pattern confirms that fast internet facilitates digital innovation hubs where companies benefit from good connectivity, proximity, shared infrastructure, and knowledge spillovers. Areas with limited connectivity show considerably weaker clustering.

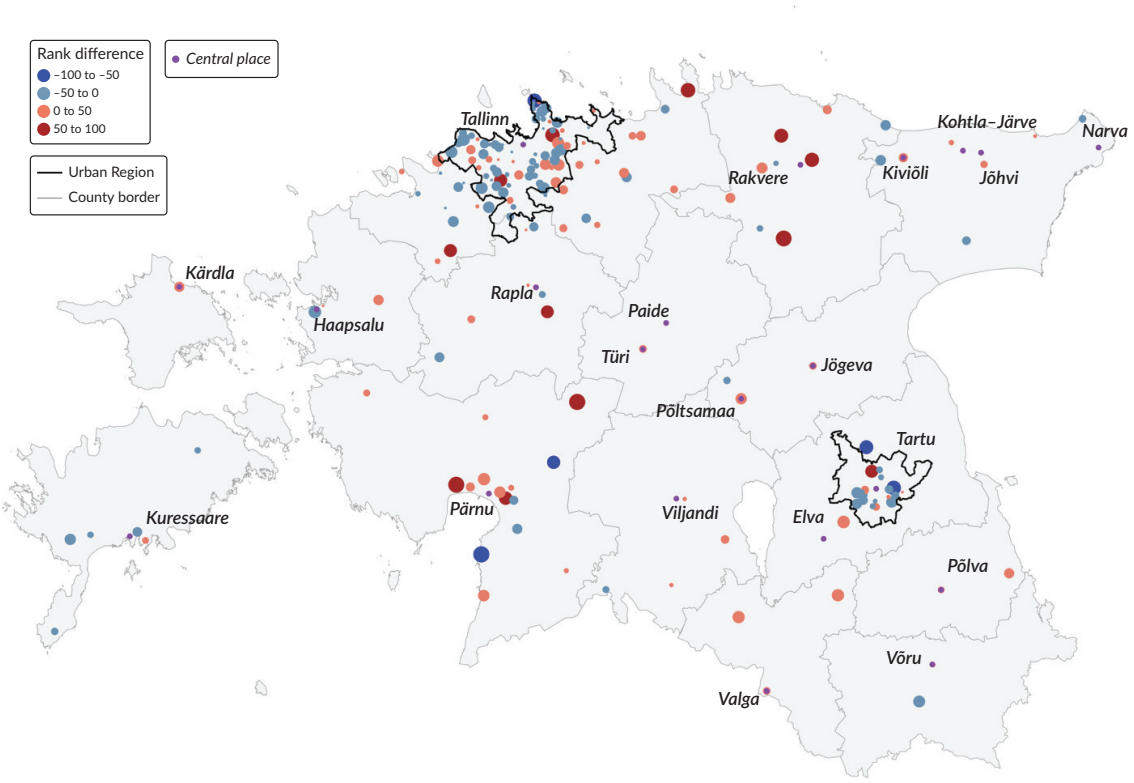

Figure 3. Placement differences between IT and other companies. Notes: Rank difference calculated as IT company rank minus other company rank for each settlement; blue dots indicate settlements where IT companies are overrepresented relative to their population/company base; red dots indicate underrepresentation.

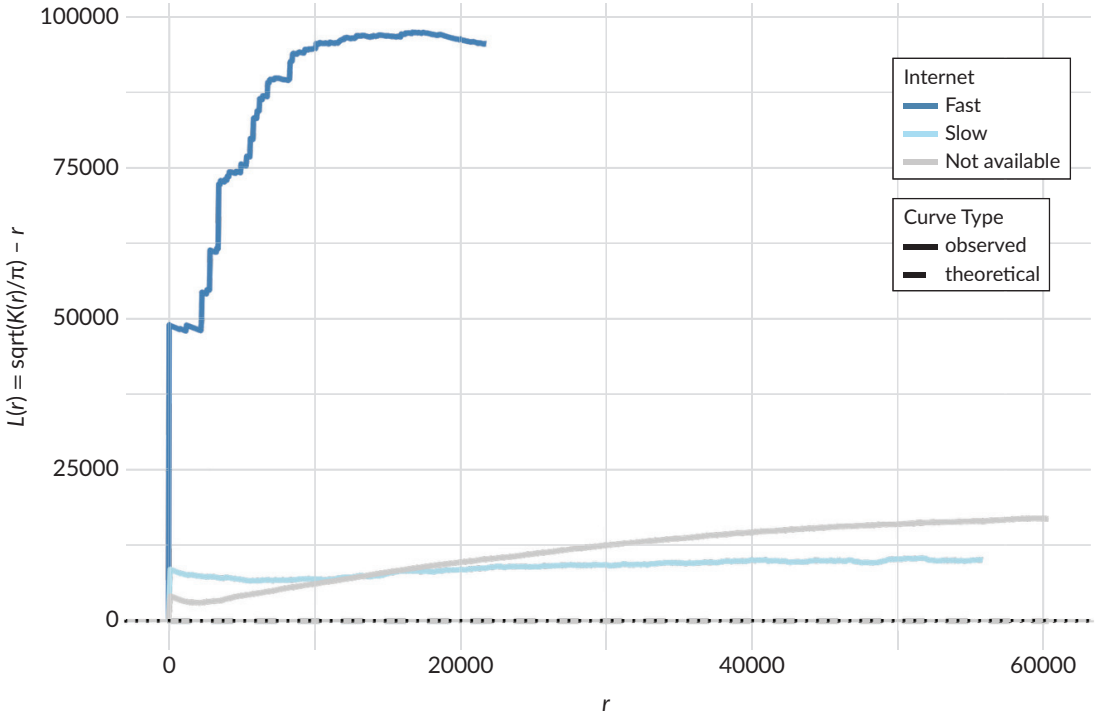

Figure 4. Ripley's *L* function of clustering of IT companies in settlements with different internet availability.

6.2.2. Temporal Dynamics

Figure 5 illustrates the spatial distribution of newly established IT and other companies across Estonia, contextualized by the availability of internet infrastructure. The analysis reveals a clear and intensifying concentration of these new IT companies in areas equipped with high-speed (1 Gbps) internet access after the outbreak of Covid-19 pandemic. Among companies established during the 2022–2023 period, 12.1% of those located in areas with 1 Gbps connectivity belonged to the IT sector, compared to just 2.8% in areas with slower internet and 2.5% in settlements without cable internet access (see Figure 5 and Table 3). This stark contrast points to a growing spatial divergence in the development of the digital transition whereby already well-connected regions are capturing an increasingly disproportionate share of new IT companies. While the overall share of IT companies in fast internet areas stands at 7.8% (Table 3), the considerably higher figure of 12.1% for new IT businesses suggests that fast digital infrastructure has become a crucial catalyst for the formation and growth of the technology sector. This temporal trend highlights the importance of fast internet availability for regional development. Notably, settlements that gain from public-sector-supported access to high-speed internet exhibit similar outcomes to those with market-provided connectivity. This suggests that although public investment helps close the technological gap by expanding infrastructure access, these investments are not enough to close the connectivity-gap for rural areas. Expanding connectivity and converting it into economic gains through business attraction may require more time and additional complementary policies.

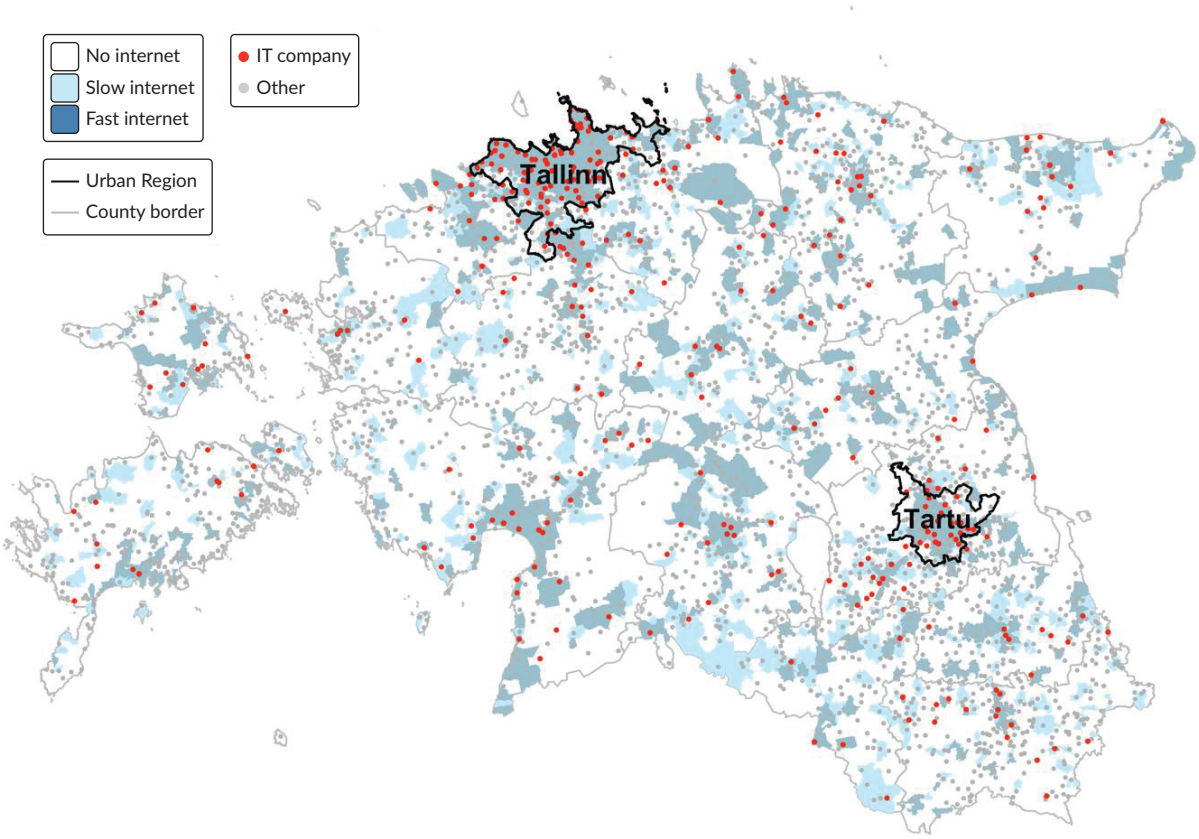

Figure 5. Distribution of established IT companies (> 2021) vs availability of the internet.

Table 3. Share of IT companies (first registered after 2021) vs internet access.

	Fast	Slow	No Internet
IT	12.1%	2.8%	2.5%
Other	87.9%	97.2%	97.5%

6.3. Residential Distribution of IT Workers

6.3.1. Spatial Distribution

Like IT companies, IT workers exhibit markedly different residential patterns compared to the general workforce. While all employed individuals are distributed across 4,466 settlement units (representing 95.0% of all Estonian settlements), IT workers reside in only 2,382 of them, or 50.1%. The capital city of Tallinn is the home of the highest share of IT workers. A more detailed rank-difference analysis of the 500 most populated settlements further highlights systematic overrepresentation of IT workers in suburban areas surrounding Estonia's major cities, particularly Tallinn and Tartu (Figure 6). Within the metropolitan areas, workers are strongly clustered in the suburbs compared to the location of IT companies. Prominent residential clusters emerge along the suburban corridors of Tallinn–Rapla and Tartu–Elva, suggesting that IT workers prefer settlements that offer a combination of proximity to urban job centers, good connectivity to

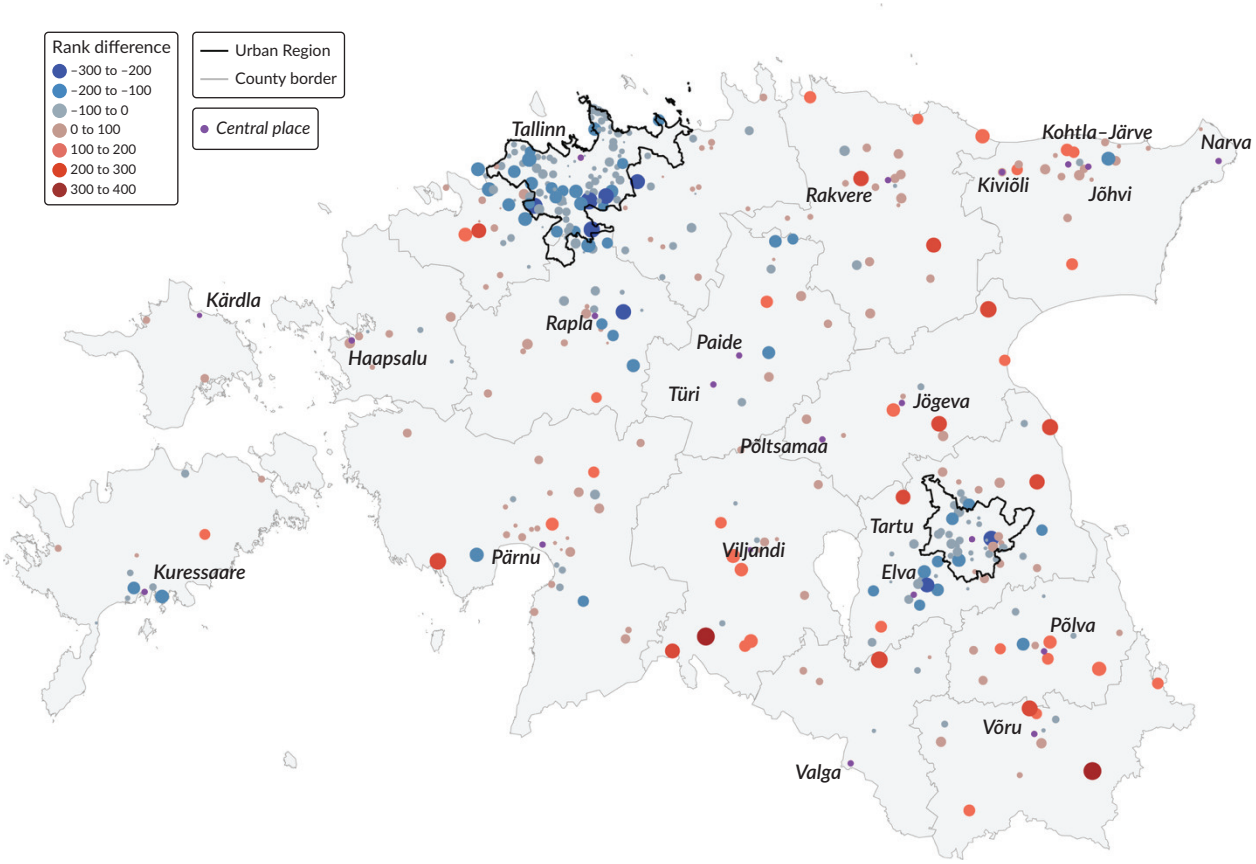

Figure 6. Home locations of IT workers for each settlement. Notes: Rank difference calculated as IT worker rank minus other worker rank; blue dots indicate settlements where IT workers are overrepresented; red dots indicate underrepresentation; dot size reflects the magnitude of rank difference.

the core city, and enhanced residential amenities in the settlement of residence. The residential clusters of IT workers thus extend beyond the immediate suburban rings of Tallinn and Tartu, reaching into more distant, ex-urban settlements. In contrast, the spatial pattern of IT companies remains more tightly concentrated in core urban areas, where institutional infrastructure, dense business ecosystems, and agglomeration economies offer strategic advantages for company location and growth.

6.3.2. Spatial Dependence

The spatial lag regression analysis reveals a statistically significant spatial autocorrelation in the residential distribution of IT workers, underscoring the presence of spatial proximity effects in their residential decision-making. The model, which includes the number of workers in other sectors, total population size, and a spatially lagged dependent variable, confirms that IT workers are not randomly distributed across the settlement system. Instead, they tend to cluster in contiguous groups of neighbouring settlements, indicating a pattern of residential proximity among IT workers. The spatial lag coefficient (ρ = 0.057, p = 0.021) confirms that the presence of IT workers in one settlement is positively associated with their presence in neighboring settlements. Although modest in magnitude, this coefficient suggests that approximately 5.7% of the variation in IT worker residential concentration can be attributed to elevated shares of IT workers in neighboring settlements.

This spatial clustering reflects broader agglomeration dynamics, where IT professionals stay close to the IT businesses located in core cities, but being drawn to neighbouring settlements often located in suburbs, probably due to factors such as attractive housing, neighborhood reputation, access to local amenities, social networks, shared infrastructure (such as fast internet and co-working spaces), and good commuting connectivity to the core city. In addition, the strong positive coefficient for other sector workers (0.513, p < 2.2e-16) indicates that IT worker concentration is closely tied to overall employment levels, while the negative coefficient for population size (−0.197, p < 2.2e-16) suggests that smaller settlements, when controlling for total employment, are relatively more attractive to IT workers—likely due to lifestyle preferences and the availability of desirable housing. Together, these findings point to spatial logic in the residential sorting of IT professionals, who tend to concentrate on attractive urban and suburban environments.

6.3.3. Income Gains from IT Companies and Workers

IT companies and workers concentrate in large cities and suburban regions with high-speed internet, dense labor markets, and urban amenities. Since IT salaries are significantly higher than in other sectors and personal income tax is the main municipal revenue, these patterns affect settlement wealth. We examine how the availability of fast internet correlates with per capita income. The Kruskal-Wallis test (χ^2 = 137.59, df = 2, p < 2.2e-16) and ANOVA (F (2.4584) = 43.7, p < 2.2e-16) confirm income levels vary systematically across connectivity categories. Mean income estimates show a clear gradient: Settlements with high-speed internet (1 Gbps) have an average per capita income of EUR 12,224 (± EUR 4,037), compared to EUR 11,088 (± EUR 2,852) in areas with slower connections and EUR 10,813 (± EUR 4,069) in settlements lacking fast cable internet altogether (Figure 7).

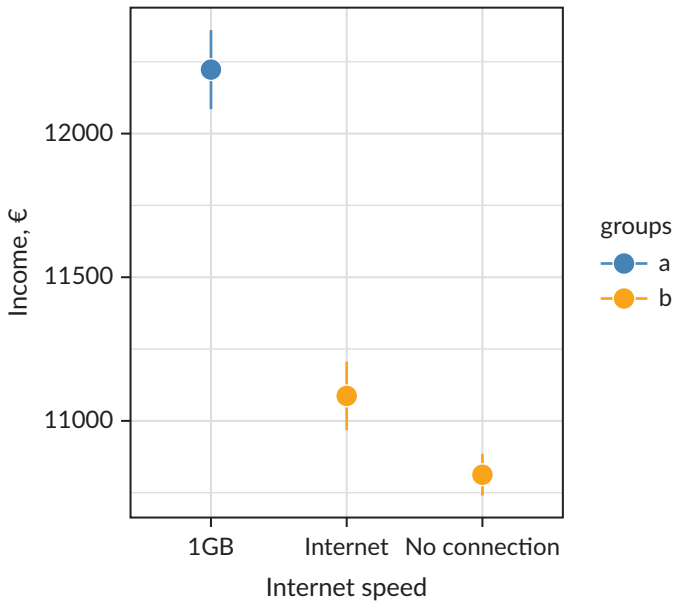

Figure 7. Annual income per capita in areas with different Internet connectivity (fast internet, slow internet, no internet).

Duncan's test ($\alpha = 0.01$) reveals two groups: Settlements with high-speed internet exhibit a 12.9% income premium over those with slow or no connectivity, reflecting economic gains associated with better business conditions, higher-skilled employment opportunities, and expanded remote-work options.

Higher incomes concentrate in and around Tallinn and Tartu urban regions (Figure 8), where high-speed internet coverage is most extensive. This overlap suggests a reinforcing dynamic: Both urban and suburban

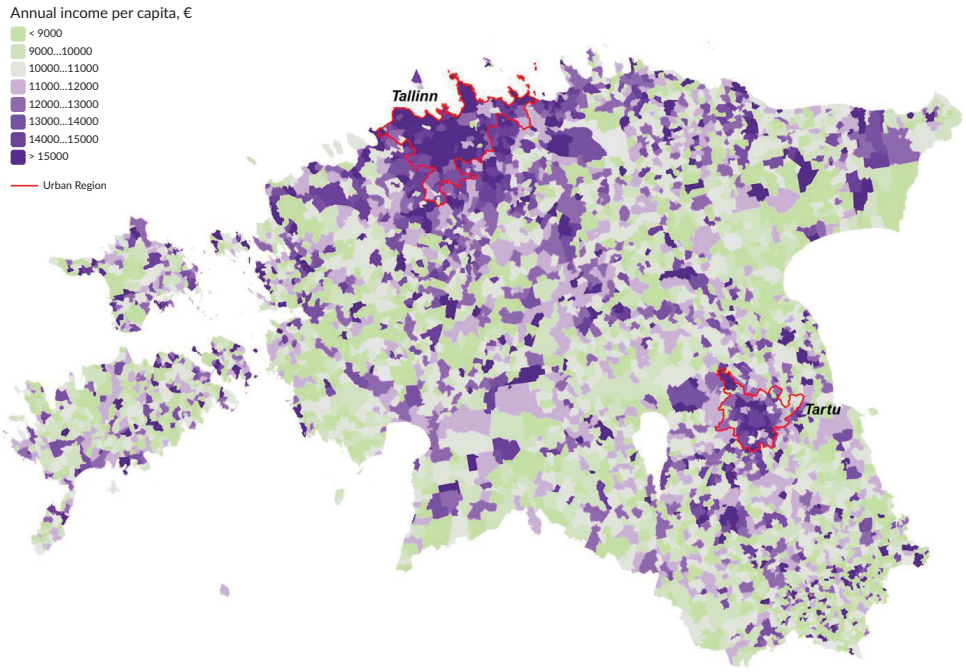

Figure 8. Annual income per capita in settlement (2022).

areas benefit from both stronger economic activity and better digital infrastructure, while peripheral areas remain disadvantaged. High-speed internet enables peripheral areas to access emerging technologies, attract IT companies and workers, and enhance economic development.

6.3.4. Combined Effects of IT Concentration and Infrastructure

To quantify the combined influence of IT worker concentration and internet speed on income, we estimated a linear regression: Income per capita ~ IT worker share + Internet speed class. Both predictors are significantly associated with income levels: IT worker share ($\beta = 56.17$, SE = 17.29, $p = 0.001$) and internet speed class ($\beta = 24.68$, SE = 8.85, $p = 0.005$). Although the model explains modest variance ($R^2 = 0.004$, F (2,4589) = 9.73, $p < 0.001$), both predictors contribute significantly to income differentiation across settlements.

Stratified analysis (Figure 9) shows the highest income levels in settlements combining high-speed internet and high IT worker concentration. Infrastructure alone is not associated with economic gains, nor do IT workers

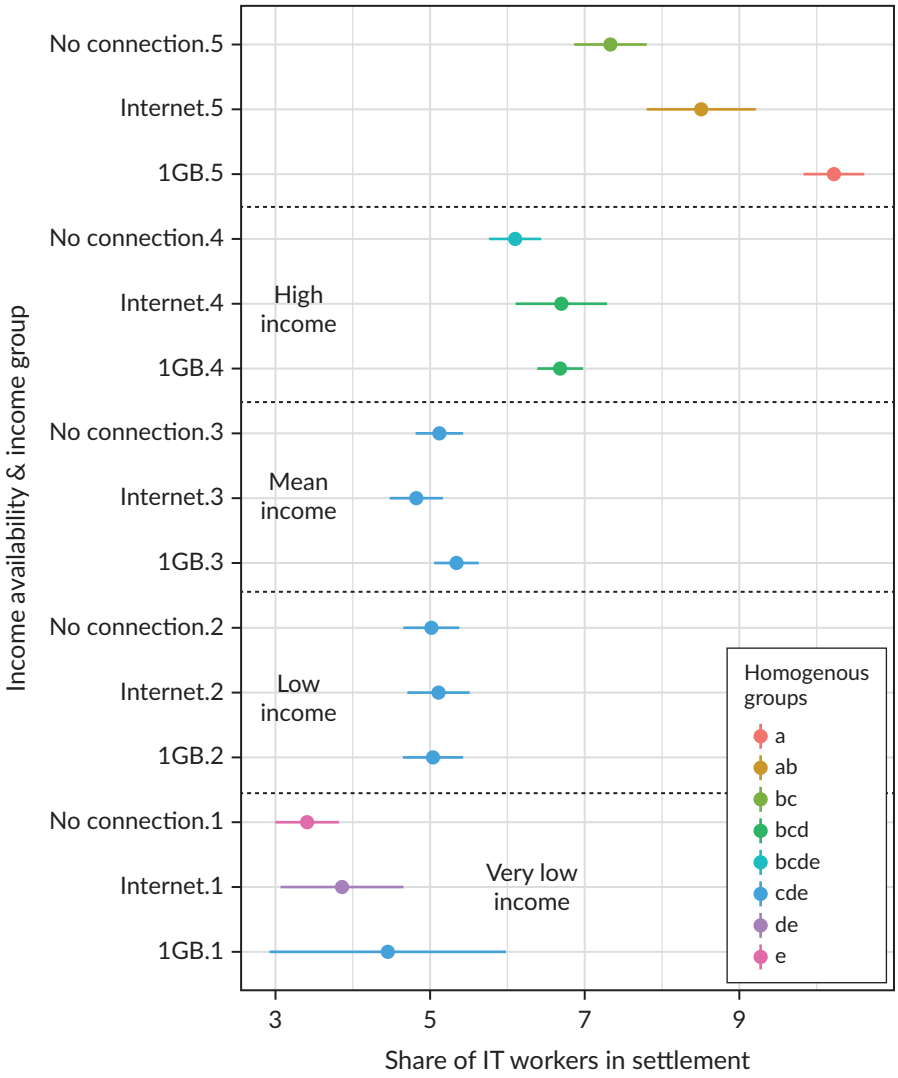

Figure 9. Share of IT workers in settlements by availability of internet and income class (scale: 1, very low income, to 5, very high income).

generate full impact without supporting infrastructure. Economic benefits are associated most strongly with the co-location of both infrastructure and companies, particularly in smaller towns and peri-urban areas.

7. Discussion of Key Findings

This study set out to examine the spatial dynamics of digital transition by analyzing how the availability of fast internet infrastructure correlates with the location of IT companies, the residential patterns of IT workers, and income disparities across settlements. While existing research often conceptualizes digital transition through a binary urban–rural lens, this study adopts a more differentiated spatial perspective—distinguishing between urban cores, suburban belts, and rural peripheries—to better understand the complex and uneven geography of digital opportunity. The empirical focus is on Estonia, a country widely recognized for its advanced digital public services and early adoption of e-governance. At the same time, Estonia offers a revealing case of minimal regional policy intervention—except for one critical area: Publicly subsidized investments in high-speed broadband infrastructure targeting underserved settlements. This contrast between a highly digitalized national environment and a largely market-led regional development provides a unique opportunity to investigate how digital infrastructure shapes spatial inequalities.

Our first research question asked whether the location of digital infrastructure follows existing regional divides. The findings reveal that digital infrastructure does not emerge in a spatial vacuum but closely tracks population distribution and pre-existing urban hierarchies. High-speed internet availability is heavily concentrated in major urban centers and their suburbs, mirroring broader patterns of centrality and reinforcing them. While Hägerstrand's (1967) theory of innovation diffusion emphasizes outward spatial spread, our results indicate that fast internet provision remains largely confined to urban cores and specific corridors, such as Tallinn–Rapla and Tartu–Elva, where residential amenity and economic opportunity align. Digital transition further reinforces the command-and-control centers of large cities in the global and national economies (cf. Sassen, 1991, challenging overly optimistic narratives of universal connectivity). However, our findings also show that public sector intervention plays a critical role in mitigating the unevenness associated with purely market-driven investments in fast internet. In Estonia, while commercial providers have concentrated on dense, high-return areas, the state—through the ELASA—has stepped in to fill market gaps in exurban and sparsely populated rural regions.

Our second research question focused on how the availability of fast internet influences the spatial distribution of companies, particularly those in the IT sector, relative to other companies. Our results show that the relationship between digital infrastructure and IT company location is particularly strong. Areas with 1 Gbps connectivity host nearly four times as many IT companies as those without, supporting Fielding's (1989) escalator region concept, showing that large cities, along with their suburbs, act as the main attractors of IT companies. In the case of Estonia, these are the two major cities, Tallinn as the capital and Tartu as the main center of higher education.

Furthermore, the concentration of IT companies in major urban regions has become even more pronounced since the acceleration of digital transition following the outbreak of the global Covid-19 pandemic. Peripheral settlements in Estonia that lack high-speed internet are increasingly underrepresented in providing IT sector jobs. Although public investments in fast internet networks have contributed to a more equitable distribution of access to the opportunities of the digital society, companies continue to favor the

dynamic labor markets of large cities in their location decisions. This is particularly concerning given the observed trend that new IT companies are increasingly concentrated in already well-connected areas. If left unaddressed, such patterns risk deepening territorial inequalities and reinforcing the perception of being "left behind," particularly in rural and remote communities—echoing Rodríguez-Pose's (2018) warning about "the revenge of the places that don't matter" where regions excluded from global economic flows risk developing social and political discontent.

Our third research question examined how fast internet availability correlates with IT worker residential distribution. Findings reveal pronounced spatial clustering of IT workers compared to other sectors. These clusters are located not only in Estonia's most globally connected cities but also in the surrounding suburban areas that offer a combination of fast internet, attractive living environments, and proximity to employment centers. Unlike IT companies, which remain tightly clustered in core urban areas, IT workers are more spatially dispersed, extending into suburban and even peri-urban locations—particularly along major transport corridors that facilitate easy access to city centers. This pattern reflects the growing relevance of remote work in shaping residential decisions of IT professionals (Zālīte et al., 2025), in line with the "donut effect" proposed by Ramani and Bloom (2021).

Spatial lag regression results indicate modest yet statistically significant spatial spillover effects: Settlements with a high share of IT workers tend to be located near others with similar concentrations. This suggests that IT professionals are influenced by both local amenities and broader regional dynamics. These findings support Malecki's (2003) argument about the importance of "place-based assets" in the digital economy—such as housing quality, lifestyle, and soft infrastructure—and are consistent with Luca et al. (2025), who argue that digital workers are increasingly drawn to high-amenity suburbs that combine digital connectivity with a high quality of life. These settlements are also characterized by higher levels of per capita income, suggesting that the residential clustering of IT workers reflects not only lifestyle preferences and digital connectivity but also underlying wealth divides, as Estonian municipalities rely heavily on personal income tax and IT sector employees typically earn the highest salaries. The residential pattern of IT workers thus underscores how the spatial concentration of digital professionals contributes to income disparities between settlements, even more so than the location of IT companies themselves.

It is important to emphasize that these conclusions apply specifically to the IT sector and its workforce. The spatial patterns observed—concentration of companies in urban cores and residential dispersal of workers into suburbs—reflect characteristics unique to IT employment, including high salaries, remote work feasibility, and dependence on digital infrastructure. Other sectors affected by digital transition may exhibit different spatial dynamics. For instance, creative industries, financial services, education, or healthcare sectors utilizing digital technologies could show alternative patterns of concentration or dispersal. Some digitally-enabled sectors may offer greater benefits to rural areas than IT does, particularly those less dependent on urban agglomeration economies or face-to-face collaboration. Understanding these sector-specific variations remains an important avenue for future research on the spatially differentiated impacts of digital transition.

This study shows that the benefits of digital transition are spatially uneven, with urban and suburban areas emerging as primary winners. High-speed internet infrastructure, IT company formation, IT worker residence, and income levels are all disproportionately concentrated in urban cores and their surrounding

suburban belts. The findings thus call for moving beyond the urban–rural dichotomy to better understand the spatial impacts of digital transition. Estonia's most globally connected cities, Tallinn and Tartu, attract the majority of IT companies due to their dense labor markets, institutional ecosystems, and agglomeration advantages. Yet it is suburban and exurban areas along major transport corridors that increasingly attract IT workers, offering digital connectivity, residential amenities, and access to urban job centers. These areas benefit not only from infrastructure but also from their capacity to host remote workers seeking quality of life, underscoring the growing role of place-based assets in the digital economy. Rural areas remain clearly disadvantaged: They host fewer IT jobs, attract fewer digital professionals, and lag in income. While Estonia's public broadband investments have helped narrow this divide, market-led distribution of fast internet deepens regional divides. In sum, the digital transition favors those regions that combine infrastructure, dynamic labor markets, human capital, and residential appeal—placing core urban areas as winners for IT company locations and suburban zones at the forefront of digital gains.

To conclude, these findings carry important implications for European regional policy debates. First, infrastructure investment alone is insufficient. While public broadband funding prevents digital exclusion, connectivity does not automatically translate into economic benefits. Policies must go beyond "laying fiber" to support conditions enabling peripheral regions to capture value from digital transition—including business support, digital skills training, and strategies to attract knowledge workers.

Second, rural areas face fundamental challenges. Without dense labor markets or agglomeration economies, rural regions struggle to attract IT companies even with fast internet. However, they may benefit by attracting remote workers rather than businesses. Policies enhancing rural quality of life—housing, services, amenities—combined with digital infrastructure may enable rural participation in the digital economy as residential rather than production spaces.

Finally, market-led infrastructure provision systematically disadvantages peripheral areas. Estonia's targeted public intervention demonstrates potential to mitigate spatial inequalities, though the timeframe since major investments remains too short for definitive conclusions about long-term impacts. For European cohesion policy, this underscores the need for sustained place-based infrastructure investments alongside broader digital strategies and long-term monitoring. Addressing digital divides requires continued public commitment as a fundamental question of spatial justice and regional development.

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Conflict of Interests

The authors declare no conflict of interests. In this article, editorial decisions were undertaken by Ulf R. Hedetoft (University of Copenhagen).

Data Availability

To use the data used in the study, please contact the authors.

Supplementary Material

Supplementary material for this article is available online in the format provided by the author (unedited).

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Location and Residential Concentration of the "Creative Class" in Riga, Latvia

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Abstract

Economic and urban geographers have paid considerable attention to creative and cultural industries, both for their propensity to cluster in urban neighbourhoods and their potential to drive economic development. The thesis of the "creative class" has been a central topic of academic debate and urban planning since the dawn of the 21st century. It is widely believed that a city's economic prosperity is directly related to its ability to attract and retain "creative people." Within this context, our study aims to examine the residential patterns of the "creative class" in Riga, Latvia, using geo-referenced individual-level census data from 2021 and a multi-scalar k-nearest neighbour approach. We identify a pronounced spatial concentration of creative class workers in the historic inner city and adjacent pre-war neighbourhoods, with substantial variation across subgroups: Cultural workers show the strongest inner-city clustering, knowledge and creative industry workers display moderately dispersed but still core-oriented patterns, and leisure industry workers are the most spatially integrated across the city. Creative class workers are markedly underrepresented in Soviet-era housing estates, reflecting established socio-spatial divides, rather than active displacement processes. These findings demonstrate that "creative class" residential patterns in Riga align with fragmented forms of urban transformation characteristic of post-socialist cities, while revealing significant internal heterogeneity that challenges the notion of a unified "creative class."

Keywords

creative class; knowledge workers; residential patterns; Riga

1. Introduction

Since Richard Florida's seminal work on the "creative class" at the turn of the millennium, urban scholars and policymakers have extensively debated the role of creative workers in shaping contemporary urban

development. Florida's thesis posited that cities capable of attracting and retaining creative professionals—defined broadly as individuals engaged in "creating meaningful new forms"—would experience enhanced economic vitality and urban prosperity (Florida, 2002). This framework has profoundly influenced urban policies worldwide, with cities competing to cultivate "creative" environments through investments in cultural infrastructure, amenities, and quality of life enhancements (Cerisola & Panzera, 2022; Grodach, 2017; Peck, 2005; Scott, 2006).

However, the creative class thesis also generated substantial criticism. Scholars have questioned its theoretical foundation, empirical validity, and social implications (Krätke, 2010; Storper & Scott, 2008). Critics argue that the focus on attracting creative workers neglects the underlying economic structures, exacerbates socio-spatial inequalities, and fuels gentrification processes that may diminish the diversity and authenticity that initially attracted them (Atkinson, 2000; Faludi, 2019; Ley, 2003). The relationship between creative class clustering and gentrification has emerged as a particularly contentious issue, with research demonstrating that creative professionals often serve as "pioneers" of neighbourhood change, preceding and facilitating subsequent waves of capital investment and displacement (Kitsos et al., 2025; Ley, 2003; Lloyd, 2010; Zukin, 1982).

Empirical studies of creative class residential patterns have revealed complex spatial dynamics that vary across national and urban contexts. In Western European and North American cities, creative workers tend to concentrate in inner-city neighbourhoods characterised by historic architecture, cultural amenities, ethnic diversity, and vibrant street life (Markusen, 2006; Musterd & Gritsai, 2013). These "soft" locational factors—authenticity, cultural capital, and social milieu—appear to outweigh traditional "hard" factors such as proximity to employment centres, although accessibility and housing affordability remain significant considerations (Bontje et al., 2011; Comunian et al., 2010). Research across European cities has demonstrated that creative class settlement patterns follow predictable trajectories, beginning with concentration in transitional inner-city areas and subsequently diffusing outwards as gentrification advances and life-course factors influence residential choices (Lawton et al., 2013; Musterd & Gritsai, 2013).

In post-socialist contexts, creative class dynamics intersect with distinctive urban legacies and transformation processes. Cities in Central and Eastern Europe have experienced rapid socio-economic restructuring since 1990, characterised by privatisation, marketisation, and profound changes in urban structure and social geography (Sýkora & Bouzarovski, 2012; Tammaru et al., 2015). The spatial outcomes of these transformations differ markedly from Western patterns, with post-socialist cities exhibiting complex mosaics of renewal and decline, persistent residential segregation along ethnic and socio-economic lines, and distinctive forms of gentrification that often remain fragmented (Gentile et al., 2012; Kovács et al., 2013). Research on creative class settlement in post-socialist cities remains limited, showing that while some patterns partially mirror those observed in Western cities, their settlement also exhibits distinctive local characteristics (Górczyńska, 2017; Kozina et al., 2021).

Riga, the capital of Latvia, presents a compelling case for examining creative class residential dynamics in a post-socialist context. As the second largest city in the Baltic states and a significant regional economic centre, Riga has undergone substantial transformation since Latvia's independence in 1991 and particularly following its accession to the European Union in 2004. The city's historic core, recognised as a UNESCO World Heritage Site for its exceptional concentration of Art Nouveau architecture, has experienced selective

renovation, in-fill, and commercial development (Treija et al., 2020), while Soviet-era housing estates on the periphery house the majority of the population. Riga is characterised by significant ethnic diversity, with approximately half of the population identified as Russian-speaking minorities, creating complex patterns of socio-spatial segregation (Krišjāne & Bērziņš, 2014). Recent scholarship has documented emerging gentrification processes in select inner-city neighbourhoods, although these remain more limited and fragmented compared to Western European cities (Krišjāne et al., 2015).

Despite Riga's regional significance and distinctive post-socialist trajectory, the residential geography of the creative class remains underexplored. This study addresses this gap by examining the spatial distribution and concentration of creative class workers across Riga using high-resolution, individual-level data from the 2021 Population and Housing Census. Specifically, we investigate: (a) How are creative class workers spatially distributed across Riga at multiple scales? (b) Do creative class subgroups (creative, knowledge, culture, and leisure industries) exhibit distinct residential patterns? (c) How do these patterns relate to the urban structure, neighbourhood characteristics, and ongoing processes of urban change?

The spatial scale of analysis has proven critical for understanding the residential patterns of different social groups, including the creative class (Lawton et al., 2013; Lichter et al., 2020). By employing a multi-scalar k-nearest neighbour approach and location quotient analysis on a uniform 1-hectare grid, this study provides methodologically rigorous insights into creative class residential geographies while avoiding the analytical limitations associated with administrative boundaries. Our findings contribute to broader debates on creative class theory, gentrification, and socio-spatial polarisation in post-socialist urban contexts, with implications for understanding how urban residential patterns shape creative economies.

2. Data and Methods

This study utilised anonymised, individual-level data from the 2021 Population and Housing Census, collected by the Central Statistical Bureau of Latvia. The dataset covered all employed residents of Riga, geo-referenced to their place of residence. The "creative class" was defined by economic sector based on the Statistical Classification of Economic Activities (NACE, Revision 2) 2-digit codes, including workers within (a) creative industries, i.e., motion picture and video, radio and TV, software and consultancy, architecture; (b) knowledge industries, i.e., financial intermediation, law and accounting, business and management consultancy, R&D and higher education, market research and public opinion polling; (c) culture industries, i.e., art and entertainment, library and archives, museums; and (d) leisure industries, i.e., catering and bars, sport and recreation. This comprehensive definition captured 54,273 individuals, or 17% of Riga's workforce, while acknowledging that some hybrid or emerging occupations may not be fully represented by these classifications, a known limitation of occupational coding systems (Connelly et al., 2016).

While leisure industry workers exhibit distinct socio-demographic profiles from other creative class subgroups, their inclusion reflects how urban policy and "creative city" strategies commonly frame the broader creative economy as encompassing both producers of symbolic goods and facilitators of creative urban lifestyles (Bille, 2010; Florida, 2002; Roberts, 2006). Leisure industries play a crucial role in producing the urban "scene" and amenity infrastructure that attracts and sustains creative workers. From this perspective, treating leisure industries as part of the wider creative economy allows us to empirically examine how workers who contribute to these scenes are positioned within the urban social and spatial structure.

Simultaneously, we explicitly acknowledge the conceptual tension between this broad, policy-driven understanding of the creative economy and class-analytic approaches to the "creative class" that emphasise high levels of human capital, autonomy, and professional status. Therefore, we do not claim that leisure industry workers occupy the same class position as knowledge, culture, or creative professionals. Instead, we retain them as a clearly differentiated subgroup to critically interrogate the internal segmentation that is often obscured when urban policy discourses aggregate diverse labour segments under a single "creative city" label.

To precisely analyse intra-urban spatial patterns, a uniform grid of 1-hectare cells covering the city of Riga was used (Figure 1). This fine resolution grid was selected to balance sufficient spatial detail with computational efficiency while addressing the modifiable areal unit problem by avoiding reliance on administrative boundaries. The 1-hectare resolution effectively captures neighbourhood-level variation while maintaining analytical tractability, aligning with similar high-resolution spatial analyses in urban geography. A coarser grid would obscure the small-scale clustering characteristics of the fragmented post-socialist urban environment. The systematic grid enabled consistent comparison and aggregation across spatial scales, thus providing a robust framework for capturing urban diversity in creative-class residential patterns.

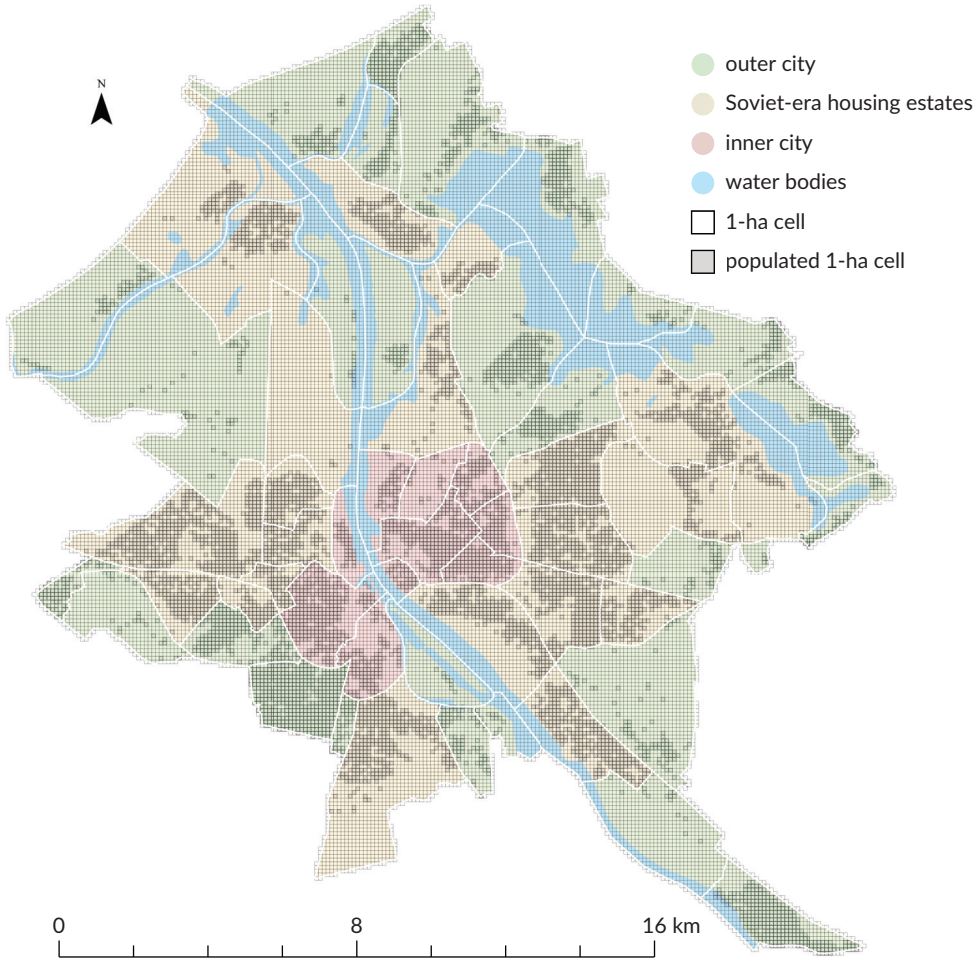

Figure 1. Gridded study area and administrative neighbourhoods by urban structure in Riga.

Scale sensitivity has important implications for both theory and policy, highlighting the need for analytical frameworks that capture spatial heterogeneity, while avoiding the modifiable areal unit problem inherent in analyses based on administrative boundaries (Openshaw, 1996). For spatial analysis, we employed the k-nearest neighbour approach, which computes individualised neighbourhoods comprising the k-nearest neighbours (or nearest residents) for each grid cell. The selected k values were 200, 800, and 6,400, allowing a multi-scalar analysis, where a smaller k value corresponded to the immediate local surroundings, and a larger k value captured a broader urban context.

Then, to quantitatively assess residential location and concentration patterns of the "creative class," the location quotient (Apparicio et al., 2014) was calculated for each individualised neighbourhood. Recognising heterogeneity within the "creative class," subgroup analyses were performed to differentiate between the creative, knowledge, culture, and leisure industries. Each subgroup was profiled across sociodemographic variables, including average age, gender ratio, ethnicity, education, marital status, occupational status, and residential mobility (Table 1). Creative, knowledge, and cultural industries generally attracted more highly educated individuals occupying higher-status roles, but while knowledge, culture, and leisure industries had a larger proportion of women, creative industries were male-dominated. Cultural industries were characterised by an older and more ethnically homogenous workforce whose residential mobility was low, while leisure industries stood out for their high ethnic diversity and relatively youthful staff, often with lower levels of formal education and occupational status, suggesting differential residential preferences.

Table 1. Sociodemographic indicators of creative class subgroups in Riga in 2021.

	Creative industries	Knowledge industries	Culture industries	Leisure industries	Creative class	All employees
Mean age	38.3	42.1	48.2	38.0	40.7	45.0
Share of women, %	39.1	63.9	64.3	62.0	56.9	54.2
Share of married persons, %	47.9	49.0	42.2	35.4	43.6	49.2
Share of ethnic minorities, %	45.3	36.2	17.9	53.6	40.8	49.3
Share of university educated, %	69.8	74.6	62.2	20.1	61.1	44.8
Share of high-status occupational groups, %	71.7	57.0	65.6	13.4	52.6	34.0
Share of mobile residents, %	14.3	12.4	8.7	12.4	12.7	10.1
Total, thousands	14.4	24.5	4.2	11.2	54.3	316.2

Source: Authors' calculations based on data from Central Statistical Bureau of Latvia (2025).

Individualised neighbourhoods were computed using Equipop Flow (Östh, 2024), location quotients were computed using Geo-Segregation Analyzer v.1.2 (Apparicio et al., 2014), and mapping was carried out using ArcGIS Pro.

3. Results

3.1. Creative Class Multi-Scalar Analysis

This subsection examines the overall spatial distribution of creative class workers across Riga using the k-nearest neighbour approach at various scales. Spatial analysis revealed a pronounced scale-dependent concentration of Riga's creative class (Figure 2). At all analytical scales, creative-class workers demonstrated preferential settlement in the historic inner city and adjacent neighbourhoods, coinciding with areas characterised by diverse amenities, architectural heritage, and fragmented gentrification. These findings corroborate broader research demonstrating that creative workers privilege neighbourhoods with strong "soft" locational factors while also weighing traditional "hard" factors (Bereitschaft, 2017).

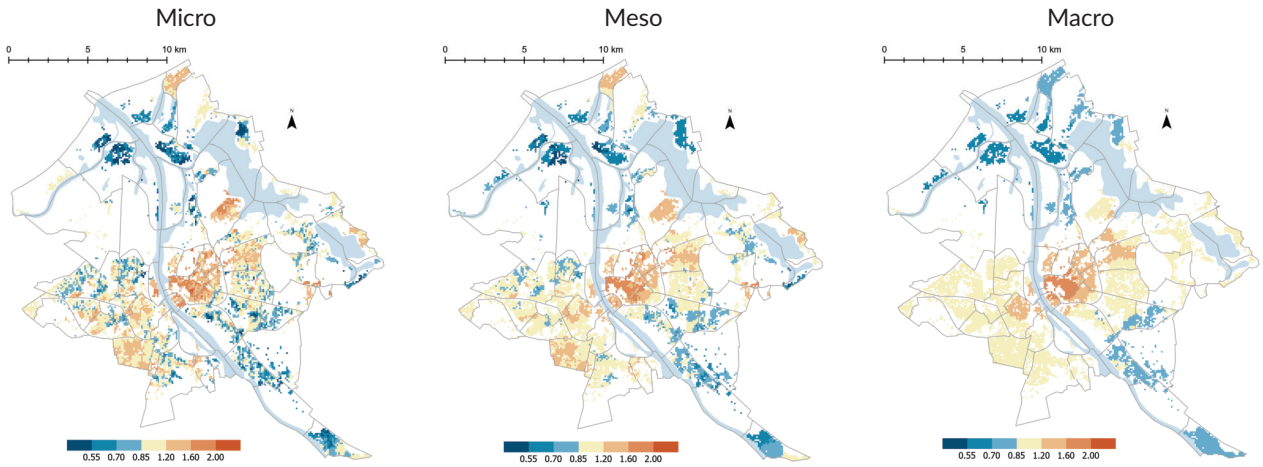

Figure 2. Distribution of location quotients of the creative class in Riga among 200, 800, and 6,400 nearest neighbours in 2021. Source: Authors' calculations, based on Central Statistical Bureau of Latvia (2025).

At the micro scale, the creative class concentration exhibited sharp spatial differentiation, with particularly high concentrations in the inner city and selected outer city locations. The most pronounced clustering occurred within the Art Nouveau district and adjacent pre-war neighbourhoods characterised by mixed-use development, historic building stock, and proximity to cultural institutions. At the meso scale, core centralisation remained robust, whereas the concentration peaks became somewhat attenuated. Notably, the micro- and meso-scale analyses also identified select pockets of elevated creative class concentration in peripheral locations, including certain outer-city and Soviet-era housing estate zones, characterised by low-rise residential areas with distinctive architectural characteristics. However, these peripheral concentrations remained isolated and substantially smaller in extent compared to the dominant inner-city clustering.

At the macro scale, the spatial distinctiveness of the creative class settlement has diminished considerably. Location quotient values converged toward unity across the western and eastern parts of the city, with only the historic core and a few adjacent neighbourhoods maintaining overrepresentation. This pattern suggests that, while creative professionals demonstrate strong preferences for specific neighbourhood types and amenity configurations, they are not categorically absent from peripheral or suburban areas when considered at aggregate spatial scales. This pattern aligns with findings from comparative European studies, where creative class settlements spread outwards from an initial city-core anchor, following the

advancement of gentrification, while balancing lifestyle preferences, family formation needs, and housing cost considerations, particularly among older cohorts (Janssen et al., 2023; Lawton et al., 2013).

3.2. Creative Class Subgroup Multi-Scalar Analysis

Turning to the internal composition of the creative class, the residential patterns of its subgroups reveal a clear differentiation. The culture, creative, knowledge, and leisure subgroups each exhibited distinct and scale-sensitive spatial distributions linked to their demographic and occupational characteristics (Figure 3). This scale-sensitive pattern reinforces key insights from creative class theory—namely, that amenity-oriented preferences and socio-demographics shape both the micro-localisation and broader residential distribution of creative professionals and that urban structure exerts a powerful filtering effect on where each subgroup ultimately resides.

Workers in *creative industries* showed moderate spatial clustering, with micro- and meso-scale peaks in Riga's inner city and areas in select outer-city and Soviet-era housing estate neighbourhoods. This subgroup, characterised by younger age, high rates of university education, a high share of high-status occupations, predominantly male and ethnically diverse, demonstrated a clear preference for central locations with cultural amenities and modern work environments. At the macro scale, creative industry workers exhibited more evenness in most of the southwestern part of the city, while remaining overrepresented in the inner city and selected neighbourhoods around the inner city's periphery. This pattern suggests that, while central locations remain attractive, creative industry professionals demonstrate flexibility in residential location choice, potentially reflecting higher incomes and varied workplace locations across the city.

Knowledge industry workers, representing the largest creative class subgroup, showed patterns similar to those of creative industry workers. However, there was a higher overrepresentation than that of creative industry workers at all scales in the inner city and several more affluent outer-city areas. This pattern reflects the distinctive socio-demographic profile of knowledge industry professionals: older average age, the highest university education rate, greater residential stability, higher likelihood of family formation, and capacity to afford housing in established middle-class neighbourhoods throughout the city, suggesting that this subgroup's residential choices balance professional identity and amenity preferences with family needs and housing quality considerations.

Culture industry workers exhibited the most pronounced spatial clustering in all subgroups. At the micro and meso scales, culture workers showed the highest overrepresentation across the inner city and selected outer-city areas. The inner-city neighbourhoods, primarily located in the Art Nouveau district and adjacent pre-war areas, have served as traditional centres of cultural production and consumption in Riga, offering both professional opportunities and lifestyle amenities valued by culture workers. The distinctive socio-demographic profile of cultural industry workers—highest average age, most ethnically homogeneous, and lowest residential mobility—suggests a settled population with long-term residential commitment to central neighbourhoods. Despite lower formal educational attainment compared to creative and knowledge workers, cultural industry professionals occupied substantial high-status positions, likely reflecting experiential expertise and cultural capital. Even at the macro scale, cultural industry workers showed persistent overrepresentation in the historic core, demonstrating stronger spatial attachment to central neighbourhoods than other creative class subgroups.

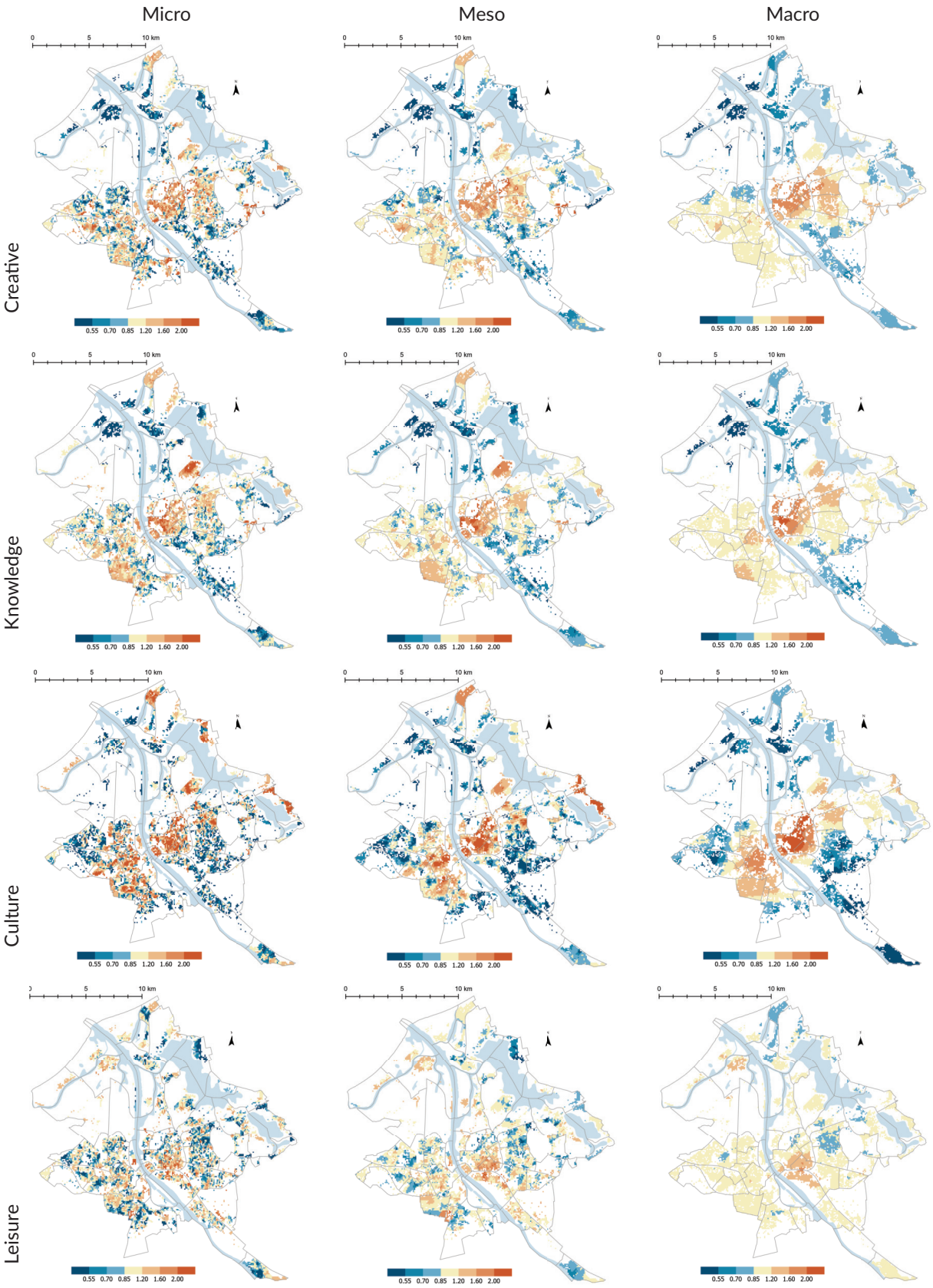

Figure 3. Distribution of location quotients of creative class subgroups in Riga among 200, 800, and 6,400 nearest neighbours in 2021. Source: Authors' calculations, based on Central Statistical Bureau of Latvia (2025).

Leisure industry workers demonstrated the most spatially integrated distribution of all creative class subgroups, reflecting both the dispersed geography of leisure employment—restaurants, cafes, bars, and recreational facilities—distributed across residential neighbourhoods rather than concentrated in specific districts, and the distinctive socio-demographic profile of leisure workers. These workers were characterised by the youngest average age, the highest ethnic diversity, the lowest educational attainment, and the lowest occupational status. These characteristics suggest that many leisure workers occupy service positions with lower socioeconomic status, potentially facing greater housing affordability constraints and residing in more diverse neighbourhood types. At the micro and meso scales, leisure workers showed only modest concentrations in the south-central areas. At the macro scale, leisure workers exhibited a nearly even spatial distribution, with very few areas of over- or under-representation. This pattern distinguishes leisure workers from other creative class subgroups and raises questions about their inclusion in creative class conceptualisations based purely on industry classification. The spatial integration of leisure workers suggests that residential patterns are driven more by housing affordability, accessibility to dispersed employment locations, and general urban amenities than by specific neighbourhood cultural characteristics or creative milieu.

The analysis reinforced theoretical insights into the multidimensional nature of residential location decisions shaped by scale-specific factors. Amenity-driven preferences dominate micro-scale localisations within favoured neighbourhood types, whereas housing affordability, family and life course dynamics, and workplace proximity increasingly shape meso- and macro-scale distributions. Urban structure, through the spatial configuration of housing, employment, and amenities, acts as a filtering mechanism aligning socio-demographic profiles with corresponding residential environments. The observed patterns suggest that creative class theory's emphasis on urban-centric settlement holds at aggregate scales, but specific neighbourhood preferences operate primarily at local resolutions.

These findings highlight the necessity of multi-scalar analytical frameworks for understanding creative class geography. Analyses restricted to coarse spatial units risk underestimating localised clustering, while micro-scale studies may exaggerate spatial distinctiveness by neglecting broader integrations. The k-nearest neighbour method applied here captures both fine-grained concentration and broader distributional patterns, demonstrating that conclusions about creative class settlement are contingent on the spatial resolution of the analysis.

3.3. Spatial Exclusion and Socio-Economic Polarisation

This subsection explores residential concentration patterns across different urban neighbourhood types, examining which areas attract or repel the creative class settlement. Except for leisure, extensive areas of underrepresentation characterised Soviet-era housing estate neighbourhoods across all creative class subgroups. Several contextual factors contribute to the absence of the creative class from peripheral housing estates. First, the standardised building typologies, high-density residential configuration, and functional separation from commercial and cultural activities of large housing estates distinguish them from the mixed-use, finer-grained urban fabric, and pre-war building stock found in the inner-city areas. Second, Soviet-era estates generally have a lower provision of cultural amenities, entertainment venues, and street-level commercial activities and are located further from major employment and cultural centres than inner-city neighbourhoods. Third, these neighbourhoods house predominantly working-class populations,

ethnic minorities, and elderly residents (Krišjāne & Bērziņš, 2014), which contributes to distinct social and demographic profiles when compared with central districts. In Riga's context, creative class clustering intersects with persistent ethnic segregation, with Russian-speaking minorities concentrated in peripheral Soviet-era housing estates, potentially reinforcing multiple dimensions of social division simultaneously. Our analysis documents an association between creative class clustering and these objectively observable features of the urban environment; it does not directly measure local perceptions of "authenticity" or neighbourhood desirability, which have been emphasised in studies of creative workers in Western cities (e.g., Florida, 2002; Graif, 2018), and may not fully translate to the post-socialist context.

The systematic exclusion of creative class residents from peripheral areas simultaneously concentrates this relatively affluent and highly educated population in inner-city neighbourhoods, a pattern consistent with higher housing market pressures, amenity-based stratification, and socio-spatial differentiation. The association between the settlement of the creative class in the urban core of Riga and the fragmented gentrification processes identified in earlier studies may be understood as part of broader concentration patterns that, according to the literature, risk undermining the diversity and authenticity that initially attracted creative professionals (Elliott-Cooper et al., 2020; Zukin et al., 2009). However, our cross-sectional evidence cannot indicate the causality between creative class settlement and fragmented gentrification. Instead, it is more consistent with the picture of limited and fragmented upgrading on top of relatively stable socio-spatial divisions, as described by Krišjāne et al. (2015). Simultaneously, our findings resonate with wider debates on how such concentration patterns may, over time, contribute to differentiated neighbourhood trajectories if they coincide with targeted investment and policy support, raising questions about the long-term social sustainability of creative class-oriented development strategies in a post-socialist context.

3.4. Digital Transition and Creative Class Residential Patterns

Our findings have important implications for understanding how digital transition and remote work possibilities relate to the residential patterns of the creative class. Labour force data for Latvia in 2021 indicate that remote work was widespread but uneven and changed throughout the year. The number of remote workers declined from 167,600, or 22.6% of the total workforce, in the first quarter of 2021 to 99,400 (13.1%) in the third quarter, before partially recovering to 143,700 (18.8%) in the fourth quarter (Central Statistical Bureau of Latvia, 2025), mirroring the tightening and easing of Covid-19 pandemic-related restrictions.

Sectoral differences in telework prevalence closely align with the internal structure of the creative class. Throughout 2021, information and communication services—overlapping substantially with our creative industries subgroup—recorded very high levels of remote work, with between 58.3% and 78.9% of employees working remotely across all four quarters. Financial and insurance activities, which form a core part of our knowledge industries, showed similarly high telework shares, ranging from 56.9% to 81.6%, indicating that remote work was a normal mode of operation rather than a temporary emergency arrangement in these knowledge-intensive services. Scientific, administrative, and real estate-related services, also largely associated with knowledge industries, exhibited moderate but persistent telework levels of 26.7–31.5%. By contrast, trade, transport, accommodation, and food services—which include many leisure industry jobs such as catering and hospitality—consistently recorded low telework levels, varying only between 7.5% and 12.5%, in line with the strong requirement for physical presence in customer-facing service work.

These statistics are reported for broad NACE sections rather than directly for our creative class definition; therefore, we use them as contextual rather than explanatory evidence. Nevertheless, they suggest that the potential for remote work is highly stratified within the broader creative economy. Workers in sectors corresponding to our creative and knowledge industries had substantially greater scope to decouple daily work tasks from fixed office locations than workers in leisure-related activities, who remained tied to onsite, contact-intensive employment. This stratification is consistent with our subgroup findings: Knowledge and core creative industry professionals, who are most likely to be employed in high-telework sectors, are also the groups most strongly concentrated in central neighbourhoods, whereas leisure industry workers, whose jobs allow little remote work, display the most spatially integrated and least concentrated residential patterns.

The persistent concentration of workers in the creative and knowledge industries within central urban areas, despite the high potential for remote work, indicates that digitalisation has not reduced the appeal of inner-city neighbourhoods. Instead, it appears to represent the relationship between the work, residence, and daily activity spaces. For many creative and knowledge workers, remote work seems to decouple employment from specific office buildings more than from the broader central urban environment: Living in inner-city neighbourhoods still provides close access to amenities, co-working spaces, cafés, and cultural institutions. These environments support hybrid online/offline working practices, facilitate informal interaction and professional networking, and can be accessed on foot or via short trips, features that are more difficult to replicate in peripheral estates.

Subgroup differences further illustrate how digitalisation interacts with urban structures. Knowledge industry workers, who are most likely to have formal remote work arrangements, remain concentrated in central and established middle-class neighbourhoods, where they can combine flexible work with access to diverse services and networks. Cultural industry workers continue to cluster around central institutions—such as theatres, museums, and galleries—that structure both their workplaces and everyday routines, which helps explain their particularly strong inner-city attachment despite varying telework possibilities. In contrast, leisure industry workers are employed in sectors where remote work is rare, and workplaces are dispersed across the city.

Taken together, these patterns suggest that the digital transition currently supplements rather than replaces the value of dense urban environments for creative class workers (Althoff et al., 2022; Sánchez-Moral et al., 2026). Remote work opportunities are unequally distributed and concentrated in high-skill, high-wage services. This unequal distribution of telework potential has implications for the spatial patterns of work, commuting, and inequality, and it aligns with our broader finding that both the benefits and constraints of digitalisation are unevenly mapped onto Riga's socio-spatial landscape.

4. Conclusion

This study analysed Riga's creative class residential patterns using individual-level census data and a multi-scalar spatial methodology. The findings demonstrate that creative-class workers are unevenly distributed, forming pronounced clusters in the historic inner city and adjacent neighbourhoods. However, the intensity and location of clustering vary substantially by subgroup—creative, knowledge, culture, and leisure industries—and depend on the spatial scale of analysis, highlighting the need to disaggregate the creative class and consider multi-scalar urban dynamics.

At all spatial scales, the creative class displayed clear preferences for inner-city areas rich in historic architecture, amenities, and cultural vibrancy. These mirror established Western research showing that "soft" locational factors—such as cultural amenities and neighbourhood diversity and ambience—act as limited attractors, while secondary concentrations in certain outer neighbourhoods indicate that residential choice also reflects affordability and life-course stage (Martin-Brelot et al., 2010; Murphy & Redmond, 2014). These nuances emerge most sharply in micro- and meso-scale analyses, which reveal localised pockets of creative class overrepresentation beyond the traditional core.

Disaggregation by occupational subgroup underscores the internal diversity of creative class residential strategies. Culture industry workers show the strongest central clustering, oriented around established cultural infrastructure and vibrant neighbourhood life. Creative industry professionals demonstrate intermediate patterns that appear in both central districts and mixed-use neighbourhoods. In contrast, knowledge industry workers, who are generally older and more socioeconomically established, display more dispersed yet still inner-city-oriented patterns, suggesting alignment with middle-class residential norms as much as creative class identities. Leisure industry workers stand apart, exhibiting the most spatially integrated and least concentrated patterns, shaped by lower socioeconomic status and widespread, service-oriented workplaces. These findings challenge the notion of the creative class as a coherent and homogeneous group, reinforcing the importance of a nuanced analysis that recognises demographic, occupational, and life-cycle heterogeneity.

The spatial logic of creative class clustering is deeply intertwined with Riga's urban structure and the legacies of post-socialist urban change. Clustering coincides with neighbourhoods that previous studies have identified as sites of selective upgrading, cultural investment, and demographic transformation, but these dynamics are best characterised as fragmented gentrification rather than large-scale, Western-style transformation (Krišjāne et al., 2015), shaped by distinct legacies of property ownership, investment cycles, and ethnic segregation. The notable absence of creative class residents in Soviet-era housing estates and peripheral zones marks an urban divide with relatively stable patterns of segregation and uneven amenity provision.

Finally, the continued concentration of creative workers in the inner city despite expanding remote work possibilities suggests that digitalisation has not weakened the centrality of urban cores in the creative economy. Instead, it appears to take advantage of daily activity spaces and working practices within these neighbourhoods, reinforcing the importance of central urban environments as platforms where digital and face-to-face interactions intersect (Bathelt & Turi, 2011).

From a policy perspective, our results suggest caution regarding the uncritical adoption of creative class strategies in post-socialist contexts. While attracting creative workers may generate economic benefits and contribute to urban regeneration, policymakers must recognise and address potential negative externalities, including housing affordability pressures and the reinforcement of existing spatial inequalities (Gilmore & Burnill-Maier, 2025; Leslie & Catungal, 2012). Strategies for inclusive urban development should equitably integrate support for creative economies with policies that ensure housing affordability, socioeconomic diversity, and revitalisation benefits.

Our analysis highlights the need for differentiated policy responses that reflect the heterogeneity within the creative class. For lower-income segments—particularly leisure industry workers and younger cultural

workers, who are more likely to occupy lower-paid positions—policy measures should focus on maintaining and expanding affordable housing options. This might include targeted rent stabilisation or subsidy schemes for vulnerable tenants, the protection and refurbishment of existing affordable housing stock, and inclusionary zoning requirements that ensure a share of new developments remains accessible to lower- and middle-income households. Such measures would help safeguard households that contribute to everyday urban vitality but are least able to absorb rising housing costs.

For higher-income creative segments, especially knowledge industry workers who are more established and concentrated in inner-city and middle-class neighbourhoods, a different policy emphasis is appropriate. Rather than directly regulating rents, policies could focus on steering the broader development process to maintain a social mix and avoid exclusive enclaves. Tools such as mixed-income housing requirements in new projects, limits on the conversion of long-term rental housing into short-term accommodation, and community benefit agreements that tie new investments to local service provision can help ensure that neighbourhood upgrading does not come at the expense of diversity.

Across all subgroups, supporting the creative economy in socially inclusive ways requires attention to non-residential spaces. Investment in cultural infrastructure, affordable workspaces, and neighbourhood-level amenities in both central and peripheral areas can extend the benefits of creative development beyond privileged districts. In the post-socialist context of Riga, where gentrification remains partial and socio-spatial divisions are relatively stable, the main policy task is to prevent future exclusionary dynamics and ensure that emerging creative clusters contribute to, rather than undermine, socio-spatial diversity.

This study has several limitations. First, the occupational classification system, although comprehensive, may not fully capture hybrid or emerging creative occupations, potentially underrepresenting certain creative class segments. Second, the cross-sectional nature of census data limits our ability to analyse residential mobility trajectories and neighbourhood change dynamics over time. A longitudinal analysis tracking creative class settlement patterns across multiple census waves would provide valuable insights into gentrification temporalities and residential succession processes. Third, while our spatial analysis documents where creative class workers live, it does not directly measure the causal relationships between creative class settlement and neighbourhood change, necessitating complementary qualitative research examining decision-making processes, neighbourhood perceptions, and lived experiences.

Future research should extend this analysis in several directions. First, comparative studies examining creative class residential patterns across multiple post-socialist cities would illuminate the extent to which Riga's patterns reflect broader regional tendencies rather than city-specific dynamics. Second, integrating qualitative methods, including interviews and ethnographic observations, would deepen the understanding of the motivations, preferences, and experiences shaping creative class residential choices. Third, a longitudinal analysis tracking neighbourhood trajectories over time would clarify the temporal relationships among creative class settlement, property investment, and socio-demographic transformation. Finally, research examining the experiences of displaced residents and communities affected by creative class-driven neighbourhood change remains critically important for developing socially just urban development policies.

In conclusion, the creative class in Riga is characterised by both spatial clustering and internal diversity, with subgroup-specific patterns influenced by urban structure, neighbourhood characteristics, and processes of selective urban transformation. These findings affirm established theories in the European and North American contexts, while simultaneously revealing the distinctive, path-dependent trajectories of post-socialist urban transformation. As competition for creative talent intensifies, it becomes even more crucial to attend not only to the economic benefits of creative class settlement but also to its complex social and spatial consequences for developing equitable and sustainable urban futures.

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Conflict of Interests

The authors declare no conflict of interest.

Data Availability

The georeferenced census data of 2021 employed in this study are subject to an agreement between the Central Statistical Bureau of Latvia and the University of Latvia. The occupational data were anonymised and processed in accordance with a confidentiality agreement, ensuring compliance with all data protection, privacy regulations, and contractual obligations. For additional information regarding data usage, please contact maris.berzins@lu.lv

LLMs Disclosure

For the purpose of language editing, we utilised the following LLMs: Paperpal and DeepL.

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The Digitalization of the Housing Market in Spain: A Case Study of the Use of Online Platforms and Spatial Inequalities

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Abstract

Online platforms are the main form of mediation in the housing market. While their importance has grown significantly in recent decades, that growth has been uneven throughout various territories and social groups. The role of online platforms goes beyond intermediation; the ease of access they provide stimulates market activity, while the concentration of listings on the same web portals homogenizes and raises prices. This article uses a unique database on housing supply for rentals and sales by census tract from Spain's primary online housing portal between 2012 and 2021. Using data from this portal as a case study, we analyse how the gradual growth of the digital housing supply (in both space and time) is connected to changes in the distribution and characteristics of the housing units. Rental and sales markets show spatial differences, with opposing dynamics in rural and urban areas, highlighting a digital divide. Middle-class urban areas, which also attract tourists, are the most active markets, while rural areas remain less dynamic. Housing in more active markets, in turn, appreciates, increasing territorial inequality. Rising prices benefit existing owners but are a disadvantage to potential buyers, especially lower-income households. In that respect, our case study points to the conclusion that the digital divide in the use of online intermediation tools amplifies territorial and social inequalities.

Keywords

digital divide; housing; proptech; purchase; rental

1. Introduction

Building on advances in information and communication technologies, contemporary societies are replacing established procedures, work practices, and systems of exchange with new digital tools. Digitalization, however, is not an entirely new phenomenon, but rather the intensification of a broader, long-standing process. As early as the 1930s, Toynbee (1987) identified this trend, which he termed "etherealization," in which materials are progressively reduced, lightened, and ultimately dematerialized. This trajectory has transformed not only physical objects, such as telephones and computers, but also social processes, fundamentally reshaping how problems are addressed and solutions enacted.

For its part, housing exemplifies materiality in its most tangible form. As a solid construction anchored to the land, it resists portability and allows only limited, often complex modifications, so much so that many prefer relocation to renovation. Given its high cost and centrality to everyday life, housing constitutes one of the most significant markets in social and economic terms (Zhao & Liu, 2023). The difficulty of navigating this market, which has been shown to be greater for lower-income families and young people, has elevated the role of intermediaries, particularly online real estate platforms. These companies are commonly included as part of so-called property technologies—often shortened to "proptech" (Asensio-Soto & Navarro-Astor, 2022)—a broader term referring to the incorporation of different advances in IT into the real estate business. Such actors have been crucial to the shaping of the capitalist city (Yates, 2021). Indeed, the housing market has undergone a profound transformation in recent decades due to digitalization (Asensio-Soto & Navarro-Astor, 2022), although its implementation has been slower than in other sectors. Advertisements once displayed on office bulletin boards or affixed to the balconies or windows of properties are now predominantly hosted on digital platforms, especially regarding the rental market (Fernández Gallardo & Millán Vázquez de la Torre, 2021).

Digitalization is not only reshaping behaviours and businesses, but is also altering the social structure. Unequal access to—and uneven proficiency with—new technologies and devices has created a digital divide between different social groups, broadening and deepening social inequalities (Barbeta-Viñas & Sánchez-Gelabert, 2023), with digitalization at times playing a crucial role in social life, such as during the Covid-19 pandemic (González Vidal & Gewerc Barujel, 2021). This raises questions about whether digitalization, in the form of the rise and consolidation of these platforms, also impacts the existing inequality in already unequal societies.

Our article addresses this gap by focusing on the growth of real estate portals, as an example of the housing market digitalization that has happened around the world in recent decades, and by questioning how this evolution affects socio-spatial inequality at different scales. To that end, we used data on the number of advertisements and prices in Idealista, the largest online real estate platform in Spain and one of the pioneers in the field, making it an ideal case study for developments in the field overall. Data from this source has already proven to be a valid indicator for studying the market in previous studies (Rey-Blanco, González, et al., 2024). The main objectives in this article are to (a) analyse the evolution of the use of this online housing platform in space and time, (b) identify areas where the use of the real estate portal has increased the most in both the rental and sales markets, and (c) analyse the association between these areas and price dynamics at the local level. Our findings contribute to the literature in three key ways. First, they demonstrate the potential of data derived from private platforms like Idealista for social, urban, and political

research. Second, the results reveal substantial differences between urban and non-urban areas, both across metropolitan regions and between neighbourhoods, indicating that housing markets are unevenly represented and shaped by online platforms. Third, these spatially uneven patterns of digitalization have direct implications for urban policy, as they can reinforce existing territorial inequalities, affect the availability and visibility of housing information, and determine the capacity of local governments to target and evaluate housing policies.

2. Conceptual Background

2.1. Digitalization and the Digital Divide

Although "digitization" and "digitalization" are both terms that have been widely used in the literature in recent decades—sometimes interchangeably—there is a school of thought, as presented by Brennen and Kreiss (2016), that justifies distinguishing between them. While digitization is "the technical process of converting streams of analogue information into digital bits of 1s and 0s with discrete and discontinuous value" (p. 1), digitalization is "the structuring of many and diverse domains of social life around digital communication and media infrastructures" (p. 5). However, the relationship between the two phenomena is undeniable, and applied to the subject of this study, it becomes clear that the digitization of the housing supply in Spain is a proxy for the digitalization process that is still developing in the country.

While digitalization is often presented as a matter of technical innovation, it is a phenomenon whose scope extends far beyond the technological dimension, since it reshapes markets, systems of governance, and even practices in everyday life. The extent of these changes has led to the emergence of a new social paradigm, primarily based on digitalization, as in Lupton's (2015) digital society, and on information as the fundamental raw material of the system, or Castells's (1997) information society, and specifically on data, the basis of so-called platform capitalism (Srnicek, 2018).

However, this process is not uniform across time and space. New inequalities, related to integration into the digital society, are arising in the form of the so-called digital divide. This term has also undergone its own evolution, from mainly referring to differences in access to the Internet, to control of the network, through to differences in use (Pizzi et al., 2023). These distinctions, which have been shown to be multidimensional in the literature (Pérez-Amaral et al., 2021), are therefore particularly complex to study and understand, sometimes obscuring the true causes of such gaps (Papí-Gálvez & La Parra-Casado, 2023).

Given that digitalization is a relatively recent and rapidly evolving phenomenon, the first gaps that come to mind are those related to age. Differences in digital performance according to age have been shown in recent studies, such as Papí-Gálvez and La Parra-Casado (2023), who report poorer digital socialization among people older than 75. Furthermore, even within the same age groups, it has been shown that differences in access to new technologies, and especially in the quality of that access and in the uses made of those new technologies, are also significant and are related to the socioeconomic conditions of the population, as shown in Calderón Gómez (2019) in the case of young people aged 16 to 34.

Similarly, studies on the digital divide have found evidence of a gender divide, according to which women are at a disadvantage in the digitalization race. Although this gap is narrowing in some areas, as shown in the study

by Castaño et al. (2011), and in some cases is not significant (Papí-Gálvez and La Parra-Casado, 2023), it is still notable in other areas, such as STEM studies and the labour market in Spain (González Vidal & Gewerc Barujel, 2021). However, other macro-structural factors may explain the differences between genders, such as socioeconomic or educational conditions (Calderón Gómez, 2019).

Just as age and gender appear to be mediated by factors such as education or socioeconomic status in the digital divide, another variable closely related to social class—place of residence—can also serve as a focus for studying differences in digitalization, in this case from a spatial perspective. This is particularly evident in studies on online consumption, which Barbeta-Viñas and Sánchez-Gelabert (2023, p. 42) consider a "new factor of inequality" in the digital society.

These inequalities can also occur between countries. In the case of Spain, evidence has been found of lower development in the use of ICTs when compared to the European average, as well as more pronounced gender differences than in neighbouring countries (Caridad Sebastian & Ayuso García, 2011; Castaño et al., 2011). The same phenomenon has also been identified within the same country. However, Wu and Liu (2025) have shown that although there are differences between rural and urban areas in terms of access, use and the impact of digitalization, in some respects the cross-cutting nature of digital space means that some distinctions that are apparent in the physical world are not as apparent in the digital world, although they can be identified in differences in digital culture.

Although digital space is often presented as globally accessible and has been included in studies on public space as another of its dimensions (Smith & Low, 2013), the geographies of digital consumption remain uneven, and the study of the phenomenon is an ongoing process. Nevertheless, these studies point to a spatial inequality that replicates the disparities of the physical world in both the digital realm (Liu, 2023) and the housing market.

2.2. Digitalization and the Housing Market

Digitalization in the housing market can be broadly defined as the transition from traditional, physical channels of property exchange to virtual platforms. This shift entails the migration of property advertising and brokerage from offline methods, such as newspaper listings and local estate agencies, to online portals and digital intermediaries (Boeing, 2020). The Internet has become a primary medium for property listings, fundamentally reshaping the way information is accessed and disseminated in real estate markets.

Within this context, property technology—or proptech—has emerged as a term that encapsulates the technological transformation of real estate. Proptech refers to the incorporation of digital tools, data analytics, and platform-based models in real estate intermediation (Asensio-Soto & Navarro-Astor, 2022). Online housing platforms have introduced alternative business models that challenge traditional brokerage structures. Instead of relying on physical offices and commission-based fees, online platforms often operate with reduced or fixed fees, using the digital platforms to directly connect sellers and buyers (Gedikli et al., 2025). Evidence suggests that online platforms accelerate sales processes and achieve a closer alignment between listed and realized prices compared to traditional agencies (Gedikli et al., 2025).

The impact of these platforms extends beyond their own transactions. Their growth has also influenced the behaviour of traditional brokers, forcing them to adapt by lowering fees and incorporating digital strategies to remain competitive (Asensio-Soto & Navarro-Astor, 2022). Furthermore, online platforms have expanded the visibility of properties, increasing liquidity and reducing information asymmetries in housing markets (Jiang et al., 2023; Zhang et al., 2023). As such, the rise of online agencies is reshaping not only the online market but also the dynamics of the housing market as a whole.

The increasing centrality of digital platforms raises questions about how closely online listings reflect real housing supply. Research shows that online housing markets do not fully capture the diversity of available properties. Instead, listings are unevenly distributed across urban areas, often overrepresenting affluent or central neighbourhoods while underrepresenting disadvantaged ones (Abella et al., 2025; Boeing, 2020). This creates a digital bias, where certain communities and housing segments become less visible to potential buyers and tenants.

At the same time, online listings provide a valuable proxy for understanding real housing markets. Studies using online data have been able to identify spatial segmentations and patterns of availability that would otherwise be difficult to observe (Abella et al., 2025; Boeing & Waddell, 2016). One key issue in digital housing markets is the relationship between asking prices online and actual transaction prices offline. Research suggests that online platforms tend to present inflated or strategically set prices, which may deviate from the final sale or rental price. For example, in Madrid, online rental prices are consistently higher than official market benchmarks (Rey-Blanco, Arbues, et al., 2024). This discrepancy reflects strategic pricing behaviour by landlords. At the same time, online data has been shown to provide useful predictive power for housing market dynamics. Search activity and online engagement have been linked to subsequent price changes, as increased digital activity often precedes shifts in real demand and prices (Bennöhr & Oestmann, 2014; Beracha & Wintoki, 2013; van Dijk & Francke, 2018).

Moreover, the design and information flows of online platforms affect pricing outcomes. Digital platforms can reduce mismatches between listing and final prices by improving transparency and market efficiency (Jiang et al., 2023). They also enhance valuation processes through the integration of market activity into digital metrics, such as bidding and engagement data (Saputra & Putri, 2024). These mechanisms demonstrate the dual role of online platforms in both shaping and reflecting pricing dynamics.

Despite the promises of digitalization, online housing markets are characterized by spatial inequalities. Studies conducted in the United States have demonstrated that online listings disproportionately represent wealthier, whiter, and more educated neighbourhoods, while underrepresenting disadvantaged communities (Boeing, 2020). This unevenness reflects both supply-side dynamics—landlords in affluent areas are more likely to advertise online—and demand-side factors, such as differences in Internet access and digital literacy across populations.

Spatial segmentation in digital housing markets has been documented in several contexts. Abella et al. (2025) show how online listings reveal clear divisions between neighbourhoods, reinforcing existing urban inequalities. In this respect, digital housing markets reproduce offline spatial disparities, limiting the extent to which digitalization democratizes access to housing information. The consequences of these inequalities are significant. Overrepresentation of affluent areas increases their visibility and attractiveness, potentially

accelerating processes like gentrification. Conversely, the underrepresentation of disadvantaged neighbourhoods restricts their residents' access to broader housing opportunities, perpetuating cycles of spatial exclusion (Boeing, 2020). These findings underscore that while digital platforms expand housing visibility, they do so unevenly, reinforcing pre-existing inequalities.

3. Data and Methods

This study uses housing stock and price data (for both sales and rental markets) obtained from the Idealista online real estate platform. The dataset reflects asking prices, not final prices. There is no adjusted formula to approximate actual prices, as there are no sources available with a similar degree of granulation and completion to use to make comparisons. However, for reference, actual purchase prices are generally lower than asking prices (instead of instigating bidding wars, owners usually set high asking prices and negotiate). Final rental prices, on the other hand, will be very close to the asking price. This is because the critical situation in the current housing rental market deprives renters of negotiating power, requiring them to make a significant economic effort to pay the rent (Khametshin et al., 2024). While other studies, such as Rey-Blanco, Arbues, et al. (2024), have accessed this information on prices using data scraping, our study obtained the information directly from the Idealista company, which provided us with a serialized dataset containing quarterly information for every spatial unit for a ten-year period. The dataset contains information at the census tract level for the entire country from 2012 to 2021, a period that spans from the housing market crisis to its subsequent recovery, the Covid-19 shock, and the rapid digitalization of housing market transactions. The available variables are the number of "for sale" and "for rent" advertisements per census tract, excluding duplicates (the "sale and rental stock") and the average price per square meter.

Regarding possible data limitations, no comparative study was made of different real estate portals. Instead, one specific portal was chosen based on both its importance in the sector and the fact that, as one of the oldest portals, it is able to provide a good example of the progressive development in the digital sector. A more in-depth study comparing different sources would yield more robust results. However, the lack of previous systematic studies (with either private or public data) makes Idealista a useful reference point for future, more exhaustive research.

The analytical strategy of this study follows a multiscale approach, examining the evolution of housing stock from the national scale (Spain as a whole) down to individual cities and, finally, studying differences at the census tract level for the case studies.

To address the first objective—analysing the evolution of the use of online housing platforms in space and time—we conducted a descriptive analysis of the temporal evolution of housing stock offered across Spain and within different types of municipalities. These municipalities were classified in two ways: (a) by their inclusion in metropolitan areas, according to Feria and Martínez-Bernabé (2016); and (b) by population size. To control for distortions related to municipal size, we calculated housing stock per capita, an approach that makes it possible to describe the general process of digitalization and its variation across the different levels of Spain's urban hierarchy.

For the second objective—identifying the areas where the use of the Idealista platform has increased the most—we mapped the spatial distribution of the housing stock change between 2012 and 2021 by

municipality. By using per capita housing stock rather than raw stock, we were able to control for population size effects. We mapped the results for the whole country along with a detail of two metropolitan areas (Madrid and Barcelona) using the QGIS geographic information software.

Finally, to address the third objective—analysing the relationship between these areas and price dynamics—the municipalities were ranked on two top-20 lists, according to their total housing stock for sale and for rent at the end of the study period. For each list, we present the total stock in 2021, absolute growth, and relative growth (percentage change). From these rankings, three case studies were selected: Barcelona (a big city at the top of the urban hierarchy), Granada (a medium-sized city with a high increase in digitalization), and Torrevieja (a town in Alicante, with a high degree of digitalization in the sales market, but not in the rental market). For each case, we analysed the relationship between digitalization (housing stock evolution) and price dynamics, using correlation analyses. Regarding data diagnostics, no representative outliers were identified in the cases analysed. Correlation analysis was conducted using Pearson's r, which was selected given the linear nature of the relationships under study and the results of the pre-tests. Normality and linearity assumptions were assessed and met for the variables included in the analysis. The individual results for each city are displayed in scatterplots with fitted regression lines for each year (2012–2021), using census tracts within each municipality as the unit of analysis (see Supplementary File).

4. Results

4.1. General Evolution of the Use of Real Estate Portals in Spain

The analysis of the largest real estate portal suggests that the 2012–2021 period undoubtedly witnessed an intense digitalization of the real estate market in Spain, as shown in Figure 1. However, this phenomenon occurred principally in terms of sales and not rentals, which were dwarfed in comparison.

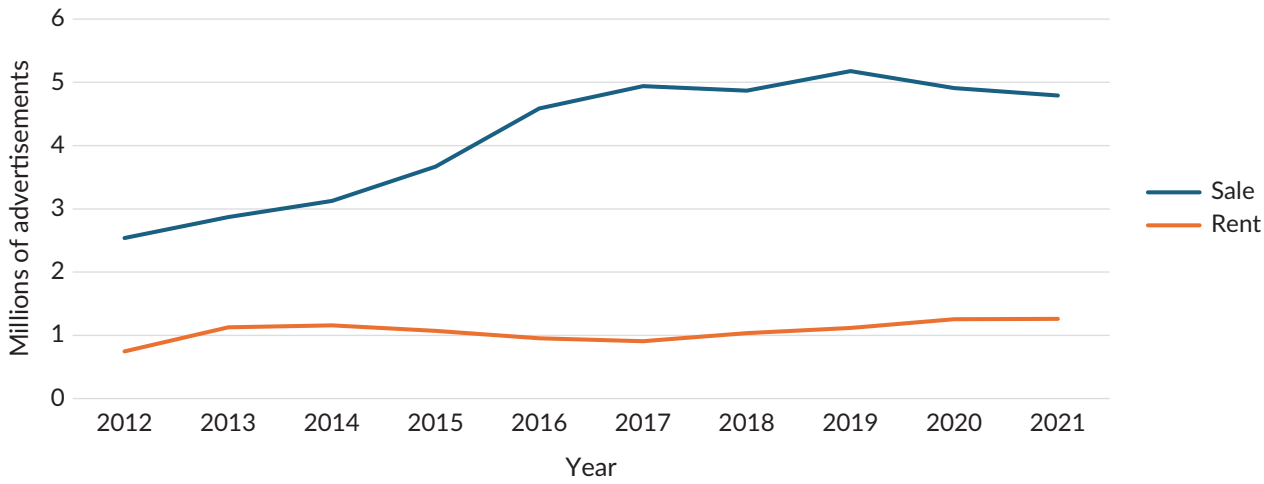

Figure 1. Evolution of overall sales and rental housing stock advertised in Spain (2012–2021), in millions. Source: Based on data from Idealista.

The number of advertisements for houses for sale on Idealista doubled in five years. But the pace of said digitalization was uneven. Three clear periods can be distinguished in the evolution of the sales stock:

1. 2012–2016 was a boom period, with an average yearly increase above 15%; the digital real estate market (and this platform in particular) was thriving, reflecting how online platforms might have become crucial in shaping contemporary urban markets (Yates, 2021).
2. The 2016–2019 period, when growth slowed to an average 5%, reaching a stagnation phase.
3. The post-Covid-19 pandemic period (2019–2021), when there was a decrease in the sales stock but a clear increase in the rental stock. While market uncertainty and an unexpected economic crisis acted as disincentives to buying a house, at the same time they reinforced the decision to rent, with its lower risks.

The size gap between the sales and rental markets makes it impossible to adequately analyse the rental stock with the first graph. Therefore, we separated the two stocks in Figure 2 and added another variable: the geographic location of the advertisements, separating those for metropolitan areas (which comprise the vast majority of urban Spain) from those for non-metropolitan spaces (rural areas and small cities). We also represented sales advertisements with a blue line and rental advertisements with orange columns (each with a different scale) to facilitate comparison.

This data segregation reveals some interesting differences. Regarding housing for sale on Idealista, the metropolitan supply was more consolidated at the beginning of the period and clearly stagnated in 2016, while the non-metropolitan supply was lower in 2012, but maintained steady growth until 2019. This difference reflects the earlier digitalization of urban spaces, confirming the existence of a digital divide on this real estate portal. Rural areas and smaller cities generally have an older, less educated population, and

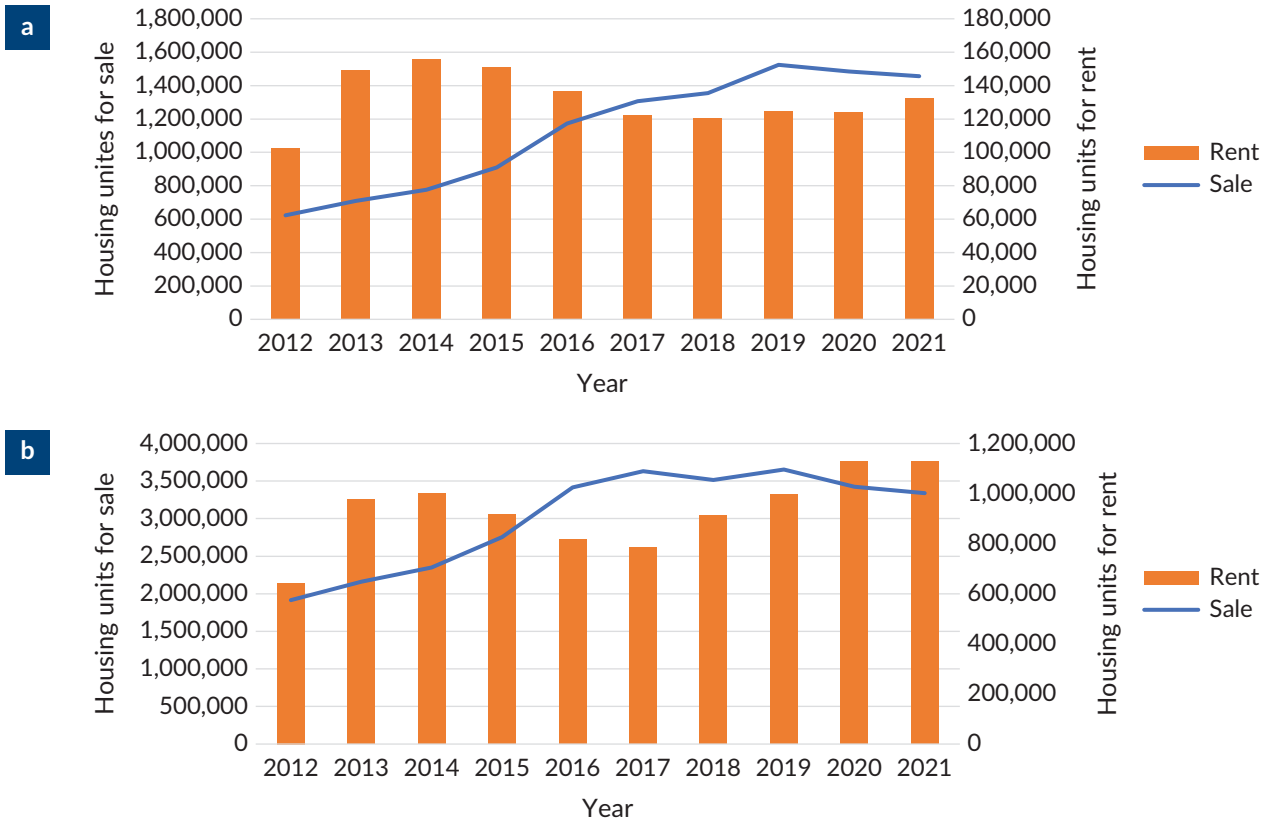

Figure 2. Evolution of housing stock for sale and rent in Spanish (a) non-metropolitan and (b) metropolitan municipalities (2012–2021). Source: Based on data from Idealista.

both characteristics could be connected to a lower degree of digital literacy. As noted by Papí-Gálvez and La Parra-Casado (2023) and Calderón Gómez (2019), digital performance is strongly mediated by education and socioeconomic status. The digital divide amplifies pre-existing inequalities, as these spaces also have a lower per capita income and fewer public and private services, which can be seen as a new factor of inequality in the digital society (Barbeta-Viñas & Sánchez-Gelabert, 2023). This institutional neglect, coupled with depopulation, has led these rural parts of Spain to be referred to as "empty Spain," later renamed "emptied Spain." This subtle difference emphasizes the active role of public and private actors in the depopulation process, through inaction or even direct actions that foster the abandonment of rural spaces (Andrés Cabello, 2024).

The rental stock on the Idealista portal had a similar evolution during most of the period in both metropolitan and non-metropolitan spaces, with initial growth up to 2014 and a phase of decline, followed by the appearance of differences: While there was a timid recovery in the rural areas, the increase in the more urbanized areas was faster. The differences between the metropolitan and non-metropolitan areas were even greater than the initial impression. A comparison of the scales on the left and right sides of the graphs shows that there are ten times more houses for sale than for rent in non-metropolitan locations. In metropolitan areas, the scales are closer, with units for sale roughly tripling rental units. This information indicates the need for further exploration of the digital divide and the uneven territorial distribution of housing. Rental is a minority option in Spain, with public rental opportunities being virtually non-existent. Generally speaking, renting is a secondary option for individuals who cannot afford home ownership or for highly mobile groups who prefer to have more flexibility, with both subsets of renters concentrated in the large metropolitan areas and within them, in the central municipalities. Areas in high demand, then, also reflect the structural difficulties faced by both regular and potential urban inhabitants, for example, young people entering the housing market (Echaves García, 2017).

Figure 3 focuses on the gap between the number of advertisements for houses for sale and for rent. This figure includes a new variable, the population of the municipality, in order to study the stock. As the overall stock of a municipality is linked to its population, we calculated a new measurement: stock per 1,000 inhabitants in the municipality. The examination of Idealista suggests that the digitalization of the real estate market may

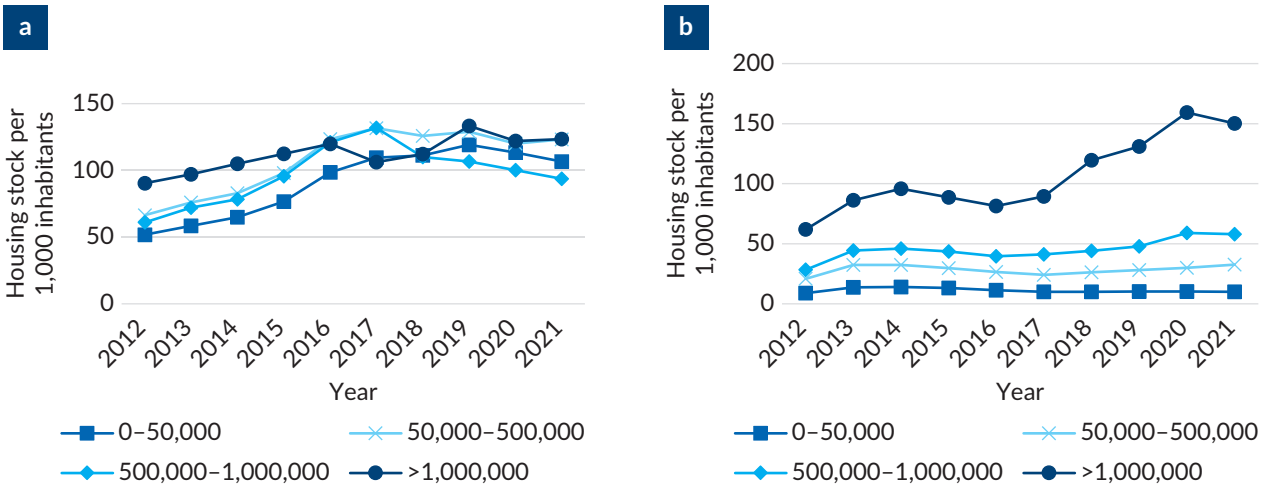

Figure 3. Evolution of (a) sales and (b) rental housing stock per capita (‰) in Spanish municipalities by population (2012–2021). Source: Based on data from Idealista and Spain's National Statistics Institute.

have been much more advanced in the bigger cities until 2016, when the mid-sized cities between 100,000 and 1,000,000 inhabitants took the lead. The size of the municipality is clearly associated with digitalization, as the lines in the graph are almost parallel and ordered by municipality size (with the noteworthy exception of the two most populated cities, which have a decline in advertisements per capita, probably related to the appearance of new competitors, which decreased Idealista's share of the market in some locations; in 2017, some new fully digital real estate companies began to operate in Spain, as reported in *Expansión*, a newspaper that specializes in financial news: see Fernández, 2019). Since the new agencies first arrived in the bigger cities, the smaller ones were not initially affected.

The rent graph is more clear-cut: Rental advertisements in Idealista were always concentrated in bigger cities, and the smaller the municipality, the less stock per thousand inhabitants (the variable is perfectly linear, without exceptions). While the arrival of new real estate agencies may have decreased the share of sales advertisements posted in Idealista, their position in the rental market was not affected, with very prominent growth in the bigger cities in Spain. The Idealista business model, which allows both individuals and conventional real estate agencies to advertise properties, seems very well suited to the rental housing market. Advertisements for sales, on the other hand, have been affected by the new conditions offered by digital real estate agencies. Often, these companies do not manage viewings, which allows them to save on personnel costs. These savings, in turn, enable them to offer more affordable brokerage services to clients: Instead of charging a percentage of the sale price, they charge a flat fee for their services (which can mean savings of thousands of euros in the case of high-value properties).

4.2. Mapping Real Estate Digitalization in Spain From 2012–2021

Our second goal was to identify the municipalities and urban areas where the use of the digital real estate portal Idealista has increased the most. We explored the distribution of advertisements in broad terms, grouping the evolution of metropolitan/non-metropolitan areas and cities by their population size. However, thanks to the granularity of the information in our database, we were able to study the territorial distribution of the properties advertised online with much more spatial detail, in line with our interest in analysing digitalization at the municipal level for the country as a whole. This representation makes it possible to study territorial inequalities between regions, between coastal and inland areas, and between metropolitan centres and their surrounding municipalities within metropolitan areas.

The first map in Figure 4 shows the changes in the number of sales advertisements per 1,000 inhabitants at the municipality level for the whole of Spain. The boundaries of the metropolitan areas are drawn to identify the rural spaces and major urban agglomerations. The predominance of green and blue indicates the overall advances in digitalization (based on the analysis of the Idealista portal) in most of the country, with some exceptions. In addition to the small municipalities across the country, four major metropolitan areas have a predominance of red: the three provincial capitals in the Basque Country (Bilbao, San Sebastian, Vitoria) and the biggest city in the country, Madrid. The decrease in the number of advertisements per inhabitant during the period is linked to their large share of the real estate market at the beginning. Due to the starting point of 2012, the evolution over the decade studied largely reflects the effect of new competitors entering Idealista's business in these cities. These four cities also show an overspill effect on their surroundings, creating a blue ring encircling the red in the centre. The rest of the metropolitan areas clearly increased their supply, as expected.

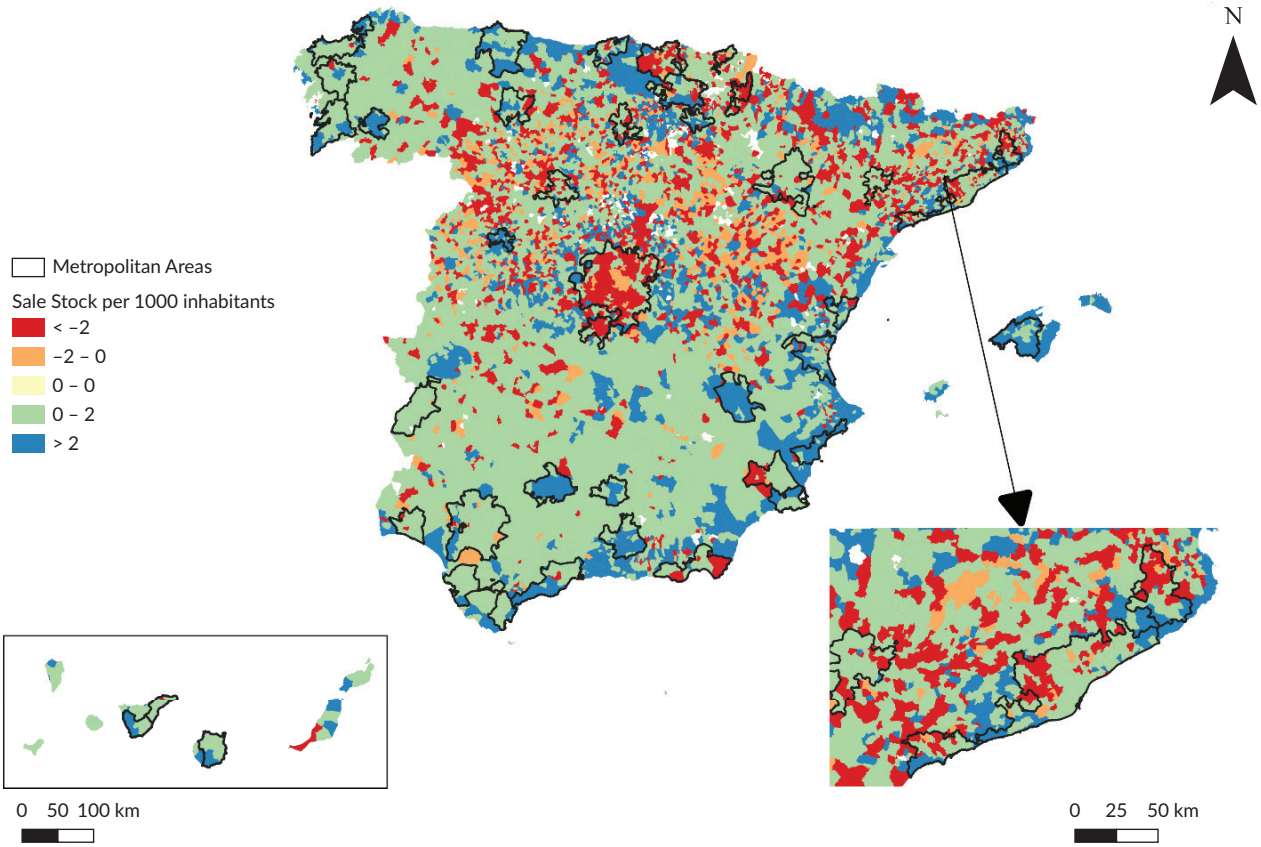

Figure 4. Evolution of housing stock for sale in Spanish municipalities for the peninsula, Balearic Islands, and Canary Islands (bottom left) and detailed map for the metropolitan area of Barcelona (bottom right), from 2012 to 2021 (change in ‰). Source: Based on data from Idealista and Spain's National Geographic Institute.

In spatial terms, two distinct features are clear. One is the coast-inland divide. Coastal areas are predominantly in the higher category that represents increases, due both to the appeal of these municipalities and to the higher property values in these areas, which leads to a more active market. The island of Mallorca is a perfect example, where only the municipalities in the centre of the island have a moderate increase in the number of advertisements. Mountainous areas also show a similar behaviour. These municipalities can be very attractive due to their landscape or the presence of specific amenities like ski resorts, another reflection of the spatial segmentation of digital housing markets, where affluent or desirable areas are overrepresented, as observed by Abella et al. (2025). A comparison of the real estate digitalization map with the elevation map clearly shows the blue areas in the major mountain ranges in Spain: the Pyrenees, the Cantabrian Mountains, the Central System, and Sierra Nevada.

An enlarged map of Barcelona provides an example of the evolution of Idealista stock in a specific city. Although most of the area is green, the largest increases are in the municipalities furthest from the capital, which are also coastal. Only a few inland municipalities show decreases in the supply of homes for sale.

The second map in Figure 5 looks very different from the previous one. In terms of surface area, at the territorial level, the prevailing dynamic is a decrease in the number of advertisements per person, producing a predominance of orange and red. However, the map may overestimate large, sparsely populated municipalities in rural areas due to their large surface area, while municipalities that are not as big, but are

densely populated, appear much smaller. A perfect example in this respect is Madrid, which is enlarged in the figure. Although the metropolitan area appears almost entirely red, there is a large blue spot in the middle: the municipality of Madrid, meaning that it is the capital that accounts for the major increase in rental supply. In other words, what is on view is not so much a decline in rental supply as its concentration in large cities. The same pattern can be seen in Barcelona, Seville, Zaragoza, and Valencia.

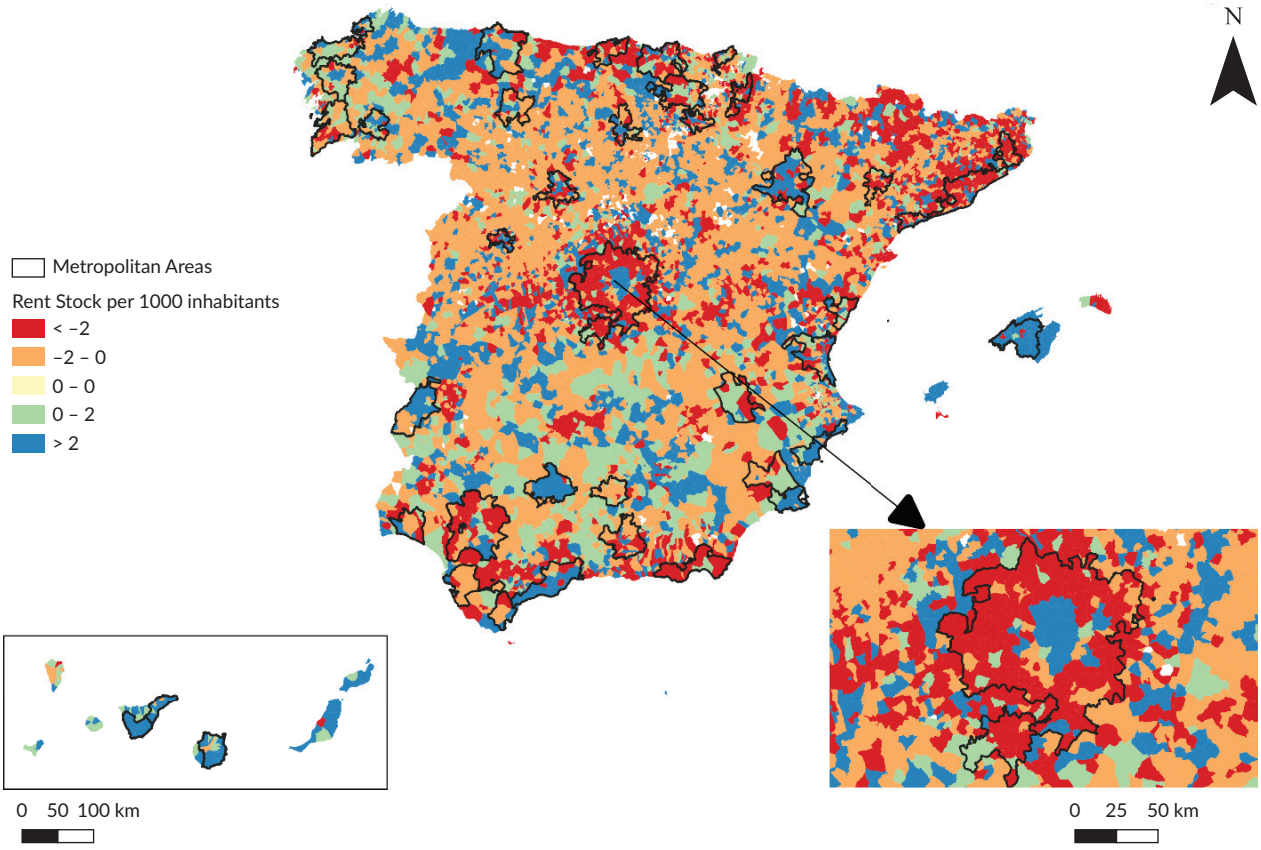

Figure 5. Evolution of housing stock for rent in Spanish municipalities for the peninsula, Balearic Islands, and Canary Islands (bottom left) and detailed map for the metropolitan area of Madrid (bottom right), from 2012 to 2021 (change in ‰). Source: Based on data from Idealista and Spain's National Geographic Institute.

Another significant pattern is seen in the proliferation of advertisements for island rentals. The Canary Islands, Mallorca, and Ibiza are all almost uniformly blue. Different studies have analysed the specific problems linked to specialization and tourist overexploitation in the residential markets of the Canary Islands (García-Hernández et al., 2018) and the Balearic Islands (Martinez-Garcia et al., 2025). Other prime coastal locations, such as the Costa del Sol in Malaga and the coastal municipalities in Cadiz, Murcia, Valencia, and Alicante, also have important increases in the rental supply per inhabitant. The dynamics suggest that the platform is being used to search for holiday houses in valuable locations, as well as long-term rentals in central cities. The two different uses share a common characteristic: high prices. The more expensive the area, the more the incentive to rent; therefore, these areas attract investors who will buy to rent the property out, and their actions reinforce the price escalation.

4.3. The Relationship Between Digitalization and Housing Price Dynamics

Exploring the link between Idealista posts and price escalation required expanding the level of detail in the analysis, moving down from the municipal level to the census tract. Zooming in on this level reveals new patterns previously hidden within the municipalities. Although it would be ideal to systematically include the entire territory, the scope of this article is limited to the sub-municipal level. Results are presented for three case studies, selected based on their characteristics. The following two tables present a ranking of the cities where the digitalization process is most advanced (for housing sales and rentals, respectively). This is augmented by the evolution of the housing supply during the period under study, in both absolute and percentage terms.

In Table 1, the total sales stock shows how, although the largest cities lead the ranking, some mid-sized cities appear ahead of others with much larger populations. Particularly noteworthy are the positions in the ranking of Torrevieja (a city that is not part of any metropolitan area, but has a large tourist presence) and Granada (a mid-sized city that appears in fifth place and has the largest increase in listings in relative terms).

Table 1. Top 20 Spanish municipalities according to the digitalization of the sales market.

Municipality	Metropolitan area	Sale stock 2021	Increase 2012–2021	Increase (%)
Madrid	Madrid	195,742	253	0%
Barcelona	Barcelona-Sabadell	140,991	88,304	168%
Marbella	Málaga-Marbella	87,428	67,869	347%
Valencia	Valencia	86,213	25,999	43%
Granada	Granada	71,282	60,690	573%
Alicante	Elche-Alicante	69,507	39,645	133%
Torrevieja	Non-metropolitan	55,893	38,005	212%
Palma	Palma de Mallorca	52,744	27,483	109%
Estepona	Málaga-Marbella	52,484	41,071	360%
Málaga	Málaga-Marbella	50,611	18,428	57%
Córdoba	Córdoba	49,983	30,478	156%
Murcia	Murcia	44,114	18,460	72%
Mijas	Málaga-Marbella	43,139	32,627	310%
Seville	Seville	41,570	5,662	16%
Benalmádena	Málaga-Marbella	35,664	23,315	189%
Orihuela	Non-metropolitan	35,412	25,117	244%
Elche	Elche-Alicante	35,319	24,679	232%
Zaragoza	Zaragoza	33,602	5,974	22%
Oviedo	Avilés-Gijón-Oviedo	32,482	19,259	146%
Salamanca	Salamanca	28,330	17,690	166%

Source: Based on data from Idealista.

While the ranking of the rental stock in Table 2 reflects the population size of cities more clearly, once again, Granada ranks fifth, despite its population being less than a quarter of a million. It is also the city with the highest increase in supply, along with Salamanca. Both cities share some characteristics: They are mid-sized

cities with large universities, which attract a type of population that overwhelmingly chooses rent as a form of tenure.

Taking both rankings into account, we decided to use the cities of Barcelona, Granada and Torrevieja as case studies: Barcelona as a large city with strong rental and purchase markets (and less affected by its initial situation than Madrid); Granada as a mid-sized city, but with significant rental and purchase markets; and Torrevieja as a non-metropolitan city with a dynamic linked to tourism and with a strong imbalance between a large purchase stock but low rental stock.

Table 2. Top 20 Spanish municipalities according to the digitalization of the rental market.

Municipality	Metropolitan area	Rental stock 2021	Increase 2012–2021	Increase (%)
Madrid	Madrid	262,735	147,327	56%
Barcelona	Barcelona-Sabadell	146,705	92,020	63%
Valencia	Valencia	49,532	20,342	41%
Seville	Seville	37,277	16,222	44%
Granada	Granada	35,574	26,089	73%
Málaga	Málaga-Marbella	31,653	18,057	57%
Palma	Palma de Mallorca	25,607	17,233	67%
Alicante	Elche-Alicante	21,439	11,526	54%
Marbella	Málaga-Marbella	18,798	13,271	71%
Salamanca	Salamanca	17,435	12,978	74%
Palmas de GC	Palmas de GC	14,781	9,601	65%
Oviedo	Avilés-Gijón-Oviedo	14,488	8,707	60%
Zaragoza	Zaragoza	13,066	4,369	33%
Córdoba	Córdoba	11,531	5,439	47%
Murcia	Murcia	11,425	982	9%
Bilbao	Bilbao	11,004	4,136	38%
Benalmádena	Málaga-Marbella	9,673	6,209	64%
Vigo	Pontevedra-Vigo	9,314	−2,212	−24%
Gijón	Avilés-Gijón-Oviedo	8,297	4,087	49%
A Coruña	A Coruña	8,251	2,369	29%

Source: Based on data from Idealista.

Once the cases were selected, a key question became clear: Is the Idealista stock associated with an improvement in competitiveness in the sector (and therefore a decrease in prices) or, on the contrary, does it contribute to price increases? The literature contains studies that largely support the latter supposition (Boeing, 2020; Rey-Blanco, González, et al., 2024). During the period studied here for Spain, there was a general increase in prices while the use of online real estate portals was becoming widespread, meaning that a certain common trend is to be expected. However, how is this relationship spatially correlated at the micro level, and from year to year? In other words, is the proliferation of advertisements in a neighbourhood associated with a variation in prices?

The results in Table 3 show that the association between the Idealista stock and housing prices is clearly positive: The proliferation of advertisements in a census tract is usually accompanied by a clear increase in prices. The correlation is not very strong in the case of sales, but it is very consistent, with no exceptions in the direction of the association. In the Idealista rental market, the correlation is much stronger, with coefficients between 0.5 and 0.6 in Barcelona and Granada (Torrevieja's rental data are not relevant here, as its rental market is almost non-existent).

Table 3. Correlations between housing prices and stock in Barcelona, Granada, and Torrevieja.

	Barcelona		Granada		Torrevieja	
	Sale	Rent	Sale	Rent	Sale	Rent
2012	0.37	0.56	0.17	0.61	0.35	0.23
2013	0.47	0.56	0.18	0.61	0.25	0.10
2014	0.49	0.60	0.19	0.58	0.17	−0.09
2015	0.50	0.60	0.30	0.57	0.20	−0.10
2016	0.44	0.53	0.40	0.56	0.29	0.22
2017	0.37	0.54	0.50	0.56	0.42	−0.05
2018	0.38	0.59	0.30	0.61	0.40	0.22
2019	0.39	0.56	0.28	0.51	0.54	0.16
2020	0.39	0.55	0.32	0.59	0.58	0.02
2021	0.35	0.55	0.33	0.58	0.60	0.10

Note: Correlation levels between ±0.3 and ±0.5 are considered moderate, while those above ±0.5 are considered strong.
Source: Based on data from Idealista.

These results provide an insight into how the comparison features of digital portals are used: Rather than seeking competitiveness by offering prices lower than the market rate, sellers tend to match rising prices (i.e., comparisons are used to maximize the profit on the property, not to stand out from other competitors). The analysis of our platform suggests that the sales market seems to be slightly more diverse, indicating that the need for short-term cash can drive sellers to offer properties at lower prices. In the rental market, on the contrary, the trend seems to be very clear and sustained: Information on prices in the neighbourhood is used as a guide to set minimum rental rates, which contributes to the rising cost of housing. As explained in the newspaper *20 minutos* (Rodero, 2025), landlords who offer rentals below market price face enormous pressure: They receive persistent calls from estate agents to raise their prices, even though they are not looking to earn more. In other words, these agencies have a clear interest in avoiding downward competition or the existence of alternatives at below-market prices.

For the interpretation of the data at the census tract level, the Supplementary File contain a series of scatter plots representing supply and price by tract and year, for both rentals and sales, and for each of the three case studies selected. One of the first things that stands out in all the graphs is how digitalization (based on our case study) might be accompanied by increasing diversification. In the early years of the study, the points appear much more concentrated in all the graphs, but their dispersion increases enormously in the later years. This dispersion might point to two phenomena. The first is the concentration of real estate activity in certain sectors, which have a much higher number of listings than the rest of the city. This may be due to natural factors, such as the urbanization of new spaces, but also to processes of transformation linked to gentrification and touristification. Secondly, in terms of prices, the cities studied are becoming increasingly unequal. Certain

areas are reaching ever-higher prices, especially in the rental market. This rise in prices almost immediately leads to a process of displacement of residents, since Spain has no social rental alternatives to mitigate this effect in the private market. The use of digital portals as a tool to increase prices becomes particularly serious in the most expensive areas, as there is greater potential profit for landlords, making it more likely to result in the displacement of residents.

5. Conclusion

Digitalization is a process that seems unstoppable at present. New areas of social life are replacing analogue spaces and functions with a growing dependence on digital technology. Although this change offers enormous opportunities for economic gain, these advantages and opportunities have a less positive side that this article has explored. This work represents a novelty in the field, as it provides empirical evidence of growth in the use of property portals at different territorial levels, linking this evolution with that of prices (both rental and purchase). To date, no other studies in Europe have carried out an analysis of this type. While this article presents evidence based on a case study to portray the progress of digitalization in the Spanish property market and its effects on social inclusion, the conclusions reached apply to other countries that have followed a similar path.

Our main findings show how the digitalization of the property market in Spain between 2012 and 2021 was a rapid but uneven process. In large cities, the online posting of properties was active since the beginning of the period, while in smaller towns, the increase in the number of online advertisements has been slower and more recent. The effect of these differing trajectories is that technology further stimulates the most dynamic markets, widening the territorial divide (Arundel et al., 2024). Regarding tenancy, the use and consequences of posting housing units are quite different. Advertisements for sales are distributed nationwide and the increase in stock does not correlate strongly with local price increases. Online renting is concentrated on the islands and in large cities, and stock increases strongly correlate with rising prices. The incorporation of technology into ways of searching for housing in highly competitive and spatially concentrated rental markets does not improve market efficiency, but rather eliminates downward competition, as it is used by individuals and companies to set high, uniform prices by area. The lack of public housing—which could provide homes for people priced out of the market—ends up producing a situation where landlords have little incentive to offer housing at low prices. Moreover, in the rare case that they do so, they come under pressure to correct them (Rodero, 2025). Individual actions by conscientious landlords can scarcely change a much broader dynamic.

Housing is the cornerstone of social inclusion, forming the basis from which other public services can be accessed and fostering support and social networks, which are essential and spatially located resources. A large part of the population faces problems when trying to gain access to decent housing in current housing market conditions in Spain. To this day, digitalization has not helped to correct deficiencies in the system. If technological development does not alleviate these problems, then solutions need to begin with public intervention in housing that is both politically determined and covered by the budget. Given current trends, and taking into consideration our findings, the alternatives that are truly capable of curbing the rise in rental prices are, in the short term, much stronger price controls in areas under high pressure, and in the long term, the creation of a public housing stock capable of providing an alternative for people who cannot afford private market prices and a counterbalance to stabilize excessive price increases in areas under pressure from market dynamics.

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Conflict of Interests

The authors declare no conflict of interest.

Supplementary Material

Supplementary material for this article is available online in the format provided by the authors (unedited).

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Uneven Digital Visibility of Urban Places: Evidence From TikTok Hotspots

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Abstract

Social media platforms increasingly shape how urban places gain visibility and attention in the digital age. In this article, we examine patterns of "place visibility" on TikTok in Amsterdam. We propose and operationalise a TikTok Place Visibility Score, defined as a composite indicator based on user engagement metrics, to measure the relative visibility of places on the platform. We then explore how TikTok mediates and redistributes visibility within existing urban hierarchies. Drawing on 3,767 TikTok posts associated with #amsterdam and hotspot-related keywords, we apply geo-parsing, spatial mapping, visualisation, and network analysis to analyse how visibility is distributed across the city. Our results show that several neighbourhoods just outside the historic urban core—rather than only central locations—exhibit high digital visibility on TikTok. These areas function as digitally prominent activity spaces despite their non-central position in the urban hierarchy, while central neighbourhoods maintain a strong online presence. The findings suggest that social media algorithms and user interactions affect digital visibility and may reconfigure how attention is redistributed across urban space. We argue that digital visibility patterns shape how places are circulated and prioritised in the digital public sphere, with implications for how people use and engage with urban space. More broadly, the article highlights the importance of attending to platform mechanisms and visibility dynamics when studying urban space in the digital transition era.

Keywords

digital visibility; hotspots; social media; TikTok; uneven representation

1. Introduction

In contemporary societies, social media has become an important lens through which people perceive, imagine, and experience cities (Boy & Uitermark, 2017; Degen & Rose, 2021; Zasina, 2018). The identification of urban "hotspots" is no longer limited to tourist guidebooks or official planning discourses, but is increasingly driven by the interplay between social media platform algorithms and user-generated content (UGC; Fan & Zhang, 2022). In this era of digital transition, social media platforms have not only reshaped how people engage with and perceive urban spaces but also redefine which places become visible, attractive, and perceived as worth seeing or visiting (Chang & Spierings, 2023). This, in turn, can influence a neighbourhood's reputational capital, transportation and human mobility, rental values, and even patterns of redevelopment (Bronsvoort & Uitermark, 2022; Törnberg & Uitermark, 2022). While social media is often framed as a tool that breaks down traditional information monopolies and supports pluralistic representation, the visibility it generates is uneven (Thompson, 2005). Some urban areas are highly visible on social media platforms due to popular content, visual appeal, or algorithmic preferences, while other neighbourhoods remain "invisible" for long periods of time (F. Zhang et al., 2020). Importantly, this unevenness is also related to the mundanity of most everyday locations. Social media posting behaviour does not reflect routine presence in space but rather resembles the logic of postcards: Users are more likely to share places, events, or moments perceived as new, exciting, or noteworthy, while ordinary and repetitive environments tend to be underrepresented. As a result, the everyday spaces where most urban life unfolds are structurally less visible on social media platforms. This form of platform-generated visibility is not merely symbolic; it may be contributing to a reordering of urban hierarchies and the distribution of social and cultural capital within the city.

A growing body of research has examined how social media data relate to urban spatial structure and socio-spatial inequality, particularly through analyses of geotagged content, representations of place, and patterns of attention (Indaco & Manovich, 2016; Shelton et al., 2015). Early studies highlighted the spatial concentration of social media content and questioned the representational biases embedded in platform data (Tasse et al., 2017). Subsequent work has demonstrated how location-tagged posts and platform-mediated visibility can reinforce existing socio-spatial divisions by selectively foregrounding certain places, communities, or narratives while marginalising others (Boy & Uitermark, 2020). More recent research has expanded this perspective by examining the role of social networks, online discourses, and platform affordances—such as likes, shares, hashtags, and algorithmic ranking—in shaping attention and visibility dynamics across digital spaces (Adelfio et al., 2020; Hausmann et al., 2025). However, despite these advances, relatively little attention has been paid to how platform-specific visibility mechanisms intersect with place-based spatial hierarchies, particularly in relation to hotspots within cities. This article approaches uneven visibility as an empirical question by examining how different urban areas become differentially visible through platform-mediated interactions.

To address these gaps, this study will construct a TikTok place visibility score (PLVS) using TikTok videos tagged with #amsterdam and hotspot-related terms to measure and define the digital visibility of urban spaces on social media. Through geo-parsing, calculating PLVSs, mapping, statistical analysis, and network analysis, we compare digital places with urban amenity density by points of interest (POI) and distance from the city centre, identify places that exhibit high digital visibility despite relatively low POI density or far from the city centre—what we term "unexpected hotspots." We further analyse the hashtags of these places represented on TikTok

and consumption topics in relation to the hotspots. The research question of this study is: What patterns of social media visibility across the city relate to, reproduce, or diverge from existing urban spatial structures?

This study selects TikTok as a case platform for analysis. TikTok has become one of the most influential social media platforms globally and is particularly popular among younger generations (Fong et al., 2024). Its algorithm-driven content dissemination and emphasis on short, visually engaging videos have made it a powerful medium for shaping urban perceptions and spatial visibility. In recent years, media reports and case observations, such as long queues at TikTok-famous locations like Fabel Friet ("Amsterdam Residents Sue City," 2025), suggest that viral content may shape visitation patterns in urban settings, though systematic quantitative investigation remains limited.

This article makes three main contributions to the literature. First, it develops and operationalises a multi-dimensional indicator of TikTok place visibility, capturing how urban places become differentially visible through platform-mediated interactions. Second, using TikTok as a case, it empirically examines how platform-specific content logics and visibility mechanisms intersect with existing urban spatial hierarchies. Third, the article contributes to debates on urban spatial inequality by highlighting how algorithmic processes and politics of visibility shape emerging digital hotspots and generate new governance challenges, complementing existing perspectives focused on physical and infrastructural dimensions of urban space.

2. Background Literature

2.1. Spatial Inequality and Centre-Periphery Theory

Spatial inequality refers to the uneven distribution of resources, services, accessibility, and development opportunities across geographic space (Harvey, 1992). It is often reflected in differences between urban and suburban areas, between core and peripheral communities, and between popular and neglected spaces. Such differences are not accidental but result from structural mechanisms (Van Ham et al., 2024). "Centre-periphery theory," for example, provides a framework for understanding this structure (Friedmann, 1970; Myint, 1965; Prebisch, 1962). The theory stresses that, in geographic or social spaces, the "centre" region is dominant due to economic, cultural, and informational concentration, while "periphery" regions remain in subordinate and dependent positions (Myint, 1965). This perspective helps explain how the concentration of spatial resources in visible areas creates inequality in power and accessibility (Wallerstein & Wallerstein, 2011). At the same time, alternative spatial theories, such as Christaller and Baskin's (1966) central place theory, emphasise a hierarchical distribution of services and consumption functions across urban space, particularly in relation to retail and everyday amenities. This model suggests a more functionally differentiated spatial structure than the more polarised centre–periphery logic. These theories provide analytical references for examining digital and physical urban spatial hierarchies.

In the 1970s, when social media did not exist, people had limited access to travel information, relying mainly on travel agents, guidebooks (e.g., Lonely Planet), and recommendations from friends and relatives (Yuan & Peluso, 2021). Although these media strongly influenced destination choices, their scope of dissemination was limited, and updates were slower than digital media. In this environment, the physical structure of urban space, shaped by historical development and planning paradigms such as Garden City models and modernist functional zoning (Howard & Osborn, 2001), largely determined consumption spaces and travel mobility.

Daily activities such as dining, shopping, culture, and entertainment tended to concentrate in urban centres due to accessibility, high facility density, and information centrality, whereas peripheral areas—often separated as residential or industrial zones—received less public activity. This pattern reflects the combined influence of planning, transport infrastructure, and centralised information networks. Such space-dominated travel behaviour reinforces the centre–periphery structure and produces spatial inequality (Kühn, 2015). The centre attracts traffic and resources, while the periphery is often disadvantaged in visibility and participation. Since the 1970s, mass tourism has expanded, and tourists are less likely to visit restaurants or shops in the city outskirts. Travel agencies and guidebooks began promoting new destinations, including "hidden gems" outside traditional centres, giving selective visibility to these places. With the rise of the internet and social media, this trend has accelerated, as visitors increasingly travel to locations discovered online, reshaping activity patterns beyond central areas (De Vos & Meijers, 2019).

In the context of Web 2.0 and the rise of social media, many scholars have examined how ICT changes daily activities and spatial behaviour (Ellegård, 2019; Shen et al., 2020). Social media is seen as a tool that weakens the centralised control of traditional media and empowers ordinary users, encouraging the production of UGC (Wilken & Humphreys, 2021) and giving new visibility to non-mainstream locations. For example, users create personalised "little Lonely Planets" through blogs, graphics, and short videos, providing travellers with more personalised and immediate travel information (Wu & Pearce, 2016). This decentralised content production allows marginal neighbourhoods or lesser-known destinations—often described as "off the beaten track"—to reach wider audiences and influence subsequent tourists through early sharing behaviours (Bronsvoort & Uitermark, 2022). In addition, virtual social relationships reshape spatial choices: Research shows that the number of friends and the strength of social ties significantly influence travel behaviour (Chen et al., 2018). However, it remains unclear whether social media reshapes spatial distributions of functions and flows in ways that diverge from traditional centre–periphery dynamics. Platform recommendation algorithms, converging visual aesthetics and influencer effects also channel attention toward a limited number of visually appealing or highly shareable landmarks—often described as the "Instagrammability" of locations (Lobo, 2023; Törnberg, 2025)—creating new forms of "digital centres" within urban space. This shifts the logic of spatial centrality from the physical level to the platform level. Rather than dispersing attention, social media may reinforce the concentration of visibility on specific locations. This platform-driven "re-centring" of space may exacerbate digital marginalisation and concentrate tourism pressures (Gretzel, 2019; Siegel et al., 2023).

2.2. Platform Urbanism and Social Media Visibility

As digital platforms become more embedded in urban life, the concept of "platform urbanism" describes their role in spatial governance, resource coordination, and shaping urban experience (Ash et al., 2018; Leszczynski, 2015). Platforms function not only as channels for information flow but also as agents organising space and distributing resources (Sadowski, 2020). Operating within commercial and advertising-driven logics of data capitalism, platform algorithms tend to amplify content and places that are consumption-oriented, aesthetically appealing, or promoted by influencers and commercial accounts, rather than emerging organically from everyday users. This selective amplification turns platforms into covert marketing instruments, shaping which urban locations gain attention. Spatial data processed through APIs, algorithms, and interface design becomes tools for commercial and urban management (Barns, 2019). This exemplifies the concept of "code/space," highlighting the co-dependent relationship between digital systems and spatial experience, where coded infrastructures shape how urban space is used and understood (Zook &

Graham, 2007). Similarly, "platform affordances" determine which places become visible, how users interact with them, and how attention is redistributed online, showing how algorithmic and interface design mediate social and spatial hierarchies (S. Zhang & Zhang, 2025).

Within platform urbanism, "visibility" is a key mechanism reshaping digital space. It no longer refers merely to whether a place exists on a map, but to the extent and way it is seen, shared, and circulated on social media (Neumayer & Rossi, 2018). Digital visibility results from algorithmic design, user behaviour, and media strategies. The concept links to Foucault's "politics of visibility" (Gordon, 2002), while "mediated visibility" (Thompson, 2005) highlights how media allows individuals and events to appear beyond time and space limits, while exposing them to judgement. A recent approach frames visibility as a process shaped by communication intention, platform mechanisms, data accessibility, and meaning-making (Neumayer et al., 2021). Visibility is not merely likes or follower counts. Practically, social media visibility operates through three mechanisms: algorithmic visibility, shaped by platform algorithms and user interaction; strategic visibility, driven by creators' optimisation and engagement tactics; and networked visibility, influenced by users' positions in the social network (Neumayer & Rossi, 2018). Together, these produce unequal patterns of visibility and power, reshaping how urban space is perceived and experienced (Zeng & Kaye, 2022).

Quantitative research provides tools to operationalise these concepts. Early Twitter studies showed that surface indicators like follower counts do not fully capture influence, while mentions, retweets, and reach better reflect visibility (Cha et al., 2010). Despite challenges such as bots or inactive users (Davis et al., 2016), these metrics allow measurement of how platform mechanisms and social interactions amplify certain content (Harada et al., 2017; Suh et al., 2010). Building on this, "dynamic visibility" (Sun et al., 2024) considers post-ranking and duration, offering insight into how visibility shifts under algorithmic control. In this study, such metrics enable quantifying which urban hotspots on TikTok gain attention, how algorithmic and social factors interact to produce spatially uneven visibility, and the extent to which these patterns echo Amsterdam's spatial hierarchies.

2.3. Uneven Digital Visibility on Social Media

Although social media is widely recognised for breaking the information control of traditional media, the "digital visibility" it brings is uneven across urban space. Geographically peripheral places that are frequently referenced on social media have seen marked increases in visibility and spatial reconfiguration (Speake et al., 2023). However, such processes are often accompanied by social media-induced tourism, commercial gentrification, and encroachment on residents' living spaces (Chang & Spierings, 2023). While social media reshapes ideas of which places are worth seeing, it may also reinforce existing spatial hierarchies and generate new hotspots and cold spots. This dynamic can be seen as a digital version of the centre–periphery model, where platforms and user behaviour define new "digital centres" and render untagged areas as "digital peripheries." Instead of a single dominant core, a "polycentric social media city" emerges, structured around multiple attention hubs.

Uneven digital visibility refers to the unequal attention different urban areas receive on platforms such as Instagram, where some places attract far more posts and engagement than others (Indaco & Manovich, 2016; Neumayer et al., 2021; Sanderson et al., 2024). It is reflected not only in platform recommendations and user engagement but also in how certain areas gain attention, commercial investment, and tourism

through frequent tagging, while others remain in a "digital periphery" with little visibility (Boy & Uitermark, 2020; Speake et al., 2023). Increased exposure of certain areas has been linked to gentrification and shrinking everyday residential space (Chang & Spierings, 2023). These transformations often follow patterns of selective representation, where particular images and narratives are repeatedly highlighted, reinforcing urban divisions in subtle, fragmented ways—producing reduced difference but increased variation (Boy & Uitermark, 2020). Critiques from relational spatial theory and critical GIS argue that analyses should consider the relational and processual nature of spatial production and the power relations embedded in spatial data, rather than treating geotagged social media as neutral, static representations (Burns, 2021; Kitchin, 2014; S. Zhang & Zhang, 2025). Social media data should thus be treated as evidence of spatial production in process (Shelton et al., 2015).

Despite growing interest in the spatial effects of social media, uneven digital visibility remains underexplored. Many studies map geotagged post distributions and identify high- or low-density areas (Lansley & Longley, 2016; Levin et al., 2015), but this provides limited insight into how digital attention interacts with urban spatial structure. The mechanisms producing uneven patterns—including platform algorithms, user engagement, and social practices—remain underexamined. Mapping hotspots highlights spatial concentrations, but does not explain how digital prominence relates to existing urban hierarchies. In this article, we treat uneven spatial patterns of digital visibility as an empirical phenomenon, focusing on how hotspots gain visibility through platform interactions and algorithmic processes, and how these patterns may reinforce, challenge, or diverge from existing spatial hierarchies.

3. Case, Data, and Methods

3.1. Case Selection and Background

This study uses Amsterdam, the capital of the Netherlands, as a case study of a typical tourist city to examine how its hotspots are represented on TikTok and whether this deviates from the city's spatial structure. Amsterdam consists of eight districts, including the central Centrum, surrounded by West, Zuid, Oost, and Noord. To provide context for analysing social media visibility, a functional mix map (Figure 1a) shows land-use distribution across residential, commercial, cultural, and leisure activities. Functional diversity is highest in Centrum, where commercial, cultural, and residential activities are most interwoven. Within Centrum, the Jordaan neighbourhood is notable for its high residential share compared to surrounding areas dominated by tourism and commerce. In contrast, the adjacent districts—West, Zuid, Oost, and Noord—are predominantly residential with lower concentrations of tourism and mixed-use functions. Property value maps (Figure 1b) indicate a spatial gradient: Centrum, West, Zuid, Oost, and Noord all have relatively high housing prices, with Zuid the most expensive, while Oost and Noord are comparatively lower.

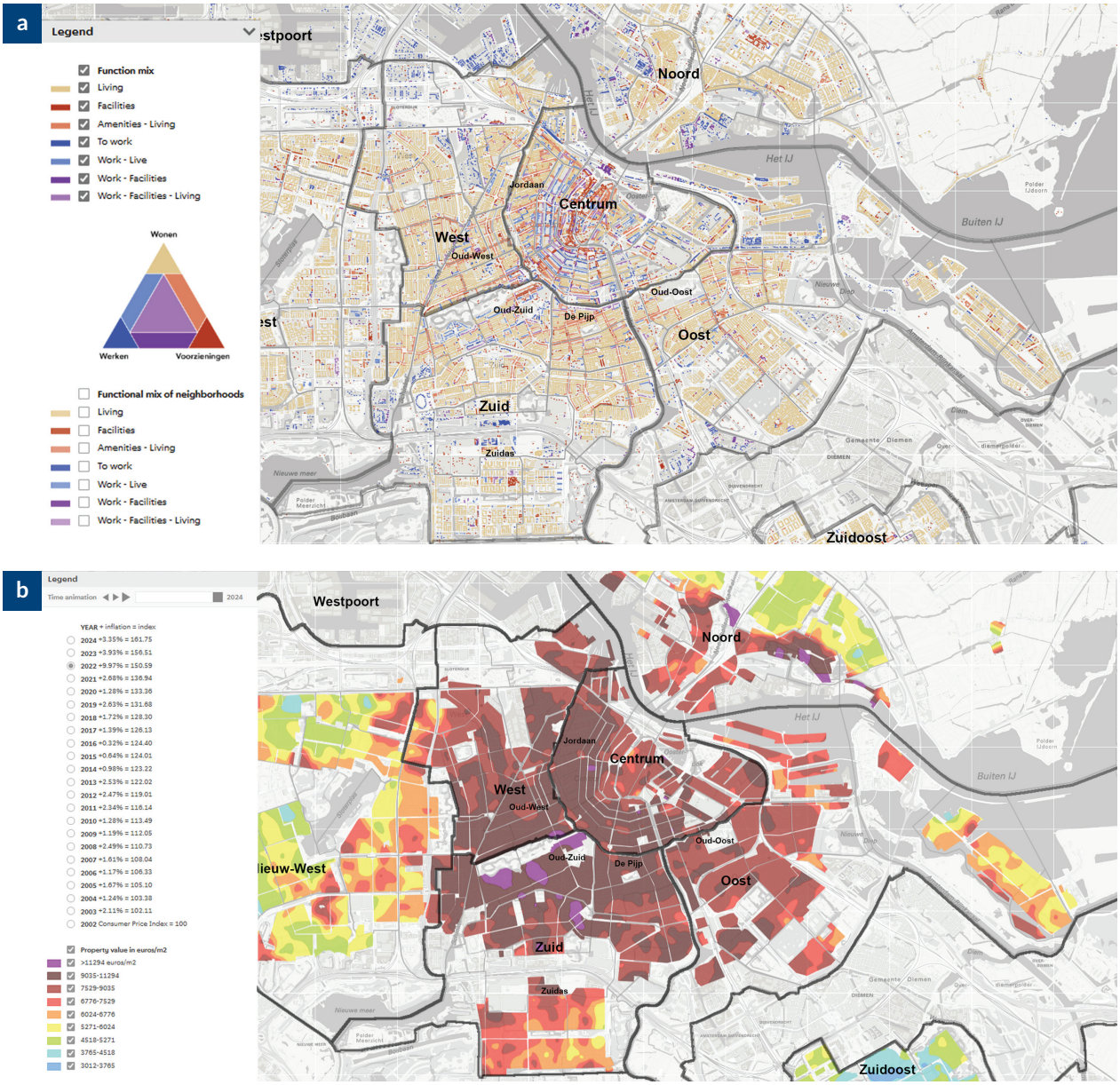

Figure 1. Functional mix map of Amsterdam (a) and property value map of Amsterdam (b). Source: Functional mix map (https://maps.amsterdam.nl/functiemix) and property value map (https://maps.amsterdam.nl/woningwaarde)

3.2. Data Collection

This study selects TikTok as the case platform due to its highly algorithm-driven content dissemination and strong emphasis on short-form, visually oriented videos, which makes it particularly suitable for examining patterns of digital place visibility. The data analysed in this study consist of publicly available TikTok posts associated with #amsterdam and hotspot-related keywords. TikTok content is distributed through recommendation algorithms, meaning that the visibility of places is shaped by engagement metrics and platform logics.

3.3. Analytical Methods

Based on the Amsterdam case city and TikTok case social media platform, the data and methods process of this article is shown in Figure 2.

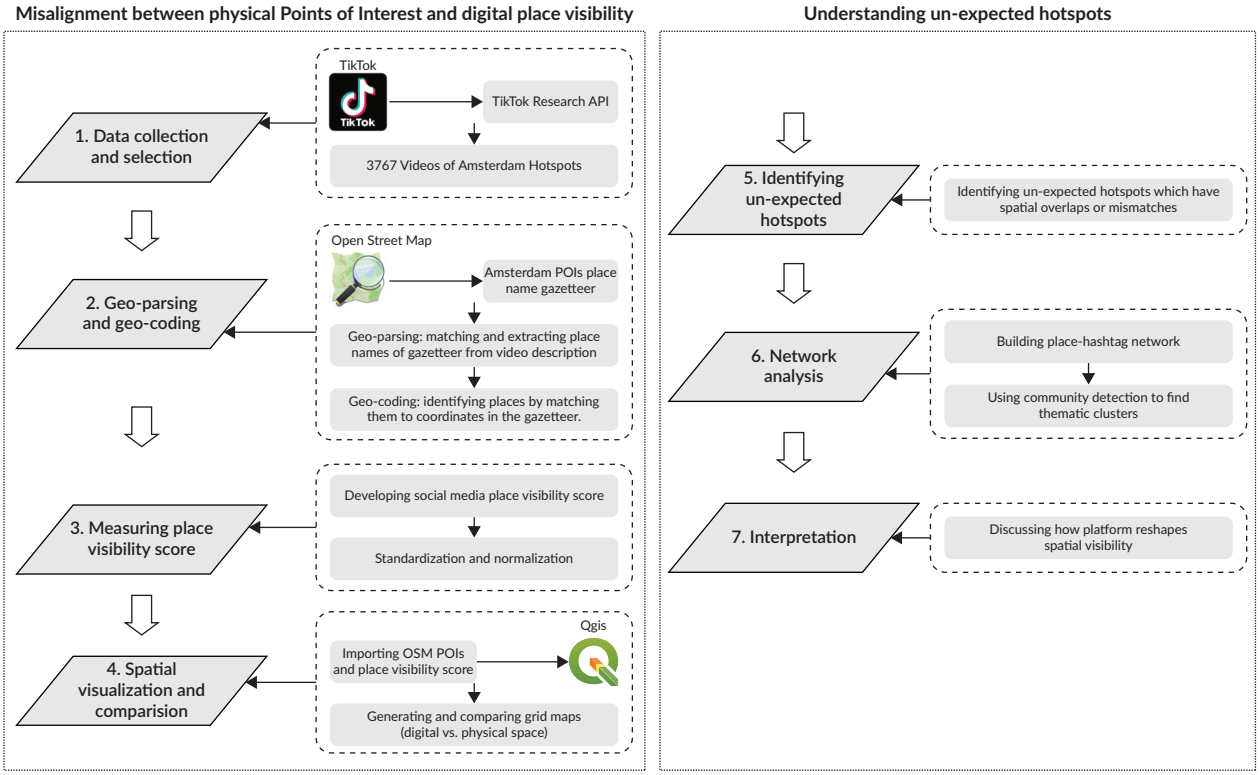

Figure 2. The research methods framework.

This study first collected TikTok video post data using the TikTok research API. The data collection period was determined by historical data availability (starting in 2020) and the API access duration (ending in 2023). To capture content related to urban hotspots, filtering keywords—such as hotspot, mustsee, travel, tour, todo, visit, trip, recommendation—were applied, yielding 3,767 posts associated with popular locations in Amsterdam. Each post includes metadata such as descriptions, hashtags, views, likes, comments, shares, and publication time, forming the basis for visibility analysis.

As TikTok does not provide explicit geographic coordinates, a geo-parsing method was used to extract location references. This involved three steps. First, a local gazetteer was built using OpenStreetMap (OSM) POI data for Amsterdam, including place names, category attributes, and coordinates (Psyllidis et al., 2022). Standard geocoding services, like Nominatim, are optimised for larger-scale features and do not reliably capture smaller venues such as shops or cafés. The local gazetteer provides a fine-grained reference for mapping TikTok hotspots at the venue level. It was cleaned by standardising names and merging near-duplicates. Second, the gazetteer was matched with post descriptions to identify place names. Manual verification improved accuracy, given informal expressions and spelling variations. Finally, identified names were matched with coordinates for geo-coding and mapping.

Based on this geographic information, a visibility scoring system was designed to measure how visible a place is on TikTok. The system considers user interactions—views, likes, comments, shares—and whether viral hashtags were used. Hashtags such as #foryoupage increase the likelihood of content being recommended by TikTok's algorithm, amplifying visibility. Drawing on the principle of user effort, actions requiring more input are weighted higher: Views indicate basic recognition, likes and comments indicate moderate engagement, and shares reflect active endorsement. Hashtag usage is associated with higher visibility, as the TikTok algorithm tends to promote content that is more likely to go viral (Darvin, 2022; Eriksson Krutrök, 2021). Based on this framework, the post visibility score (PVS) and the place visibility score (PLVS) were developed (Table 1). The visibility of each place is calculated by summing the PVS of all posts associated with it.

Table 1. Indicators for calculating social media's PVS and PLVS.

Level	Indicator	Description	Weight	Computation/data source
Post visibility level	View count	Measures how many times a post is viewed; reflects basic exposure.	1	TikTok metadata; $\log(x + 1)$ transformation, min–max scaling
	Like count	Indicates users' positive reactions; reflects mid-level engagement.	2	Same as above
	Comment count	Reflects deeper cognitive engagement and discussion intensity.	5	Same as above
	Share count	Shows users' willingness to redistribute content; represents the strongest interaction.	10	Same as above
	Presence of viral hashtags (e.g., #foryoupage)	Captures whether a post adopts algorithmically promoted hashtags that enhance visibility.	6	Binary variable (1 = *used*, 0 = *not used*)
PVS	= (view count × view weight) + (like count × like weight) + (comment count × comment weight) + (share count × share weight) + (presence of viral hashtags × hashtag weight)			
Place visibility level	Aggregated PVS	Represents the total digital visibility of a specific location, calculated by summing all PVS mentioning that place.	—	PLVS = Σ (PVS of all posts referring to the same place)
PLVS	= SUM (PVS of all related posts mentioned that place)			

Note: Interaction counts (views, likes, comments, and shares) were log-transformed and normalised.

The weights were determined based on the depth of user engagement and the effort investment principle: Actions requiring greater effort (e.g., sharing) contribute more to visibility than low-effort actions (e.g., viewing) (Cha et al., 2010). As shown in Table 1, view weight is 1, like 2, comment 5, hashtag 6, and share 10. Alternative weighting sets were tested, yielding consistent spatial patterns, indicating robustness to parameter choices. A sensitivity analysis aggregated TikTok visibility on 250- and 500-meter grids and used raw post counts instead of weighted PLVS scores. Spatial patterns and regression results remained consistent, confirming the PLVS robustness (see details in the Supplementary File). Interaction variables were log-transformed ($\log(x+1)$)

and rescaled to [0,1] using min–max scaling. The theoretical PLVS range is 0–25, while empirical values ranged from 0 to approximately 1300 across grid cells, reflecting cumulative visibility from multiple posts.

Visibility scores were aggregated onto a 500-meter grid for standardisation and compared with OSM POI to examine alignment with functional spatial structure. Global Moran's I was calculated to quantify spatial clustering, with positive values indicating clustering of high- or low-visibility areas and highlighting non-random spatial patterns. The relationship between TikTok visibility and urban characteristics was examined using OLS regression, with aggregated PLVS as the dependent variable and POI density and distance to the city centre as independent variables, assessing how digital visibility echoes functional structure and centrality.

"Unexpected hotspots"—areas with low OSM prominence or distant from the centre but high TikTok visibility—were identified. OSM prominence was measured by POI counts per 500-meter cell, and TikTok visibility by PLVS. Cells with high PLVS but low POI were classified as unexpected hotspots. To explore content co-occurrence, a bipartite network linked places and hashtags. Community detection using the Louvain algorithm (Blondel et al., 2008) uncovered latent "thematic communities"—groups of hashtags consistently co-occurring in specific spatial contexts, indicating which hashtags are associated with particular areas.

Finally, visibility scores were interpreted alongside the bipartite network, providing insights into how platform-mediated visibility reflects TikTok user preferences and how digital attention differs from the physical spatial structure.

4. Results

4.1. Misalignment Between Physical POI and Digital Place Visibility

Analysis of TikTok place visibility across the 500 m grid reveals distinct spatial patterns in Amsterdam (Figure 3a). Areas such as Zuid, with relatively low POI counts, exhibit high digital visibility, while some central locations with dense POI show moderate or low TikTok visibility. These observations indicate that platform-mediated attention does not strictly follow the city's functional structure, and digital visibility can concentrate in areas that are not traditionally central or commercially dense. The bipartite network of hashtags and locations shows that clusters such as food and drinks are associated with these digitally prominent areas, reflecting thematic patterns of social media activity.

Using a 500-meter grid covering Amsterdam (Figure 3b), both OSM POI and TikTok PLVS were aggregated onto the same grids for systematic spatial comparison. POI distribution is heavily concentrated in the city centre (Centrum), consistent with centralised urban functions (Figure 3a). In contrast, TikTok visibility scores reveal a more polycentric digital pattern. Global Moran's I is 0.494 ($p < 0.001$), indicating significant positive spatial autocorrelation—high-visibility locations cluster rather than being randomly distributed. While the city centre remains highly visible, surrounding areas such as De Pijp and Zuidas show unexpectedly high visibility relative to their POI density. The Jordaan neighbourhood, at the edge of the historic centre, also emerges as a strong digital hotspot (Figure 3b).

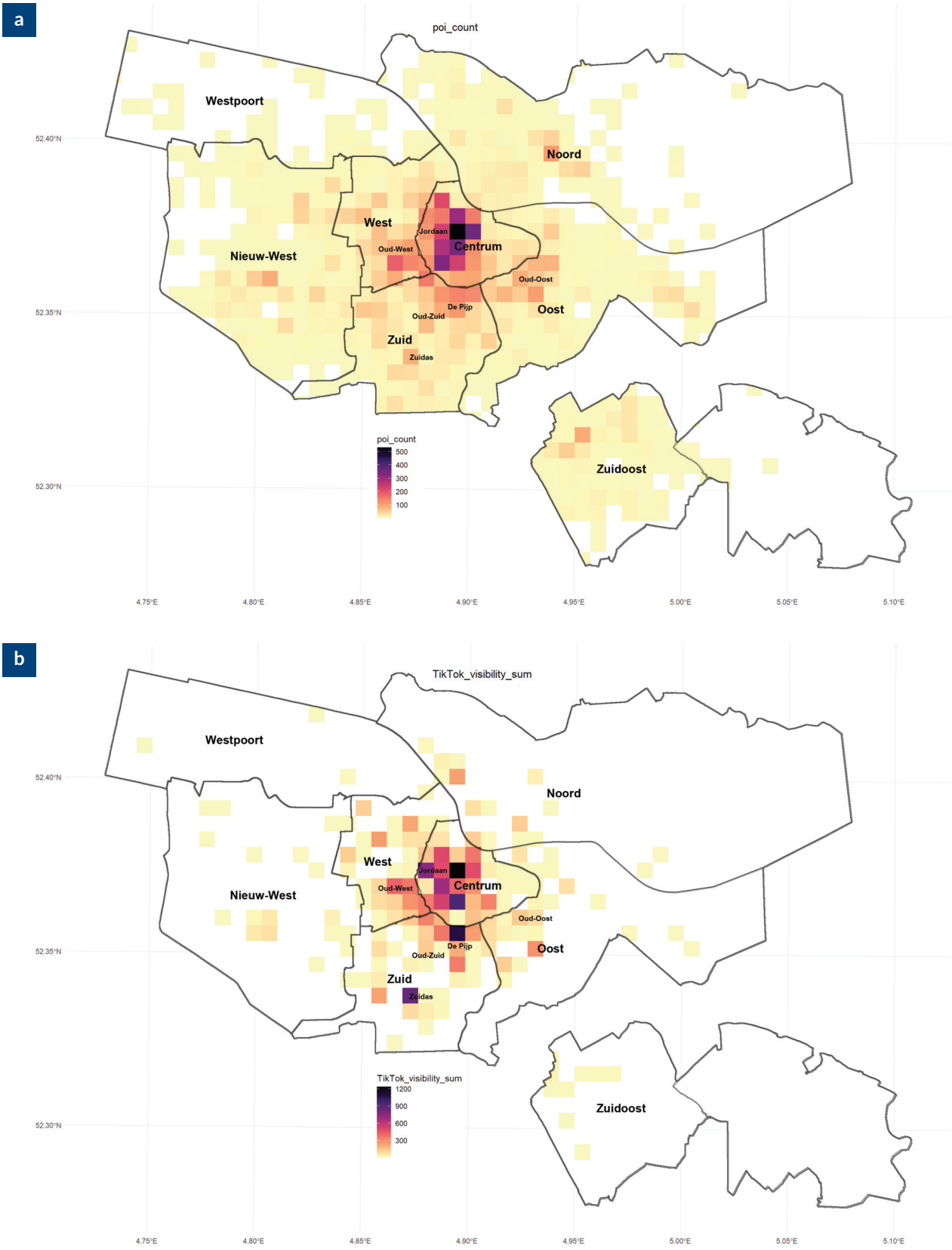

Figure 3. 500-meter spatial grid aggregation of POI from OSM (a) and 500-meter spatial grid aggregation of TikTok PLVS (b).

Among the hotspots, De Pijp and Zuid are primarily residential or lifestyle-oriented neighbourhoods rather than traditional tourist or commercial centres. Their prominence on TikTok suggests that digital visibility is not solely determined by spatial hierarchies but also by how users experience and represent urban life. These areas deviate from the physical urban centralities, showing how everyday residential environments gain symbolic visibility through social media, where visibility is shaped by aesthetic and experiential values rather than functional hierarchies. Unlike other platforms, TikTok is primarily populated by residents rather than visitors, making living areas more visible than traditional tourist centres.

Furthermore, we applied scatter plot visualisation and OLS regression to examine how digital visibility aligns with urban functional structure and distance from the city centre, allowing a robust assessment of spatial distribution and the influence of POI.

Figure 4 presents the OLS results. Figure 4a shows a strong positive association between visibility and POI density, indicating that areas with more amenities generally attract more attention. However, several grid cells exhibit high visibility despite low POI density, suggesting that POI alone does not fully explain observed patterns. Figure 4b shows visibility declines with distance from the city centre, but the presence of high-visibility cells outside the core suggests decentralisation occurs through localised peripheral

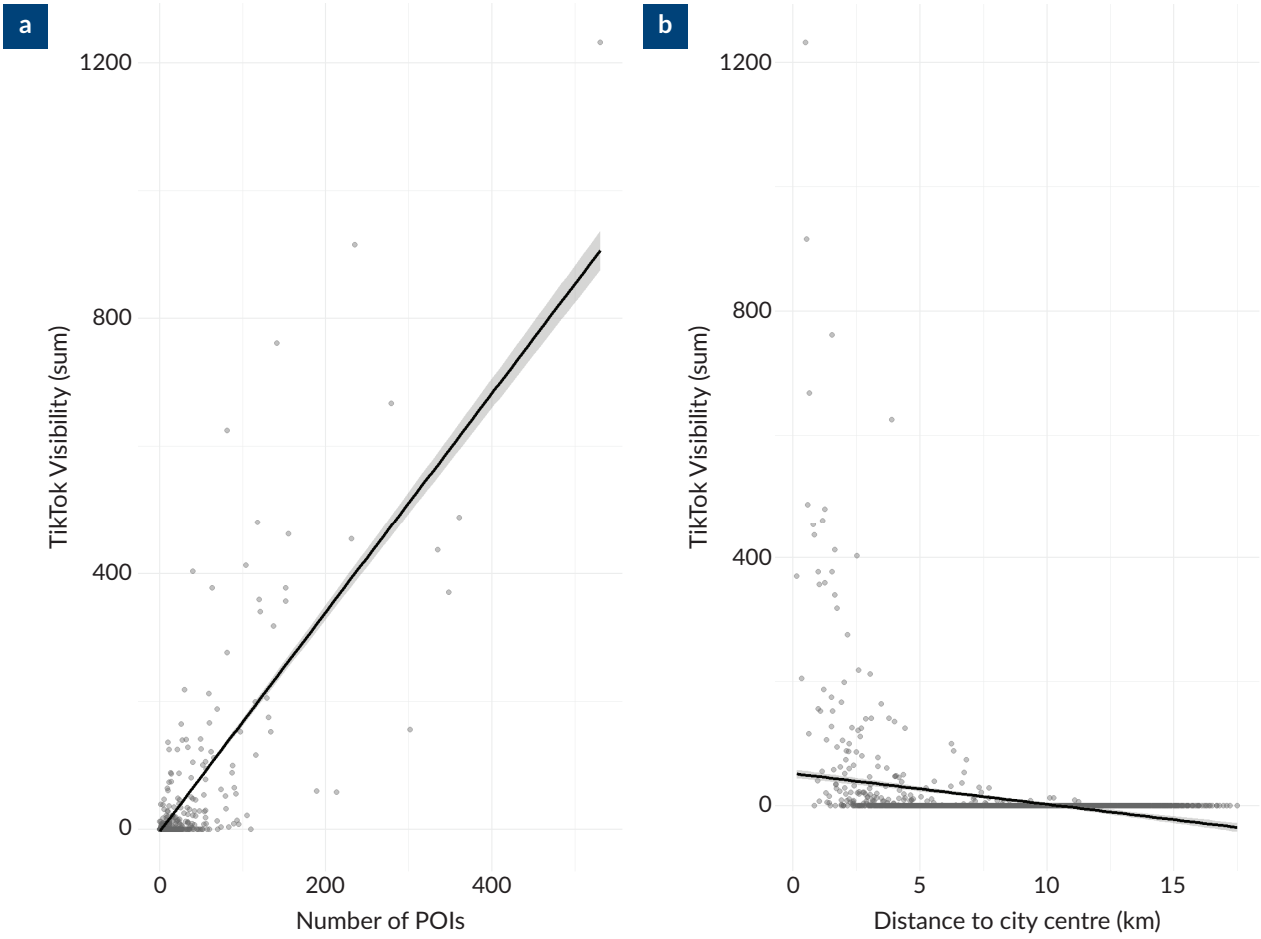

Figure 4. Spatial and statistical patterns of TikTok place visibility across the city: Relationship between TikTok place visibility and POI density (a) and relationship between TikTok place visibility and distance to the city centre (b).

concentrations rather than uniform outward diffusion. Table 2 shows that POI density is the strongest predictor ($\beta = 1.748$, $p < 0.01$), while distance to the centre has a small but significant positive effect ($\beta = 0.001$, $p < 0.01$), indicating some peripheral locations achieve higher visibility than central locations with similar POI density. The combined model explains approximately 65% of the variance (Adjusted $R^2 = 0.645$), showing that while functional density drives most TikTok activity, attention is redistributed to select non-central areas, creating unexpected hotspots beyond traditional cores.

Table 2. OLS Regression of TikTok visibility.

OLS Regression of TikTok Visibility		
Predictors	**Estimate (Std. Error)**	***p*-value**
Distance to Centrum	0.001*** (0.0003)	0.0004 ***
POI Count	1.748*** (0.033)	0.009 ***
Intercept (Constant)	−8.973*** (2.510)	< 0.001 ***
Model Statistics		
Observations	1,820	
R^2	0.645	
Adjusted R^2	0.645	
Residual Std. Error	36.237 ($df = 1817$)	
F-statistic	1650.327*** ($df = 2$; 1817)	

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Overall, these findings highlight the interplay between physical urban structures—represented by OSM POIs—and digital social media, where place visibility is shaped by user behaviour and platform algorithms. TikTok visibility is strongly associated with functional urban density, while distance to the city centre exerts a small but significant influence, indicating that selected peripheral areas can achieve unexpectedly high visibility. While central areas dominate in absolute terms, attention is conditionally redistributed, with some non-central neighbourhoods emerging as new digital hotspots.

4.2. Understanding Unexpected Hotspots

To explore digital visibility patterns, we examined three neighbourhoods with relatively high TikTok visibility, including Zuid, De Pijp, and Jordaan. Zuid stands out as the most prominent hotspot, while the others also exhibit elevated visibility compared to surrounding areas. The analysis focused on the types of locations and hashtags associated with posts, providing insights into spatial attention distribution. Most content in these neighbourhoods is produced by younger users, the majority of TikTok's Amsterdam user base. Based on a preliminary, internal assessment of user profiles of the Jordaan neighbourhood (authors' unpublished data), approximately 68.3% of these users appear to be residents, indicating that digital hotspots primarily reflect younger local activity and interests. The analysis does not assess whether non-local users discover these places, and no causal claims about visitation are made.

De Pijp, outside the historic core, appears prominently on the TikTok visibility map. This visibility is not solely produced by social media; De Pijp has long had dense urban amenities, including Albert Cuyp Market, lively streets, and historic sites, attracting residents and visitors. In the hashtag–place bipartite network (Figure 5), posts are frequently linked to hashtags related to food, street markets, cafés, and everyday leisure, showing

that the neighbourhood's existing visual richness and social vibrancy are strongly represented. These findings suggest digital visibility is associated with, rather than generative of, urban qualities such as visual appearance, social interaction, and everyday consumption. De Pijp illustrates how neighbourhoods with established cultural and symbolic capital are more readily amplified on platforms, without implying causal effects or social media-driven temporal shifts.

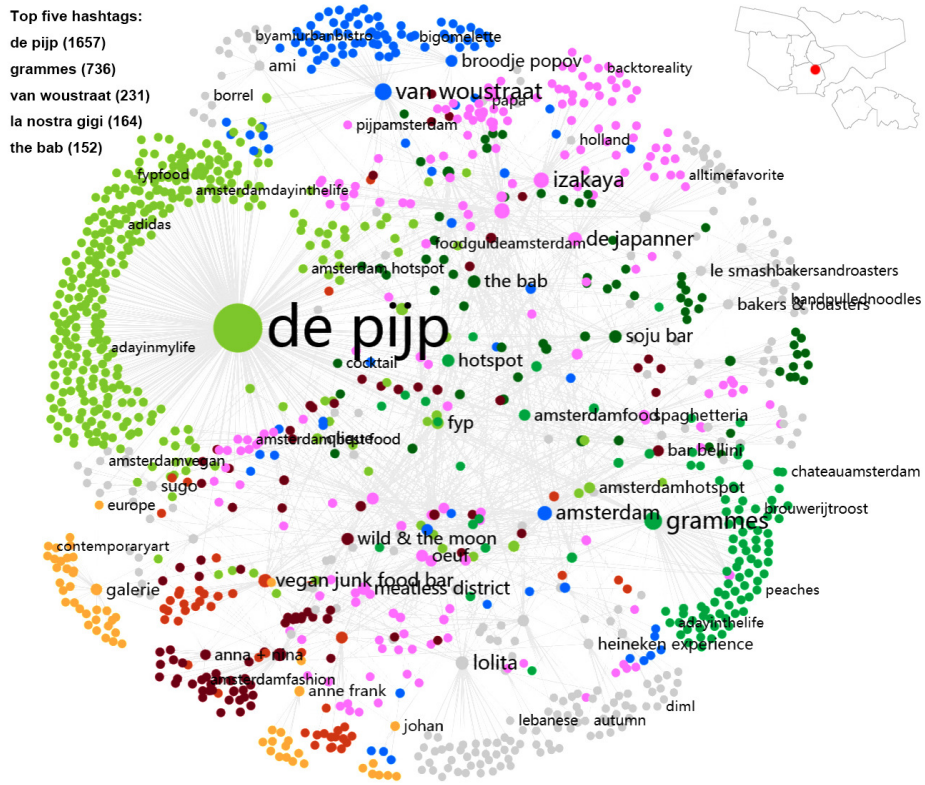

Figure 5. The hashtag–place bipartite network with community detection of De Pijp.

Zuid is located in the peripheral area of Amsterdam. Its network connections emphasize spatial landmarks like Amstelpark, Zuidas, and Oud-Zuid (Figure 6). Zuid has a more diverse mix of landscapes centred on "urban green space–high-end office–historic housing." The visibility of Zuid relies more on the aesthetic value of the space itself than on the interaction between people and objects. For example, the greenery and symmetrical horticultures of the Amstelpark are often used as places for walks, tranquillity, and nature-related videos.

Jordaan, at the edge of Amsterdam's Centrum, stands out in the bipartite network for its thematic richness, with hashtags linked to vintage, museums, tourism, and aesthetics (Figure 7). Its visibility is driven not by a single identity but by a convergence of cultural, visual, and tourist-oriented narratives. Content often features antique shops, art galleries, street performances, and canal walks, frequently filtered through a nostalgic or stylized lens, creating a hybrid storytelling that resonates with local charm and global appeal, connecting with Jordaan's strong TikTok visibility. Its visibility emerges from the interaction between pre-existing cultural appeal and platform-mediated representation, with TikTok amplifying rather than generating popularity. Jordaan thus serves as a digitally mediated symbolic hub where multiple urban imaginaries intersect, showing how social media visibility is shaped by feedback loops between spatial attractiveness, user activity, and platform affordances rather than by social media alone.

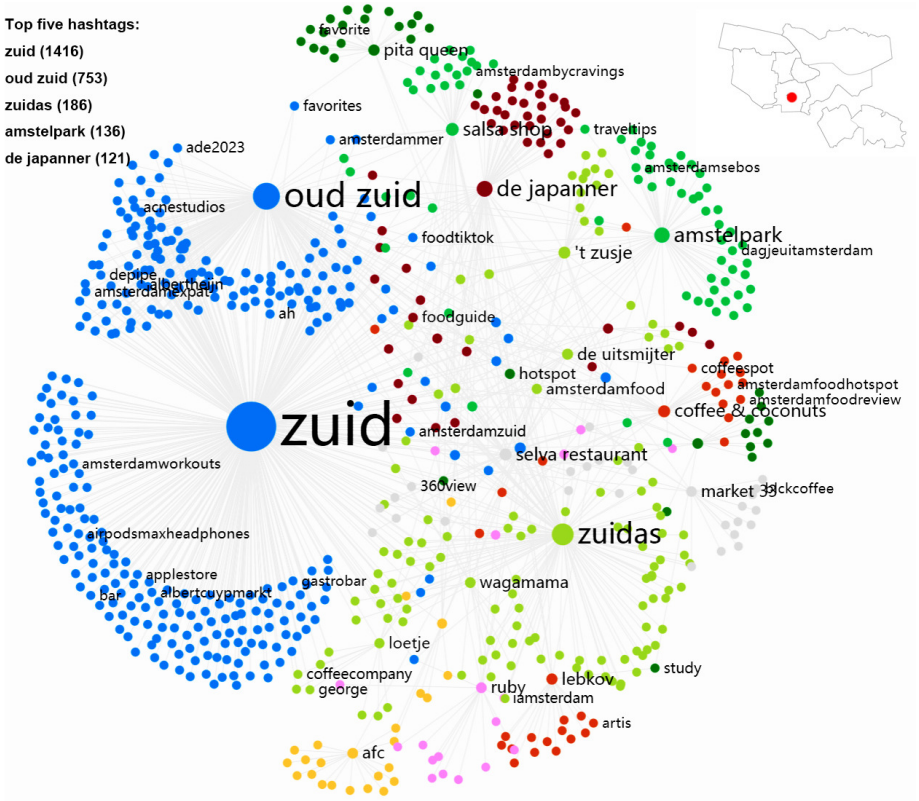

Figure 6. The hashtag–place bipartite network with community detection of Zuid.

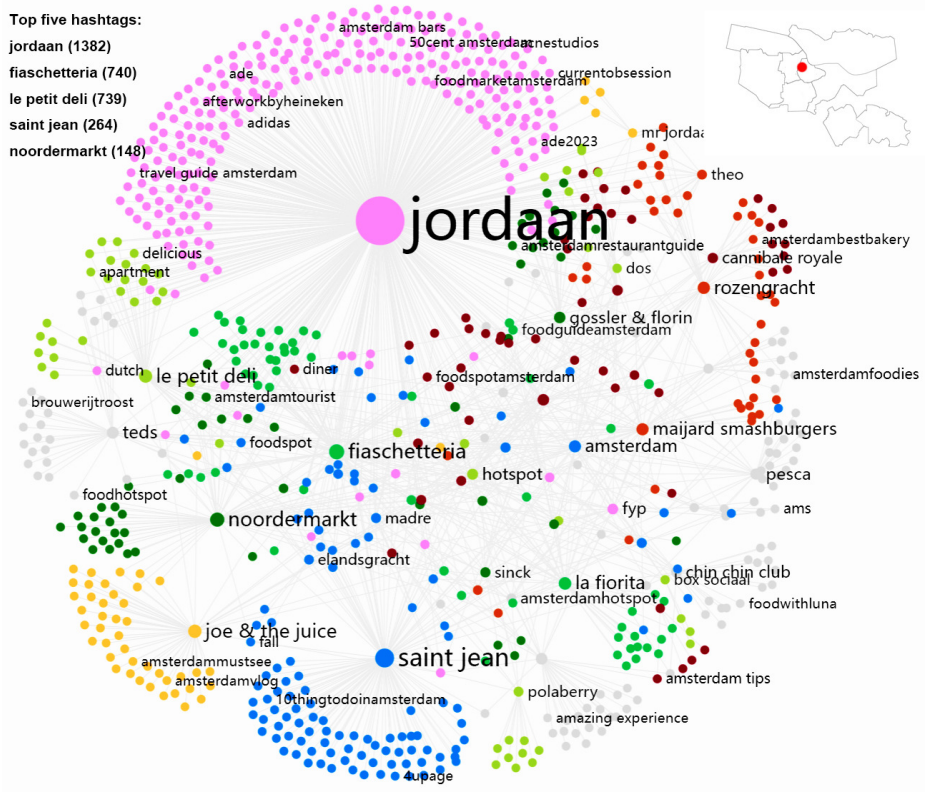

Figure 7. The hashtag–place bipartite network with community detection of Jordaan.

Analysis of De Pijp, Jordaan, and districts like Zuid shows that several areas outside or at the edge of Amsterdam's historic centre achieve high TikTok visibility. Compared with their functional prominence (POI density) and centre–periphery position, De Pijp and Zuid display disproportionately high digital visibility, highlighting a divergence between physical urban structure and digital engagement. Jordaan is more ambiguous: Although its functional intensity is lower than that of some central zones, it remains well-known and frequently visited. Its high digital visibility reflects both established cultural prominence and continued resonance in platform-mediated representations, rather than an entirely unexpected outcome.

5. Discussion

5.1. Digital Place Visibility Both Mirrors and Reshapes Urban Structures

The spatial distribution of digital hotspots on TikTok both reflects and partially loosens the urban structure. Urban studies have long shown that spatial inequality in cities is tied to uneven distribution of infrastructure, services, and economic resources (Friedmann, 1970; Harvey, 1992). Social media research similarly shows that digital representations of places cluster in central and prominent areas (Lansley & Longley, 2016). Our findings are consistent with this literature: Areas with higher functional density attract greater digital attention. However, they extend prior work by showing that digital visibility is not a simple mirror of physical centrality. Some locations with modest functional roles achieve high TikTok visibility, supporting arguments that visibility has become a distinct dimension of urban prominence, shaped by platform-mediated attention rather than infrastructure alone (Barns, 2019; Zook & Graham, 2007).

This study also links visibility patterns to spatial structure using a grid-based approach and statistical analysis. While prior social media research focused on Twitter or Instagram, TikTok—despite rapid growth and unique algorithms—has received limited spatial urban research. Our analysis shows platform-driven attention is conditionally redistributed: POI density predicts visibility, yet distance to the city centre has an independent effect, allowing some non-central areas to emerge as digital hotspots. This supports calls to move beyond surface-level mapping toward analyses of platform mechanisms producing uneven visibility (Shelton et al., 2015; Sun et al., 2024).

Digital visibility redistributes symbolic and cultural capital across urban space, echoing but complicating discussions of symbolic power and mediated visibility (Neumayer et al., 2021; Thompson, 2005). On social media, attention and visibility of symbolic content matter more than infrastructure or centrality. Locations lacking physical centrality may become highly visible digital landmarks if they receive frequent engagement. This shows how algorithmic and user-driven processes intersect with, rather than dissolve, established urban structures.

5.2. Platform Mechanisms Drive Uneven Visibility and Attention Across Urban Hotspots

The emergence of digitally prominent neighbourhoods outside the traditional urban core aligns with research on algorithmic visibility and platform affordances. Social media platforms privilege content that is visually appealing, shareable, and aligned with dominant aesthetic norms, producing uneven exposure patterns (Boy & Uitermark, 2020; Chang & Spierings, 2023; S. Zhang & Zhang, 2025). Our findings show areas such as Zuid achieve high visibility through lifestyle-oriented, visually rich content rather than formal centrality or institutional importance.

This redistribution does not create a fully decentralised or egalitarian attention landscape. Platforms generate a new exclusivity: Only places effectively represented within platform logics—through visual aesthetics, everyday practices, and algorithmically amplified engagement—gain sustained visibility. Analysis of hashtags and hotspots shows that highly visible neighbourhoods often feature attractive environments and strong lifestyle associations, suiting TikTok's short-video format. Content on food, fashion, art, and daily experiences is frequently shared. High interaction—likes, comments, shares—and engagement from influential users further boost visibility. This echoes critiques from critical GIS and digital urban studies: Platform-mediated representations privilege certain urban forms while rendering others less visible (Boy & Uitermark, 2020; Degen & Rose, 2021). Digital platforms thus do not merely diversify urban representation but actively reshape spatial hierarchies through selective amplification.

5.3. Implications

These "unexpected hotspots" pose challenges for urban governance and city branding. Local authorities can no longer easily predict which places will gain digital attention, as viral trends often emerge outside formal planning logic. Residential areas, industrial sites, or small cafés can suddenly become tourist destinations from a single viral post, altering space use, daily rhythms, local identity, and sometimes public order. Platform-driven spatial consumption blurs public and private boundaries, everyday life and tourism, challenging social control and perceived liveability (Van Dorst, 2012). City branding is similarly affected: Urban images are no longer shaped solely by official narratives but constantly reshaped by UGC, raising questions for policy on responding to fluid algorithmic space.

The visibility of neighbourhoods on social media links to broader processes of transformation and gentrification. Platforms like Instagram amplify aestheticized urban imagery, enhancing symbolic attractiveness and accelerating cultural and commercial upgrading (Bronsvoort & Uitermark, 2022). Studies of "Instagrammable" spaces show visually appealing cafés, streets, and neighbourhood scenes that become markers of emerging consumption landscapes (Boy & Uitermark, 2017; Chang & Spierings, 2023). Mediated urban images circulating on platforms can reshape reputations and attract visitors, investment, and cultural attention (Speake et al., 2023; Törnberg & Uitermark, 2022). Increased digital visibility can bring symbolic capital and economic opportunities, but also reinforce selective representation, cultural stereotyping, and uneven transformation. Excessive visibility may intensify surveillance and digitization of everyday spaces. Visibility thus represents a paradoxical form of spatial power, fostering identity while generating new inequalities in urban life.

5.4. Limitations and Future Research

This study advances understanding of how digital platforms reshape urban hotspot patterns through analysis of place visibility, but several limitations apply. TikTok's trending data primarily reflect young, socially active users, so observed patterns may not represent the broader urban population, especially older or less digitally engaged groups. Consequently, TikTok-derived hotspots tend to correspond to areas offering lifestyle experiences, leisure activities, and visually appealing environments, aligning with this user group's preferences. While TikTok provides insights into visibility, attention, and representation, it does not directly measure material practices such as consumption, mobility, or service use—a limitation common to social media–based urban research (Hargittai, 2020; Sanderson et al., 2024). Platform data are shaped by

algorithmic filtering, content moderation, and commercial logics, which privilege certain places and user groups while marginalising others, limiting direct applicability for urban governance without careful contextualisation (Olteanu et al., 2019).

This study focuses on a single platform and city. Although Amsterdam is suitable for exploring digitally mediated visibility, platform effects, and mechanisms likely vary across urban contexts due to demographic, cultural, tourism, and digital infrastructure differences. Comparative studies across platforms and cities, integrating complementary sources such as Instagram, Google Maps reviews, mobility data, or surveys, could triangulate findings and improve robustness.

Future research should further examine how platform-mediated visibility interacts with urban redevelopment, gentrification, and platform governance. Future research could differentiate between POI categories to examine how specific types of urban functions relate to digital visibility. More work is needed on how algorithmic bias and commercial incentives shape which places become visible, for whom, and with what consequences, and to critically assess the role of social media data in informing urban policy and planning.

6. Conclusion

This study investigates how social media platforms redistribute visibility within existing urban hierarchies, focusing on TikTok in Amsterdam. Unlike most previous research that has primarily examined Instagram or Twitter (Boy & Uitermark, 2020; Lansley & Longley, 2016), this article provides an empirical analysis of TikTok, which has not yet been extensively studied in the context of urban digital visibility.

The article makes three main scientific contributions. First, it is based on previous research on social media visibility (Sun et al., 2024) and develops a quantitative indicator of TikTok PLVS, capturing the relative attention that urban places receive on TikTok through user interactions such as views, likes, comments, shares, and hashtag use. This indicator provides a systematic and replicable measure for studying digitally mediated urban prominence. Second, by linking TikTok place visibility to POI density and distance from the city centre, the analysis demonstrates that digital attention is partially aligned with, yet also diverges from, existing urban hierarchies. While areas with high POI concentration tend to attract more attention, those located on the edge of the city centre—such as De Pijp and Zuid—achieve unexpectedly high visibility relative to their functional status. Centrally located neighbourhoods like Jordaan remain highly visible, but the emergence of peripheral hotspots highlights a conditional redistribution of attention, shaped by platform algorithms and user behaviour. Third, this study illustrates the mechanisms by which social media platforms contribute to uneven spatial visibility, showing that digital prominence is not only determined by the physical or functional characteristics of urban space but also by the algorithmic amplification and interaction patterns of platform users.

These findings contribute to the literature by confirming that digital visibility partly mirrors traditional urban structures while also creating new layers of attention that may diverge from physical hierarchies, supporting recent calls to move beyond surface-level mapping toward analysing the mechanisms that produce uneven digital attention (Shelton et al., 2015). Overall, this study demonstrates how digital platforms have become new actors in the representation of urban space, emphasising that in the age of social media, understanding urban spaces must go beyond the physical to a deeper focus on algorithmic power and the politics of visibility.

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Conflict of Interests

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Data Availability

The data that has been used is confidential.

Supplementary Material

Supplementary material for this article is available online in the format provided by the author (unedited).

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The Response by Co-Working Spaces to Digital Transformation in Singapore

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Abstract

This article examines how the digitalisation process has reshaped the evolution of co-working (CW) spaces in Singapore and has contributed to the emergence of hybrid work ecosystems. Drawing on qualitative data from semi-structured interviews with managers of CW spaces in Singapore, the findings suggest that digitalisation did not create entirely new client segments but instead reinforced the existing ICT-dominated customer base by stabilising hybrid and remote working practices. At the same time, digitalisation made possible the institutionalisation of virtual CW practices, supported by platforms which serve to integrate video conferencing, collaborative software, and digital community tools. These virtual extensions enhance flexibility, inclusivity, and cross-border collaboration whilst remaining complementary to physical CW spaces. Within the Singapore context—one which is characterised by strong digital infrastructure and its role as a regional headquarters and innovation hub—CW spaces are evolving towards structurally-embedded hybrid models. This study contributes to the available literature by conceptualising CW spaces as digitally-enabled socio-spatial infrastructures which operate within hybrid work ecosystems rather than as purely physical shared offices.

Keywords

co-working space; digitalisation; hybrid work ecosystem; Singapore

1. Introduction

Over the past two decades, the rapid advance of digital forms of technology has reshaped work organisation, the structure of labour markets (Acemoglu & Restrepo, 2020; Charles et al., 2022), and the physical spaces in

which work is carried out (Alfieri et al., 2025; Shifrin & Michel, 2022). The process of digitalisation is understood within this study as one through which digital forms of technology, which include cloud computing, artificial intelligence, digital communications platforms, and data analytics (Brynjolfsson & McAfee, 2014; Charles et al., 2022), are adopted and integrated into economic activities, organisational structures, and everyday work practices (Vial, 2021). This process has not only expanded employment levels in the information and communications technology sector (ICT) but has also profoundly transformed traditional sectors through the application of increased automation (Acemoglu & Restrepo, 2019), increased numbers of digital platforms (Martindale & Lehdonvirta, 2023), and new forms of connectivity (Frey & Osborne, 2017). These transformations, which were accelerated during the Covid-19 pandemic, have fostered across a wide range of sectors the normalisation of remote work practices, work which partially is carried out outside the default place of work (International Labour Organization, 2021), along with increasing hybrid work arrangements which are defined as a blended mode of in-office and out-of-office work (Manzini Ceinar & Mariotti, 2021; OECD, 2023; Sostero et al., 2020).

Despite the gradually growing degree of implementation in terms of digital solutions, the persistent demand for collaborative and professional interaction simultaneously has given rise to co-working (CW) spaces (Pernice et al., 2025; Spinuzzi et al., 2019). A CW space is a shared space which is used by individuals who pay for access on a flexible, membership-based model, and who therefore are bound by community norms rather than a common employer (Gandini, 2015; Spinuzzi, 2012). In this sense, CW spaces offer not only physical space but also social space for communities and networks which foster collaboration, innovation, and knowledge exchange (Capdevila, 2015; Merkel, 2015).

Digitalisation has, on the one hand, prepared the ground for the emergence of CW spaces as a phenomenon, while, on the other hand, the process of digital transformation is continuously reshaping the way in which they operate. This study aims to shed some light on how and to what extent digital transformation serves to change the traditional CW model. In order to address this overarching question, we seek to answer the following questions: How is digitalisation understood and to which degree is it accepted within the context of CW spaces? Which new elements or transformations does digitalisation introduce into the core components of the CW business model, including practices, values, and customer structure? How do digital and physical spaces interact within the CW model? This article seeks to address these questions by investigating the perspectives of CW managers in Singapore in terms of the relationship between digitalisation and CW. As decision-makers who are responsible for implementing digital tools, redesigning physical infrastructure, and adapting service portfolios, managers provide an aggregated and strategic perspective on digital transformation processes and ecosystem-level change.

Empirically, this study is based on the Singapore context. As a global financial hub and one of the world's most digitally advanced economies, this city-state has actively promoted its "Smart Nation" agenda, embedding digitalisation into economic policy, public services, and urban planning (Woo, 2018; Yeo, 2024). At the same time, Singapore's limited physical space, high real estate costs, and its role as a regional headquarters location for multinational corporations has created distinctive pressures upon and opportunities for CW spaces. The clustering of innovation ecosystems around major universities such as the National University of Singapore and Nanyang Technological University (Das & Kwek, 2024), combined with the cross-border mobility of professionals who are commuting from neighbouring countries, further diversifies the CW landscape.

By combining insights which have been received from managers with broader literature on digitalisation and CW, this article provides two contributions. Firstly, it examines the emergence of new extensions of CW spaces and assesses their temporal character, calculating whether they constitute temporary adaptations or enduring structural transformations. Secondly, it sheds some light on the interplay between physical and digital spaces, evaluating whether they operate as complementary, substitutive, or coexisting dimensions of the CW ecosystem. Together, these findings contribute to ongoing scholarly debate on the digital transformation of work and the evolution of CW space models within the context of a small city-state economy.

2. Theoretical Background

Rapid digitalisation has significantly reshaped and restructured global labour markets, contributing through task replacement, task creation, and the transformation of work arrangements to labour market segmentation which can be characterised as the division of the labour market into distinct segments which are characterised by different wages, working conditions, and career opportunities (Autor & Dorn, 2013; Charles et al., 2022; Goos et al., 2014; Piore, 1983). As a result of the processes of digitalisation, globalisation, polarisation, and economic restructuring, two segments of the labour market have grown quite extensively: the low-skilled service sector and highly-skilled knowledge workers—employees or freelancers whose primary tasks involve the creation, processing, analysis, or communication of information and knowledge (Autor & Dorn, 2013; Drucker, 1999; Merkel, 2015). Therefore, it can be seen that ICT and creative professionals and, more broadly, mobile employees who can work outside their primary workplace, became the main customer pool for the rise of CW spaces (Bednář et al., 2023; Merkel, 2015; Spinuzzi, 2012). Their preferences, and their ability to adopt hybrid work models which combine office and remote work, further contributed to the growth of CW spaces (Bloom et al., 2022; Migliore et al., 2021). Such spaces became multilayered spatial environments (Yang et al., 2019), integrating designed, well-equipped physical spaces with a strong community-building dimension (Gandini, 2015), and functioning as micro-clusters which are co-located with creative and knowledge-intensive industrial hubs and districts within urban spatial ecosystems (Capdevila, 2015; Clifton, 2022; Coll-Martínez & Méndez-Ortega, 2023).

Relative to traditional office and home-based work, CW practices provide a wider range of physical and psychosocial environmental factors which shape user outcomes, including ergonomic design, noise management, and opportunities for collaboration (Kinsman et al., 2024), thereby improving concentration, productivity, and well-being (Lukeš et al., 2026; Robelski et al., 2019) and reducing isolation (Ciccarelli, 2023). In addition, CW spaces help to reduce long-distance daily commuting to central offices, generating both private financial savings and broader public benefits, including reduced traffic congestion, lower carbon emissions, and more sustainable urban mobility patterns (Curtis et al., 2025; Fai et al., 2025; Lejoux et al., 2019).

Although the model of CW spaces is considered to be sustainable, it has evolved significantly. Being the driver for the rise of CW spaces, digitalisation at the same time began transforming the CW model itself (Sinitsyna et al., 2022). The Covid-19 pandemic forced a reconsideration of the role of physical space and physical events, meetings, and social interactions, which were the core elements behind the value of CW spaces (Kraus et al., 2022). In response, CW spaces shifted some activities into the digital space in the form of virtual CW spaces, with these being ICT-mediated environments which replicate the social proximity, motivation,

and knowledge-sharing functions of any physical CW space (Hofeditz et al., 2020). CW spaces therefore no longer remained exclusively physical workspaces (Hirschmann et al., 2026; Sinitsyna et al., 2022).

Virtual CW spaces are a relatively new concept and practice. Although their advantages are recognised in terms of flexibility in time and space, 24-hour access, and access to global knowledge networks, so also is recognised their socio-technical constraints such as participation fatigue and difficulties in sustaining informal communication (Dell'Aversana & Miglioretti, 2025; Hopkins & Bardoel, 2023). However, the depth of knowledge regarding the sustainability of this model remains imbalanced. While some scholars emphasise the temporary nature of the virtual space due to participation fatigue (Di Marino et al., 2023; Sinitsyna et al., 2022), others consider virtual CW to be a promising hybrid work environment (Hofeditz et al., 2020; Mao, 2025).

Both CW spaces and virtual CW spaces serve an economically-significant yet limited segment of the labour market (Di Marino et al., 2023; Mariotti et al., 2019). This may raise broader questions of urban social justice. A well-functioning and innovative labour market depends not only upon digitally-connected professionals but also on essential service workers whose livelihoods rely on affordable housing, accessible transportation, and robust social security systems (Florida, 2017; Harvey, 2012). As cities tend to position themselves as innovation hubs, the expansion of CW infrastructures may inadvertently contribute towards the imposition of spatial inequalities (Vogl et al., 2024), gentrification pressures, and the exclusion of lower-wage workers from central urban areas (Zukin, 2012), potentially forcing and reinforcing existing socio-economic stratification and unequal access to opportunities (Fainstein, 2014; Mariotti et al., 2023). On the other hand, CW spaces often co-locate with start-ups and creative hubs, thereby benefiting from the clustering and knowledge-sharing environments these spaces provide and, therefore, contributing to urban variety by activating underused or abandoned buildings, stimulating local service economies, and attracting complementary businesses into surrounding neighbourhoods (Mariotti et al., 2021; Merkel, 2015).

3. Digitalisation and the Rise of CW Spaces in Singapore

A recent market report estimates that the CW industry in Singapore, which was valued at USD 88.2 million in 2023, will surpass a figure of USD 407 million by 2030, with an annual growth rate of 24.3% during 2024–2030 (Next Move Strategy Consulting, 2025). This rapid expansion did not occur randomly. Rather, it is a consequence both of global shifts in the future of work towards digitalisation, Singapore's transformation into a financial and corporate hub for the Indo-Pacific region, and the city-state's specific economic and spatial planning policies (Nunnington et al., 2017).

Firstly, the digitalisation of Singapore's labour market and its adoption of digital solutions across sectors have both served as a strategic driver for its growth. Singapore has actively promoted itself as a "Smart Nation," adopting at a state level wide-ranging digital solutions across industries, public services, and education (Das & Kwek, 2024). This transformation has not only expanded the ICT sector but has also reshaped work practices across all segments of the economy (OECD, 2023). As businesses digitalise their operations, the requirement has diminished for employees to be physically co-located on a daily basis, whilst remote and hybrid work practices have become mainstream (Ei et al., 2021; Sostero et al., 2020). This is the niche for CW spaces: offering a technologically equipped office which can flexibly be accessed (Dell'Aversana & Miglioretti, 2025).

A second structural driver lies in Singapore's role as a regional headquarters hub. Establishing a headquarters in Singapore carries symbolic weight, a move which signals prestige, stability, and access to South-East Asian markets (Barr, 2016; Yue, 2001). Yet not all companies can maintain a physical office in Singapore due to its high property prices (Han, 2005; K. W. Wong & Bunnell, 2006). Some of these companies choose to retain a prestigious Singapore address but outsource or downsize their physical office requirements (Van Meeteren & Bassens, 2016). For such firms, CW spaces offer a digital registration address and some limited services (such as postal handling and reception services).

Thirdly, Singapore's broader planning strategy to decentralise economic activity (P. K. Wong et al., 2010) resulted in the emergence of knowledge-intensive hubs outside the city's central business district (CBD). This created a spatial niche for CW spaces. The presence of world-class universities such as the National University of Singapore and Nanyang Technological University has fostered the emergence of suburban innovation clusters (P. K. Wong et al., 2011). Both universities host technology parks and start-up incubators, thereby attracting ICT entrepreneurs, researchers, and spin-off ventures (Oswin & Yeoh, 2010). CW spaces have capitalised on these concentrations, situating facilities close to campus areas in order to capture the demand.

Finally, regional labour mobility and commuting practices serve to shape demand for a flexible workspace. The high cost of living in Singapore means that many professionals who are employed by Singapore-based firms do not permanently reside in the city. Instead, they are based in neighbouring countries such as Malaysia or Indonesia, commuting periodically to Singapore for meetings, negotiations, or project work (Hui, 1997; Yeoh & Chang, 2001). These cross-border professionals often maintain a home office in their country of residence but rely on temporary workspaces when in Singapore. For them, CW spaces provide flexible access to professional environments for a few days or weeks, avoiding the need for long-term rental contracts. The rise of such commuting professionals highlights the broader regional integration of Singapore's labour market and underscores the functional role of CW spaces as bridges between home-based work abroad and formal corporate environments.

Taken together, these four factors reinforce one another. Digitalisation enables remote work, but remote work creates demand for flexible offices; multinational firms desire a Singapore base, but spatial constraints push them towards shared facilities; universities attract ICT entrepreneurs, and CW captures this trend; regional professionals circulate between Singapore and neighbouring states, and CW provides their temporary anchor.

4. Method

4.1. Study Participants

The study targeted the managers of CW spaces which are located in Singapore. The selection of CW spaces was guided by several criteria in accordance with the definition of CW space which has been applied in this study. Firstly, a CW space should have a headquarters which is located in Singapore. Secondly, it should operate as a private, profit-oriented business with independent ownership. Thirdly, each maintains a physical workspace and provides flexible desk membership. For this reason, fully online-based virtual spaces were excluded. Public libraries and semi-private social spaces were also excluded from the sample. In addition, we excluded micro-providers of CW spaces, temporary pop-up spaces, and closed corporate

spaces which usually are accessible only to corporate employees. Additional exclusion criteria were used to ensure transparency. To qualify for inclusion, the CW space should have an updated website with publicly available contact details, in English, and managers should be available for the interview, also in English. However, during the desk research and recruitment phase, no invitations were declined due to language-related reasons. We did not intentionally focus on CW spaces which specialised in a particular sector (such as creative industries or ICT), as our aim was to observe the impact of digitalisation across differing sectoral contexts. As a result, a list was compiled of 12 CW spaces. Seven were randomly approached for face-to-face interviews. Based on manager availability, readiness, and willingness to participate, 3 of the 12 were visited for pilot interviews during the first phase of data collection. In the second stage of data collection, two additional CW spaces agreed to participate. In total, we contacted 5 out of 12 CW spaces across different districts in Singapore, including both the CBD and suburban innovation and creative hubs close to university clusters (Supplementary File, Table 1).

Established between 2012 and the early 2020s, these spaces range from small student-oriented work environments (CW space B) to internationally-connected hubs which are embedded in the CBD (CW spaces C and E). Membership profiles vary from freelancers and creative entrepreneurs to large multinational corporations, reflecting diversified demand patterns within Singapore's knowledge economy. In terms of scale, some CW spaces maintain single-site facilities (CW space B), while others operate as multi-location networks across Singapore (CW spaces A, C, D, and E). The provision of services also differs substantially: While some spaces emphasise community-building, creative production facilities, and flexible desk arrangements (CW spaces A and D), others focus on premium business lounges, premium office services, and corporate-oriented meeting infrastructures (CW space C). Pricing strategies range from highly flexible, short-term memberships for students to higher-cost dedicated team offices, indicating differentiated market positioning.

Overall, the spatial distribution of the 12 CW spaces (Figure 1) is characterised by strong clustering around business hubs and innovation centres across Singapore's various districts rather than displaying any uniform distribution. This pattern reflects the result of Singapore's spatial planning policy, which, on the one hand, aims to decentralise economic activities beyond the CBD and, on the other hand, to develop creative and business hubs, thereby encouraging CW spaces to co-locate in close proximity to these hubs as they provide a pool of potential customers. CW spaces tend to cluster either (a) in the main business and financial district, where demand is highest from startups, finance, consulting, and international companies, or (b) along and in major transport corridors and hubs.

The five selected CW spaces (the red dots in Figure 1) which were included in this study's interview process are distributed across various districts in Singapore. Two of them (CWs C and E) are situated within the central downtown area, Singapore's primary CBD, which is characterised by its office towers, multinational corporations, and high financial density. Their positioning embeds these CW spaces within the formal corporate ecosystem, facilitating interaction with multinational firms and professional service networks. In contrast, CW space A is located in a historical neighbourhood which bears a strong concentration of art and creative industries. This setting reflects a more community-oriented and entrepreneurial positioning. Meanwhile, CW spaces B and D are located in the urban fringe and light-industrial areas which are characterised by a mix of commercial-residential and industrial buildings. These locations offer comparatively lower rental costs and greater spatial flexibility, often attracting startups, small and medium-sized enterprises (SMEs), and production-oriented activities.

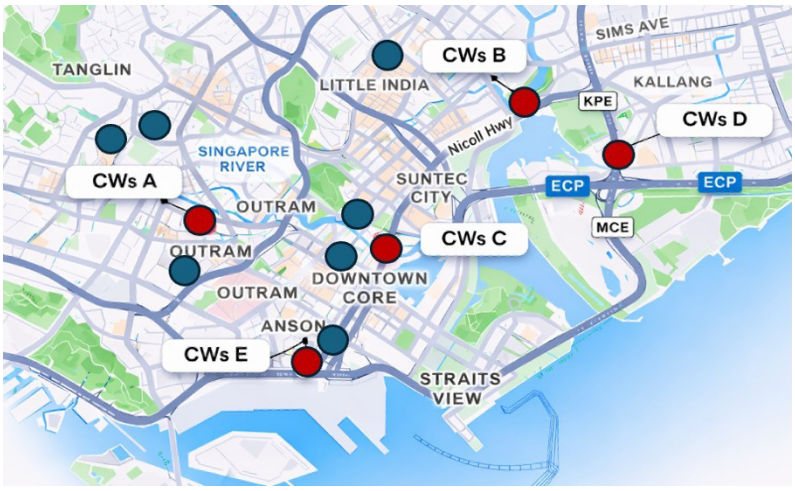

Figure 1. The spatial distribution of case study CW spaces in central Singapore. Notes: blue and red dots indicate the approximate locations of the 12 selected co-working spaces after the first stage of sampling; red dots indicate the final set of five co-working spaces which were included in interviews. Source: compiled by the authors based on the Urban Redevelopment Authority (2019).

Participation in the study was voluntary, and all respondents provided their informed consent prior to data collection. To be able to protect confidentiality, pseudonyms were assigned both to CW spaces and managers, and identifying details were removed from the transcripts. Data were stored on password-protected servers which were accessible only to the research team. The research followed established ethical guidelines for social science research, ensuring respect for participant autonomy, privacy, and the voluntary nature of participation. Informed consent was obtained from all participants while they were assured of confidentiality and were informed of their right to withdraw at any stage from the study.

4.2. Data Collection and Analysis

Data collection proceeded in two stages. Firstly, three semi-structured pilot interviews were conducted over a one-week period in April 2024 during a fieldwork trip to Singapore. Each interview lasted between one and three hours. The fieldwork in total included approximately 10 hours of observations and face-to-face interviews with managers. These interviews were held offline and included guided tours of the CW spaces, followed by semi-structured in-depth discussions with the managers. This stage was particularly important as it provided the opportunity to observe digitalisation practices in situ, engage informally with managers, and gain familiarity with the CW physical space. During observations, conversations extended beyond the formal interview questions, allowing managers to reflect on their broader perspectives on digitalisation and how digital transformation had changed their daily routines.

The first stage interview questions were developed by basing them on a review of the available scientific literature. However, the pilot interviews revealed additional topics as managers offered their own reflections on how digitalisation has reshaped and impacted the future of CW spaces. Consequently, in the second stage of data collection, the original set of interview questions was expanded to explore new insights on structural changes which can take place during digitalisation. Examples of interview questions, together with their respective theoretical foundations, are presented in Table 1.

Table 1. Examples of questions for semi-structured interviews with CW managers.

Research question	Examples of interview questions	Theoretical base
How do CW managers interpret and conceptualise digitalisation?	How do managers define digitalisation within the context of CW? Do they see it as opportunity, pressure, necessity, or transformation? Where do they perceive its strongest impact to lie?	Clifton et al. (2022); Mátyus (2021); Orel (2019).
In which ways does digitalisation restructure demand patterns and shift CW user preferences, and how do CW spaces adjust?	How has digitalisation changed customer expectations? Has the profile of members shifted? Describe how. How does digitalisation increase or decrease community engagement?	Bednář et al. (2023); Wright et al. (2022).
How are digital and physical spaces integrated within the CW space model?	How do managers see the evolution of (a) physical-only CW, (b) online extension (especially after the pandemic period), and (c) the integrated hybrid ecosystem? How do digital and physical spaces relate to each other? What is the future of digital space?	Hofeditz et al. (2020); Vial (2021); Yang et al. (2019).

In the second stage (September–November 2025), two more CW spaces were approached and interviewed using the finalised interview guide. Given the fact that data collection spanned a period of more than six months, previously-interviewed managers were re-contacted and asked to update their responses. Two previously-contacted CW managers agreed to participate in additional online interviews, which allowed us to capture recent developments in digitalisation practices and CW space adaptation. One previously-contacted manager provided written responses to the interview questions due to time constraints. New CW managers were also interviewed online. All interviews which were conducted during the second stage were held via video conferencing and lasted between 25 and 45 minutes. A total of five CW spaces were studied between April 2024 and November 2025.

All interviews were recorded, transcribed, and analysed using a qualitative content analysis approach in order to systematically examine the interview material, identify recurring themes, and develop categories which reflect both predefined analytical concepts and themes which may have emerged from the data. Some of the code examples are presented in Table 2.

The coding procedure was conducted using NVivo software and was then manually checked. The analysis process began with open coding of the interview data, followed by the identification of recurring patterns across respondents. Codes were then synthesised into higher-level topics which aligned with the study's research questions and were reflected in pilot interviews.

Table 2. Examples of codes used in the content analysis of semi-structured interviews with CW managers.

Topic	Code	Interview quotation	Focus and notes
Interpretation of digitalisation	Ddef	For us digitalisation is a long-term shift toward a more connected and data-driven workspace (CW space B manager, April 2024, Singapore).	Interpretive dimension of digitalisation. Conceptual framing. Digitalisation as a permanent trend.
Digital practices	DPben	We manage bookings, payments, and community engagement entirely through our digital platform….It just makes everything smoother (CW space D manager, September 2025, online interview).	Utility of digitalisation. Concrete implementation. Changes in internal management processes.
Impact on user profiles	DLpro	Well, our community now includes more remote employees from multinational firms. They are very flexible, more internationally mobile (CW space E manager, November 2025, online interview).	Increased diversity as a demand-side transformation. Transformation of the user profile beyond the physical space.
Digital-physical space	DPScom	I would say that the digital platforms we use, they are supporters for us and our members….And these offline/online interactions, if I may say so, are now fully interconnected (CW space A manager, April 2024, Singapore).	Complementary coexistence of digital and physical spaces.

Notes: Ddef = definitions of digitalisation; DPben = benefits of new digital practices; DLpro = digitalisation and labour market, changes in profile; DPScom = digital and physical space, complementary.

5. Findings and Discussion

5.1. Digitalisation as an Indirect Driver of CW Demand

In addressing our first research question—how digitalisation is understood and interpreted amongst CW managers—those managers framed digitalisation as an essential part of their professional routines rather than as an external or temporal shock to the sector. As one respondent noted, "Most of us already work in highly digital environments. For us, online things are just part of our everyday life" (CW space A manager, April 2024, Singapore).

Managers emphasised the fact that digital transformation is most visible in communication practices rather than in the other dimensions of CW. "In terms of productivity tools, our members are extremely advanced. AI, automation, cloud collaboration…that's nothing surprising for them," explained one manager (CW space C manager, April 2024, Singapore). The social component of CW was described as being less impacted by digitalisation. "Digital tools help coordination, but the community still needs physical presence," observed another respondent (CW space D manager, September 2025, online interview). The other manager also commented: "We know that after Covid people don't like to communicate too much. They like to control communications. So we offered our members special channels…they can simply switch it off when they want" (CW space A manager, April 2024, Singapore).

Managers nevertheless did not interpret digitalisation as a direct driver of increased demand for CW membership. "We didn't suddenly get digital workers because of digitalisation. They were already our core audience," stated one manager (CW space B manager, April 2024, Singapore). Instead, they emphasised their initial customer base as already having predominantly been composed of ICT professionals whose work had long been carried out in the digital space. Managers framed it less as a disruptive force which was generating new markets and more as an enabling environment which sustains and stabilises established user profiles. "Digitalisation didn't change who our members are, it changed how they work," summarised one respondent (CW space E manager, September 2025, online interview). Digital transformation therefore operates as an instrument of vertical expansion rather than a horizontal one, underpinning CW practices rather than being a primary causal factor in membership growth.

5.2. Digitalisation and the Rise of Virtual CW Practices

Our second research question addresses how CW spaces have adjusted in response to digitalisation. That response to the digital transformation saw CW spaces developing and implementing virtual CW spaces, understood as being digital spaces which are designed to replicate some of the functional and social dimensions of physical CW through the supply of online platforms (Hofeditz et al., 2020; Sinitsyna et al., 2022). As one manager explained, "The virtual room creates accountability. People log in, switch on their cameras, and work together even if they're in different countries" (CW space D manager, September 2025, online interview). Platforms such as Zoom, Microsoft Teams, and Google Meet were consistently cited as essential tools which supported this synchronous interaction.

At the same time, managers differentiated between activities which were suitable for the digital space and those which required a physical co-presence. Informational sessions, briefings, and certain networking events were increasingly conducted online, thereby saving commuting time and increasing efficiency. As one manager explained, "Workshops and briefings can easily be moved online. It saves everyone time" (CW space B manager, April 2024, Singapore). In contrast, events which were aimed at deeper network formation, trust-building, and community integration—particularly for newcomers—were deliberately maintained in physical settings. "You can introduce yourself online, but real connections still happen over coffee," noted a respondent (CW space A manager, April 2024, Singapore). This selective digitalisation of services created additional value for CW operators who were able to strategically integrate digital solutions. Moreover, virtual CW was perceived as reducing unnecessary commuting, aligning with broader discussions on mobility and efficiency.

Unlike assumptions reached by previous studies (Di Marino et al., 2023; Trapanese & Mariotti, 2023), virtual CW was not framed merely as a temporary response to pandemic-related restrictions but rather as a structural adaptation to the digitalisation of work. As one manager noted, "We initially moved online because of Covid, but now virtual access is simply part of how we operate" (CW space C manager, April 2024, Singapore). Managers emphasised the fact that digital platforms made it possible for multi-location teams to maintain collaboration, thereby expanding CW beyond its physical space. In this sense, digitalisation restructured CW demand from locally-embedded freelancers towards more internationally mobile and hybrid corporate users. As a respondent explained, "Our members are no longer just freelancers from one neighbourhood. Many of them have not seen each other face-to-face…they simply log in from different countries" (CW space E manager, November 2025, online interview).

Virtual CW spaces were also described as an opportunity for inclusivity and flexibility over space and time, rather than the necessity to be online (Mao, 2025). As managers explained, digital access broadened participation from different geographical backgrounds, which is particularly important for international professionals and remote workers who are operating across multiple time zones. One manager observed, "Digital access allows people who are not physically in Singapore [still to] feel part of our community" (CW space A manager, April 2024, Singapore). Flexibility in scheduling was frequently cited as a benefit, contributing to improved work–life balance and accommodating the needs of globally-distributed teams. As another respondent stated, "Some members prefer to join events online because it fits better with their schedule and family commitments" (CW space D manager, September 2025, online interview). The findings therefore confirm that virtual CW provides substantial advantages in terms of accessing global knowledge networks by means of linking members across geographical boundaries. Digitalisation therefore not only restructures internal demand patterns but also more deeply integrates CW spaces into transnational business ecosystems.

5.3. The Emergence of Hybrid Work Ecosystems as an Interaction Between Digital and Physical Spaces

Our third research question examined how digital and physical spaces relate to one another within CW models: Do they function as substitutes or complements, or as an integrated system? CW initially emerged purely as a physical phenomenon (Gandini, 2015; Moriset, 2013), which was centred on shared office infrastructures. During the Covid-19 pandemic (Di Marino et al., 2023), CW spaces had to expand into the digital space, and virtual CW practices became dominant due to mobility restrictions and the rapid expansion of remote work (Dell'Aversana & Miglioretti, 2025). However, the post-pandemic period does not reflect a simple return to the pre-digital model. Digital and physical spaces instead now operate in complementary, permanent, and mutually-reinforcing ways, giving rise to what can be conceptualised as a hybrid work ecosystem.

Digital expansion has reshaped expectations when it comes to physical infrastructure. Managers observed that, as members increasingly participate in virtual meetings and hybrid workflows, physical spaces must accordingly adapt. "Our members expect proper soundproof rooms and video pods, not just desks," explained one respondent (CW space A manager, April 2024, Singapore). This has led to spatial redesigns, including the addition of sound-isolated booths, advanced conferencing facilities, and multifunctional areas which are optimised for hybrid interaction. Therefore, physical CW spaces are not being diminished in terms of their relevance. Instead, they are being redesigned to adjust to digital transformation.

Additionally, within the Singapore context, the adoption of virtual CW was not driven solely by internal demand but also by the broader institutional environment. Managers referred to the strong governmental support for digital transformation and Singapore's positioning as a "digital nation." As one respondent reflected, "In Singapore there is an expectation that you are digitally advanced. It's part of the business culture" (CW space B manager, April 2024, Singapore). Whilst this environment facilitated technological adoption, some managers reported that they felt under pressure to maintain a digital space: "Even if not everyone uses the virtual platform daily, we feel we must offer it," explained a respondent (CW space C manager, April 2024, Singapore).

This ecosystem operates across multiple interconnected layers. At the physical layer, CW spaces provide desks, meeting rooms, event venues, and increasingly specialised soundproof or conferencing facilities.

At the digital layer, booking applications, communication platforms (such as Slack or similar systems), CRM tools, and digital access control make it possible to ensure remote coordination and hybrid participation. At the social layer, community managers facilitate networking events and peer interaction across both online and offline environments. Finally, at the organisational layer, flexible contracts, hybrid membership models, and platform governance structures allow for temporal and spatial adaptability. Altogether, this integration is supported, promoted, and sometimes enforced by national government bodies.

6. Conclusion

This study explored how digitalisation has shaped and reshaped the evolution of CW spaces, a form of workspace in which the physical component remains an integral part of its core value alongside community building. This study draws on evidence from Singapore, a city-state which is characterised by a high level of digitalisation and development, and an active spatial planning policy which aims at reducing spatial inequality and decentralising economic activity beyond traditional CBDs. Within this context, CW spaces play a dual spatial role. Firstly, they tend to co-locate in close proximity to business and creative hubs in order to position themselves near their core customer base. Secondly, they complement and extend the spatial landscape of neighbourhoods by providing an alternative workplace for remote workers. This allows those remote workers to avoid some of the negative externalities which can be associated with working from home, while at the same time reducing the need to commute to the CBD.

Our findings revealed that digitalisation in Singapore has primarily served as an indirect enabler of CW growth rather than a direct driver of customer pool expansion. Whilst CW managers do not see digital transformation as generating new demand beyond ICT professionals, they acknowledge that digitalisation is crucial in sustaining and enhancing CW practices, particularly through the emergence of virtual CW spaces. Supported by digital solutions which enable video conferencing, collaborative software, and digital community tools, virtual CW spaces, as part of the business model, have made it possible for CW spaces to be able to maintain engagement and continuity even beyond physical offices. These virtual extensions enhance flexibility, inclusivity, and cross-border collaboration, positioning CW as an adaptive physical infrastructure for the digital economy. However, virtual CW practices are not a substitute for physical space but rather serve to extend and complement that physical space, therefore suggesting that CW spaces are evolving towards hybrid work ecosystems in which digital and physical layers dynamically interact rather than compete.

Overall, CW spaces in Singapore exemplify a broader transformation toward hybrid work ecosystems, suggesting that such spaces are not shifting from physical to digital environments, but rather that both are being integrated into a multilayered ecosystem. Whilst certain functions have transitioned into the digital space, the physical space remains important and is becoming more multifunctional, increasingly technologically-equipped, and certainly flexibly designed. The hybrid work ecosystem therefore represents a reconfiguration rather than the dominance of either physical or digital spaces, and is bound by routine practices while being supported by state policy.

The future trajectory of CW in Singapore will likely follow a hybrid model, and this hybridisation appears structural rather than temporary. Therefore, the future of work is not placeless. Rather than making location irrelevant, digitalisation is reshaping the importance of location, and CW spaces are one of the key spatial forms through which this transformation becomes visible.

Although this study has attempted to advance the understanding of digital and physical space interaction through the case of CW spaces in Singapore, several gaps remain relevant here. Firstly, the analysis was limited to managerial perspectives, whereas future research could incorporate the viewpoints of CW members in order to better understand user-level experiences of hybrid work ecosystems. Secondly, comparative studies across different institutional contexts would allow for an assessment of whether the hybrid work ecosystem which has been observed in Singapore represents a global mode of work or is one which has been shaped by Singapore's specific institutional and digital environment. Thirdly, longitudinal research could examine how hybrid work ecosystems evolve over time, particularly as digital tools and artificial intelligence applications continue to develop.

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Conflict of Interests

The authors declare no conflict of interests.

Data availability

The data associated with this article are available upon request from the authors.

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Supplementary material

Supplementary material for this article is available online in the format provided by the authors (unedited).

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Does Telework Work for Everyone? Teleworking's Impact on Wellbeing Across Gender and Parental Status

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Abstract

The rise in teleworking has reshaped patterns of work, travel, residential choices, and social interaction, but its effects are not evenly distributed across space or socio-economic groups. Although previous studies highlight both positive and negative consequences of teleworking, less is known about how it affects wellbeing, and whether these effects differ by gender and childcare responsibilities—two factors closely linked to unequal household and caregiving burdens. This study addresses these gaps by examining how teleworking relates to commute-related wellbeing and general life satisfaction, and whether these relationships vary according to gender and the presence of children in the household. Data were collected through an online survey, targeting employees in East Flanders, Belgium. We estimated two OLS models to assess the influence of teleworking frequency on (a) commute-related wellbeing and (b) general life satisfaction. The results show that teleworking is a significant predictor of commute wellbeing, but not of general life satisfaction. To explore the moderating role of gender and childcare responsibilities, we estimated two extended models: one including an interaction term between teleworking and gender, and another including an interaction between teleworking and the presence of children. We did not find evidence of gender differences among teleworkers or non-teleworkers in commute wellbeing or life satisfaction. However, combining teleworking with childcare, especially for children under the age of six, was associated with lower life satisfaction, suggesting that the digital transition may reinforce existing social inequalities.

Keywords

childcare; commute wellbeing; East Flanders (Belgium); life satisfaction; remote working arrangements

1. Introduction

The share of people in Flanders who sometimes or usually work from home increased from fewer than one in five in 2019 to one in three in 2024, driven by increasing digitalisation and accelerated by the Covid-19 pandemic ("One employee," 2025a), with important implications for employee wellbeing. Previous studies show that teleworking can influence wellbeing and health both positively and negatively. In terms of physical health, teleworking is associated with higher levels of physical activity due to increased flexibility and a lower risk of physical inactivity, for example, by reducing passive commute time (Beckel & Fisher, 2022). Effects on mental and psychological wellbeing are more mixed, with teleworking associated with greater autonomy, increased performance and job satisfaction, reduced stress and fatigue, and improved affective wellbeing (Allen et al., 2015; Anderson et al., 2015; Beckel & Fisher, 2022; Delanoeije & Verbruggen, 2020), as well as increased social isolation, stress levels, and social stigmatization (Allen et al., 2015; Athanasiadou & Theriou, 2021; Beckel & Fisher, 2022; Chuang et al., 2024).

Teleworking also has mixed social effects (Allen et al., 2015; Athanasiadou & Theriou, 2021). Greater autonomy and flexibility may reduce work–family conflict and improve work–life balance, but blurred spatial and temporal boundaries and increased household responsibilities can heighten stress, distractions, and work–family conflict (Allen et al., 2015; Beckel & Fisher, 2022; Delanoeije & Verbruggen, 2020). These effects are context-dependent and moderated by factors such as telework frequency, prior telework experience, gender, job and task characteristics, voluntariness of telework, and preferences regarding work–life separation (Allen et al., 2015; Beckel & Fisher, 2022).

Gender imbalances are particularly salient, as traditional gender roles often become reinforced when working from home (Sullivan & Lewis, 2001). While teleworking flexibility may help women balance work and personal life, women are more likely to combine paid work with childcare and household responsibilities, raising concerns about wellbeing, work–family conflicts, and career progression (Beckel & Fisher, 2022; Desjardins et al., 2024; Peters et al., 2009; Sullivan & Lewis, 2001). Women are also more often expected to take on household tasks when working flexibly, whereas men tend to prioritise paid work, potentially disadvantaging women in career outcomes (Chung & van der Lippe, 2020). These gendered imbalances intensify with childcare responsibilities (Beckel & Fisher, 2022; Desjardins et al., 2024). Although childcare-related interruptions increase emotional fatigue and reduce work engagement for both genders, women are more likely to perceive work interruptions during childcare as hindering, whereas men more often report positive aspects linked to work-related goals, reinforcing gender disparities in wellbeing (Desjardins et al., 2024). The extent to which these patterns reflect gender norms versus household structure remains unclear (Beckel & Fisher, 2022).

Worker wellbeing and satisfaction can be assessed through general life satisfaction as well as domain-specific measures, such as job- or commute-related satisfaction. While telework effects on life satisfaction and job-related satisfaction are well-studied (Anderson et al., 2015; Chuang et al., 2024; Dale et al., 2024), commute-related satisfaction remains understudied (Maheshwari et al., 2024). As teleworking is sometimes adopted to avoid stressful commutes (Budnitz et al., 2020; Wöhner, 2022), it may also affect commute satisfaction.

The study aims to examine how teleworking frequency affects (a) commute-related wellbeing (CWB) and (2) general life satisfaction (SWL), and whether these effects differ based on gender and childcare responsibilities. The two main research questions are:

1. How does teleworking frequency influence CWB, and how do these effects vary by gender and childcare responsibilities?
2. How does teleworking frequency influence life satisfaction, and how do these effects vary by gender and childcare responsibilities?

We estimate a series of OLS regression models. First, a baseline model includes teleworking frequency as the main predictor. Second, we add an interaction between telework adoption and gender. Third, we include an interaction between teleworking and the presence of children in the household.

2. Literature Review

2.1. Remote Working Arrangements

Remote working arrangements have expanded rapidly due to advancements in digital infrastructure, increased awareness of work–life balance, and forced experimentation during the Covid-19 pandemic (Glackin & Moglia, 2022). These arrangements are flexible in space and frequency, encompassing working from home, satellite offices, or mobile locations (Thompson, 2019). While telecommuting has been studied for decades (Mokhtarian & Salomon, 1997; Pliskin, 1997), the pandemic catalyzed mainstream adoption across the European Union, narrowing the gap between teleworkable jobs and actual teleworking (Sostero et al., 2020). Empirical evidence shows increasing supply and demand for remote work, though employer and employee expectations may diverge (Aksoy et al., 2022), with many employees willing to accept reduced salaries for the option to telework (Lewandowski et al., 2022).

Preferences for remote or hybrid arrangements are linked to greater flexibility, autonomy, and reduced commute stress (Deole et al., 2023; Fonner & Roloff, 2010). However, benefits depend heavily on individual context. Telework mismatch, divergence between preferred and actual teleworking frequency, has emerged as a key source of dissatisfaction (Heiden et al., 2023). Negative mismatch (i.e., working from home less than preferred) is associated with lower commute satisfaction, reflecting reduced autonomy and control over working conditions.

Access to remote working is socially uneven. High-income and high-education workers disproportionately benefit (Sostero et al., 2020), although telework-enabled job postings may help reduce urban-rural employment gaps (Alipour et al., 2021). Nonetheless, digital skill divides and occupational constraints limit universal access (Cedefop, 2020; Eurobarometer, 2020), raising concerns that flexible work may reinforce existing labour market inequalities.

2.2. Teleworking and Commuting Behaviour

The most visible effect of teleworking is reduced commuting. Classical transport studies show decreased vehicle miles travelled and congestion (Walls & Safirova, 2004), but these reductions are not straightforward

(Wang & Mokhtarian, 2024). Rebound effects may occur when teleworkers (especially part-time ones) live farther from work, increasing total weekly distances travelled despite fewer commute days (Ravalet & Rérat, 2019).

Teleworking also affects commute mode and experience. Hybrid work allows greater flexibility in travel timing and mode choice, potentially encouraging cycling or public transport (Kim et al., 2021). Furthermore, cycling, e-biking, and train use are strongly and positively associated with higher commute satisfaction, relative to car use (Handy & Thigpen, 2019; St-Louis et al., 2014). Subsequently, commute satisfaction is influenced not only by duration and reliability, but also by the intrinsic experience of the journey (Ye & Titheridge, 2017).

However, not all teleworkers benefit equally. Urban form and infrastructure constrain mode choice. Telework may actually increase automobile reliance, especially in car-dependent suburban areas. Reduced commuting weakens regular travel to dense, transit-rich employment centers, while everyday activities such as shopping, escorting children, or leisure remain spatially dispersed and poorly served by public transport. As a result, teleworkers may replace fewer but longer commute trips with a higher number of short, car-based non-work trips, using telework as a strategy to cope with long commutes without changing car-oriented lifestyles, resulting in more weekly vehicle miles travelled by car (Silva & Melo, 2018). Reduced commuting to central offices may be offset by increased travel for shopping or leisure (Balbontin et al., 2024), especially in contexts where walkable neighbourhoods are lacking. These complexities indicate that telework may alter, but not necessarily reduce, total mobility demand.

2.3. Commute Satisfaction, Subjective Wellbeing, and Broader Socio-Spatial Implications

Commute satisfaction has increasingly been recognized as a component of overall life satisfaction (De Vos et al., 2013). Early studies emphasized the detrimental psychological impact of long commutes, labeling them "the stress that doesn't pay" (Stutzer & Frey, 2008). Subsequent research has expanded this perspective by conceptualizing commuting as an affective and experiential process through psychometric scales, such as the Satisfaction with Travel Scale (STS; Ettema et al., 2011), which captures both cognitive and emotional responses to daily travel.

Empirical evidence consistently shows that longer commute durations significantly reduce commute satisfaction (De Vos et al., 2022), while active and public modes, particularly cycling and e-biking, enhance it (Ye & Titheridge, 2017). These findings align with broader research demonstrating that active commuting is associated with improved mood, reduced stress, and physical health benefits (Friman et al., 2017; Martin et al., 2014). The positive correlation between commute satisfaction and overall life satisfaction also reinforces the idea that daily mobility is an integral component of subjective wellbeing (Olsson et al., 2013).

Within this framework, teleworking can be understood as a structural change that reshapes both the frequency and experience of commuting. By reducing exposure to long or stressful commutes, telework has the potential to improve commute satisfaction and, indirectly, overall wellbeing. However, these benefits are not automatic. When individuals are unable to telework as frequently as they would prefer, for instance, they may perceive each commute as more burdensome (Heiden et al., 2023). These findings reflect the broader literature linking autonomy, control over one's schedule, and wellbeing (Sardeshmukh et al., 2012). Thus, commute satisfaction is not solely a function of transport but is linked to work organization and perceived quality of everyday life.

Moreover, remote working arrangements have important implications for environmental sustainability and urban systems. Reduced commuting is expected to lower transportation emissions and alleviate congestion (Beck & Hensher, 2021), but these effects depend on mode substitution and residential location. For individuals living close to work, the environmental benefits of telework may be minimal or offset by increased residential energy consumption (Beck & Hensher, 2021), while greater flexibility may encourage longer but less frequent commutes among hybrid workers, potentially increasing weekly travel distances (Ravalet & Rérat, 2019).

From a planning perspective, telework offers opportunities for spatial reconfiguration. In principle, reduced reliance on centralized offices may create longer-term opportunities to reconsider the use of certain office-dominated urban spaces, including their potential conversion to green space or social infrastructure (Glackin & Moglia, 2022). Similarly, the decentralization of work could support the revitalization of suburban or rural areas (Alipour et al., 2021). While these dynamics align with the broader objective of proximity-based planning models such as the X-minute city, the relationship is indirect. Telework primarily operates through behavioural and organizational change, whereas proximity-based models seek to restructure daily accessibility through spatial planning and urban design (Allam et al., 2022; Moreno et al., 2021). Under certain conditions, however, telework-related decentralization may also generate trade-offs, including risks of urban disinvestment, rising suburban demand, and strain transit systems designed for radial flows, potentially redistributing accessibility, mobility costs, and service quality that disadvantage already vulnerable groups (Mouratidis, 2021).

Finally, teleworking intersects with questions of mobility justice. Workers unable to telework, who are disproportionately lower-income and in essential sectors, may experience worsening mobility conditions if transit systems are deprioritized or underfunded due to declining ridership (Lucas et al., 2016). Without inclusive and equity-oriented planning responses, the mobility benefits of remote working risk reinforcing existing socio-spatial inequalities.

2.4. Gender, Household Context, and Inequality in Digitally Transforming Societies

The benefits of teleworking are unevenly distributed across socio-demographic groups, particularly along gender, caregiving, and occupational lines. Women, especially those with young children, report lower satisfaction with telework due to intensified household labour and blurred boundaries between work and home (Castro-Trancón et al., 2024; Lu & Zhuang, 2023). These patterns echo findings during the Covid-19 pandemic that highlight the unique strains faced by parents attempting to balance productivity and caregiving in the same physical space (Bertoni et al., 2021; Rubin et al., 2020).

On the other hand, prior studies report mixed and inconclusive evidence regarding systematic gender differences in either commute satisfaction or life satisfaction. While women may experience greater caregiving burdens, they may also benefit more from flexible scheduling and reduced commute times, leading to heterogeneous outcomes (Castro-Trancón et al., 2024). Importantly, the absence of consistent aggregate effects should not be interpreted as the absence of inequality. Rather, the intersection of gender, telework, and caregiving remains deeply context-specific, shaped by organizational support (such as formal telework policies, flexibility in scheduling, or managerial attitudes), cultural expectations, and the age of children (Clar-Novak, 2024; Çoban, 2022; Karjalainen, 2023; Tremblay, 2002; Vander Elst et al., 2017).

Household composition further shapes telework-related mobility and wellbeing. Dual-income or dual-teleworker households may redistribute responsibilities and adjust mobility patterns differently than more traditional household arrangements, where the division of domestic labour may remain unchanged despite both partners working from home (Gueguen & Senik, 2021; Rubin et al., 2020). Additionally, the spatial characteristics of the domestic environment condition how teleworking is experienced. Housing size, layout, and access to private workspace influence the ability to separate work, care, and leisure activities (Azimzadeh & Sharghi, 2025), with more constrained or shared domestic settings often intensifying role conflict and negative wellbeing impacts.

Furthermore, inequalities in access to teleworking are fundamentally shaped by the nature of employment itself. Many occupations (e.g., manufacturing, retail, or care work) are inherently non-teleworkable, creating a structural divide between workers who can and cannot benefit from digital work arrangements. As a result, high-income and highly-educated individuals disproportionally benefit from teleworking, even though digitalization may offer some potential to reduce urban-rural employment disparities (Alipour et al., 2021; Sostero et al., 2020). Spatial context further conditions these inequalities. While teleworking can help to cope with long commutes, residents of less central or car-dependent areas may face constrained mode choice and increased car dependency (Silva & Melo, 2018). Moreover, individuals unable to telework, due to social, work-related, or spatial factors, may be doubly disadvantaged if declining ridership leads to reduced investment in public transport systems on which they disproportionately rely (Lucas et al., 2016).

3. Data and Method

3.1. Data Collection and Case Study

The data were collected through an online survey on teleworking, travel, and wellbeing, targeting individuals working in East Flanders, a province located in the northwest of Belgium. East Flanders is a densely populated region (529 inhabitants/km^2) with around 1.6 million residents in 2025. In 2022, 77.7% of inhabitants aged 20–64 were employed, and roughly two-thirds of them worked full-time (Provincies in cijfers, 2025a).

Teleworking has become increasingly common in the region. In 2024, about one-third of the population was teleworking, placing Flanders among the European regions with the highest uptake ("One employee," 2025a). The uptake, however, differs strongly between sectors, with around half of the public sector employees teleworking compared to 28% in the private sector ("One employee," 2025a). Belgium policy distinguishes between structural teleworking, which requires a written agreement on frequency, location, availability, and reimbursement, and occasional teleworking, which does not. Structural teleworking is by far the dominant form (over 75%), regardless of organization size, and is expected to remain so (Telewerken, 2025a). Teleworkers may receive reimbursements for work-related costs such as equipment (screen or printer) or internet access (Telewerken, 2025b).

Commuting patterns in East Flanders are diverse. The car is the most common mode (58%), followed by bike (20.5%), and public transport (17.4%). On average, households own 1.1 cars, and nearly one-third have at least one public transport subscription. Accessibility to public transport is relatively good: In 2021, 87.2% of East Flemish households lived within five kilometres of a train station, and 58.8% within 200 metres of a public transport stop (Provincies in cijfers, 2025b).

The survey was distributed to employees of public institutions and private companies in East Flanders between October 2023 and January 2024. We first contacted multiple organizations, and when they expressed interest in distributing the survey, it was shared with their employees via mailing lists. The organisations that agreed to distribute the survey were predominantly active in research and public governance (e.g., Ghent University, the Province of East Flanders, and the City of Ghent). As a result, the sample is skewed toward highly educated and higher-income respondents, as well as women. Nearly 85% of the sample reports teleworking, compared to about 33% teleworkers in Flanders overall ("One employee," 2025a). However, women, highly educated individuals, people in intellectual or scientific occupations, and those working in the public sector are all more likely to telework than the Flemish average ("Structuur van de bevolking," 2025b). Given this overrepresentation of groups for whom telework is more common, the findings cannot be generalised to the full working population but instead reflect patterns among high-skilled workers in telework-accessible positions.

3.2. Statistical Approach and Variables

The study examines how teleworking frequency affects CWB and SWL, and how these effects vary by gender and childcare responsibilities. CWB was measured with the Satisfaction with Travel Scale (Ettema et al., 2011), based on nine statements capturing affective and cognitive aspects of commute satisfaction, with the final score calculated as their mean. SWL reflects general life satisfaction and was measured using five statements from the Satisfaction with Life Scale (Diener et al., 1985), with the final score calculated as their average. An overview of all variables used in the OLS models is provided in Table 1A (Supplementary File).

Telework frequency, measured as the average number of days per week the respondent works from home, is the main predictor in the baseline model. The extended models include interactions with gender (gender model) and with the presence of children in the household (childcare model) to assess whether effects vary by gender and childcare responsibilities. Several control variables were included. For teleworking, we account for teleworking mismatch (the difference between actual and preferred teleworking days) and dual-teleworkers, a binary indicator of whether both the respondent and their partner telework at least once per week. Socio-demographic controls include gender, age, higher education, income, and household composition. Regarding occupation, two variables were added: working full-time (a binary indicator) and work frequency, the average number of days per week the respondent performs paid work. Travel-related indicators include driver's license, number of cars, main commute mode, average commute distance, average commute duration, average weekly number of commute trips, and neighbourhood. The latter captures perceived urbanization. Respondents indicated how urbanized they considered their residential neighbourhood to be on a 0–100 scale, where 0 represents a very rural area and 100 a very urbanized area. Lastly, CWB and SWL were included as control variables in each other's models due to their mutual influence (Maheshwari et al., 2024).

3.3. Characteristics of the Sample

The online survey resulted in a sample of 1290 respondents, which was reduced to 1029 after removing incomplete and invalid cases. Over 80% of the removed cases did not complete the survey. Additionally, 42 respondents had a workplace outside the study area, and eight did not fit in our definition of a teleworkable job, as unpaid work and freelance occupations were excluded.

The sample was predominantly female (65%), with nearly three-quarters living with a partner and around half having children in the household. Most respondents teleworked at least once per week (higher than the Flanders average due to the targeted companies) with an average of 1.79 days per week. On average, respondents teleworked about half a day less than they preferred, though individual telework mismatch varied substantially.

When traveling to their workspace, the car is the most common mode (32%), closely followed by non-electric bike (27%) and electrical bike (19%). Public transport accounts for around 23% of commuting trips, with the train as the main public transport mode. The share of respondents using other modes is marginal. The average one-way commute distance was 20.2 km and the one-way travel time was 35.1 minutes. Wellbeing levels were generally positive, with a mean commute wellbeing of 4.61 (7-point scale) and life satisfaction of 3.57 (5-point scale), though individual scores varied widely. A descriptive table is included in the Supplementary File for reference (Table 2A).

4. Results

4.1. Model 1: Commute Wellbeing

Three OLS models were estimated to assess (a) general effects, (b) gender-related effects, and (c) childcare-related effects of teleworking on CWB. All models were tested for compliance with OLS assumptions. Eighteen outliers were removed. Two variables, *commute distance* and *living with partner*, were excluded due to multicollinearity violations. *Commute distance* (VIF = 4.8) had a correlation of 0.82 with *commute duration*, while *living with partner* (VIF = 5.9) had a correlation of 0.89 with *dual-earners*. The correlation matrix has been added to the Supplementary File for reference (Table 3A).

Table 1 presents the outcomes of the baseline model, which explains approximately 35% of the variance in commute wellbeing. First, teleworking is a significant predictor of commute wellbeing. More frequent teleworking is associated with lower commute wellbeing: For each additional day of teleworking per week, commute wellbeing decreases by 0.141 points. In addition, teleworking less frequently than preferred (a negative telework mismatch) is associated with lower commute satisfaction. This indicates that individuals who would like to telework more perceive their commute as less satisfying. Several commute-related characteristics also influence commute wellbeing. Individuals with longer one-way commute durations report, on average, lower commute satisfaction. In contrast, those commuting by bike, e-bike/motorbike, or train report higher commute wellbeing compared to car users. The strongest positive effects are observed for e-bike and motorcycle users, followed closely by non-electrical bike users. Additionally, both age and work frequency are positively associated with commute satisfaction: Older individuals and those who work more days per week tend to report higher commute wellbeing. Finally, SWL is a strong predictor of commute wellbeing, suggesting that wellbeing in broader life domains spills over into the commuting experience.

In the two extended models, the gender model and the childcare model, no significant effects related to gender or childcare responsibilities were found. Both models are included in the Supplementary File for reference (Tables 4A and 5A). Neither gender nor the presence of children in the household had a significant impact on commute wellbeing, neither as separate variables (*female* and *children* in the baseline model) nor in interaction with teleworking (gender model and childcare model).

Table 1. Commute wellbeing: Baseline model outcomes.

	Coefficient	*t*-test	*p*-value
Intercept	1.498	3.053	0.002
Telework frequency	−0.141	−4.052	< 0.001***
Telework mismatch	0.167	4.309	< 0.001***
Dual-teleworker	−0.008	−0.096	0.924
Female	−0.018	−0.250	0.802
Age	0.022	6.198	< 0.001***
Higher education degree	0.146	1.048	0.295
Income €3501–€5500	0.096	1.142	0.254
Income < €3500	0.145	1.144	0.253
Dual-earners	−0.095	−0.891	0.373
Number of children	−0.014	−0.291	0.771
Youngest child under 6	0.092	0.708	0.479
Youngest child 6–11	0.136	1.022	0.307
Youngest child 12–17	0.020	0.151	0.880
Working fulltime	−0.150	−1.340	0.181
Work frequency	0.164	2.391	0.017**
Drivers license	−0.073	−0.491	0.624
Number of cars	0.071	1.288	0.198
Main mode bike	0.997	8.907	< 0.001***
Main mode e-bike, motorbike	1.113	10.534	< 0.001***
Main mode train	0.497	3.737	< 0.001***
Main mode tram, bus, metro	0.280	1.572	0.116
Commute duration	−0.010	−4.255	< 0.001***
Commute trips	0.020	0.669	0.504
Neighbourhood	−0.001	−0.937	0.349
Satisfaction with life	0.425	8.248	< 0.001***

Note: Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.2. Model 2: SWL

Similar to the CWB models, three OLS models were estimated to assess (a) general effects, (b) gender-related effects, and (c) childcare-related effects of teleworking on life satisfaction. All three models were tested for compliance with OLS assumptions. Eighteen outliers were removed, and the variables *commute distance* and *living with partner* were excluded due to multicollinearity issues (see Table 3A in the Supplementary File). The residuals appeared slightly left-skewed, and the Shapiro-Wilk test for normality had a significant p-value, indicating a potential violation of the normality assumption. However, given the absence of heteroskedasticity and the large sample size, which increases the robustness of OLS estimates, no serious violations were expected. As a robustness check, the models were re-estimated using robust standard errors, which showed no substantial differences.

Table 2 shows the outcomes of the Baseline model. The model explains around 16% of the variance in SWL. Telework frequency and telework mismatch were not found to be significant predictors of SWL. Although telework frequency itself was not a significant predictor of SWL, it may still have an indirect effect via the number of commute trips. However, the number of commute trips was not a particularly strong predictor of life satisfaction (p-value = 0.073). As with the commute wellbeing results, several commute-related characteristics influence life satisfaction, though with some differences. Whereas individuals commuting by bike, e-bike/motorbike, or train reported higher commute wellbeing, those commuting by e-bike/motorbike and by tram, bus, or metro reported, on average, lower SWL. The effect was strongest for those using tram, bus, or metro. Furthermore, individuals who perceived their residential neighbourhood as more urban reported, on average, lower SWL. It is important to note that this variable is a subjective measure, the perceived level of urbanisation reported by the resident, and may not necessarily correspond to the actual degree of urbanisation of the neighbourhood. Sociodemographic characteristics also played a role. In contrast to CWB, where older individuals reported higher scores, older individuals reported lower SWL.

Table 2. SWL: Baseline model outcomes.

	Coefficient	t-test	p-value
Intercept	4.324	10.098	< 0.001***
Telework frequency	0.023	0.717	0.474
Telework mismatch	−0.041	−1.151	0.250
Dual-teleworker	−0.105	−1.410	0.159
Female	0.035	0.531	0.595
Age	−0.011	−3.459	< 0.001***
Higher education degree	0.113	0.878	0.380
Income €3501–€5500	−0.281	−3.672	< 0.001***
Income < €3500	−0.351	−3.014	0.003***
Dual earners	0.368	3.764	< 0.001***
Number of children	−0.120	−2.655	0.008***
Youngest child under 6	0.071	0.589	0.556
Youngest child 6–11	0.060	0.494	0.622
Youngest child 12–17	0.112	0.893	0.372
Working fulltime	−0.001	−0.014	0.988
Work frequency	0.029	0.465	0.642
Drivers license	0.215	1.582	0.114
Number of cars	−0.031	−0.604	0.546
Main mode bike	−0.043	−0.399	0.690
Main mode e-bike, motorbike	−0.258	−2.495	0.013**
Main mode train	0.001	0.009	0.993
Main mode tram, bus, metro	−0.438	−2.672	0.008***
Commute duration	−0.001	−0.401	0.688
Commute trips	−0.050	−1.796	0.073*
Neighbourhood	−0.003	−1.967	0.050*
Commute wellbeing	0.258	8.248	< 0.001***

Note: Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Respondents with a low to median household income also reported lower SWL compared to those in the highest income group, with the strongest negative effect observed in the lowest income category. In addition, dual earners reported higher SWL than single earners. The number of children in the household negatively relates to SWL. Finally, commute wellbeing is a strong and significant predictor: Having a more positive commute wellbeing score was also associated with higher SWL.

In the Gender Model, which includes the interaction term between teleworking and gender, no significant effects related to gender were found. The table is included in the Supplementary File for reference (Table 6A). Gender does not appear to have a significant effect on life satisfaction, neither as a separate variable (*female* in the baseline model) nor in interaction with teleworking (*telework* × *gender* in the gender model). Female teleworkers did not report significantly different levels of SWL compared to male teleworkers, female non-teleworkers, or male non-teleworkers.

While teleworking frequency did not have a significant impact on SWL in the Baseline Model, the interaction between teleworking and the presence of children was found to be significant. Table 3 presents the significant results of the model extended with the childcare interaction term (childcare model). Teleworkers without children and non-teleworkers with children reported significantly higher SWL than teleworkers with children, with the strongest effects observed for non-teleworkers with children. The significantly higher life satisfaction reported by non-teleworkers with children, compared to teleworkers with children, became an even stronger association when the children were younger. The strongest effects were found for households with children under the age of six. These findings suggest that combining childcare responsibilities, especially for young children, with working from home negatively affects individuals' life satisfaction.

Table 3. SWL: Childcare Model outcomes (significant only model).

	Coefficient	*t*-test	*p*-value
Intercept	3.265	21.088	< 0.001
Teleworker, without children	0.109	2.198	0.028**
Non-teleworker, with children	0.173	1.811	0.071*
Non-teleworker, without children	0.100	1.192	0.234
Age	−0.009	−4.246	< 0.001***
Income €3501–€5500	−0.199	−3.969	< 0.001***
Income < €3500	−0.216	−2.854	0.004***
Dual-earners	0.262	4.291	< 0.001***
Main mode bike	−0.045	−0.656	0.512
Main mode e-bike, motorbike	−0.188	−2.788	0.005***
Main mode train	−0.017	−0.271	0.787
Main mode tram, bus, metro	−0.348	−3.217	0.001***
Commute trips	−0.038	−2.267	0.024**
Neighbourhood	−0.001	−1.526	0.127
Commute wellbeing	0.184	8.841	< 0.001***

Note: Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

It is important to note that gender was not found to be significant in either the baseline model or the gender model and was therefore not included in the final model (childcare model). Although prior research suggests gender differences due to unequal childcare responsibilities (Beckel & Fisher, 2022; Desjardins et al., 2024), our results show that the significant relationship is between teleworking and the presence of children in the household, regardless of gender.

5. Discussion

This study examined the impact of teleworking frequency on commute wellbeing and SWL, and how these relationships relate to gender and childcare imbalances. First, teleworking frequency is a significant predictor of commute wellbeing: individuals who telework more often report lower levels of commute wellbeing. One possible explanation is that frequent teleworkers may be more willing to tolerate less pleasant commutes because they commute less often than non-teleworkers. In this view, teleworking reduces the perceived impact of an undesirable commute: a worker may tolerate an unpleasant trip if they know they do not have to undertake it every day. Alternatively, teleworking may be used as a coping strategy for less desirable commutes. Employees with long, stressful, or uncomfortable commutes may have a stronger motivation to telework in order to reduce the burden of daily travel. This aligns with the finding that active commute modes and train travel are generally associated with higher commute satisfaction than car travel, as they can reduce stress and contribute to better physical and mental wellbeing (Friman et al., 2017; Martin et al., 2014). Conversely, longer commute times, which tend to be more common among teleworkers (Versigghel et al., 2025), are negatively associated with commute satisfaction. Furthermore, individuals who commute less frequently than they would prefer report significantly lower average commute wellbeing scores. This suggests that these respondents experience their commute as particularly unpleasant or burdensome. Their lower wellbeing scores likely reflect dissatisfaction with the commute itself, which could strengthen their desire to telework more frequently to avoid these undesirable travel experiences. In contrast to the findings for commute wellbeing, teleworking was not identified as a significant predictor of SWL. However, the weekly number of commute trips did emerge as a significant factor: Individuals who commuted more frequently reported lower life satisfaction scores on average. This suggests that teleworking may still indirectly influence SWL by reducing the number of commute trips (Budnitz et al., 2020; Versigghel et al., 2025; Wöhner, 2022).

By focusing on gender and childcare, this study also provides insight into how the digital transformation of employment affects the wellbeing of specific social groups. Regarding gender, we did not find significant differences in commute wellbeing or life satisfaction, either as a separate variable or through its interaction with teleworking. This was contrary to our expectations, given the literature on unequal childcare responsibilities between men and women (Beckel & Fisher, 2022; Desjardins et al., 2024). However, this finding does not necessarily imply that gender disparities are absent in Flanders. Employment and wage gaps persist (Assal et al., 2022), and women continue to spend more time on household chores than men (Audenaert, 2023). The lack of significant effects in our models may be due to complex underlying relationships between gender, teleworking, and wellbeing that are not fully captured by commute and life satisfaction measures alone. For example, while teleworking can increase the likelihood of work–life conflict and caretaking burdens for women as the boundaries between home and work become blurred, it can also offer benefits. Teleworking can provide greater flexibility and fewer commute trips, allowing some women to better balance work and personal life (Beckel & Fisher, 2022; Desjardins et al., 2024). These gendered

dynamics are particularly pronounced when childcare responsibilities are considered, with studies showing that gender imbalances tend to intensify in such contexts (Beckel & Fisher, 2022; Desjardins et al., 2024).

Building on this, childcare was found to have a significant effect on life satisfaction. Although teleworking offers several advantages, it has also been shown to increase household-related inequalities. In our results, teleworkers with children reported significantly lower life satisfaction than both teleworkers without children and non-teleworkers with children. The strongest effect was observed for non-teleworkers with children, indicating that among parents, those who telework experience notably lower life satisfaction than those who do not. This finding aligns with existing research showing that combining telework with childcare can create stressful and conflictual situations. Childcare interruptions during work hours and work interruptions during childcare are often experienced as disruptive, especially for women (Desjardins et al., 2024). Importantly, it is not only the presence of children but also their age, which often reflects the intensity of caregiving burden, that matters. When comparing non-teleworkers with children to teleworkers with children, the difference in life satisfaction was even larger among those with younger children. The greatest gap was observed between non-teleworkers and teleworkers with children under the age of six, suggesting that the combination of teleworking and caring for young children has a particularly strong negative impact on life satisfaction. Overall, these results indicate that the digital transformation of employment does not affect everyone equally. Instead, its effects depend on individuals' socio-economic, spatial, and work-related circumstances.

6. Conclusion

Teleworking has reshaped patterns of work, travel, residence, and social interaction, but its effects are unevenly distributed across socio-economic groups. Our study found that teleworking significantly predicts commute wellbeing, but not SWL. While gender disparities persist in Flanders and teleworking has the potential to intensify them, we found no significant gender effects on commute or life satisfaction. However, combining teleworking with childcare, especially for young children, was associated with lower life satisfaction.

These findings suggest that the digital transition may reinforce existing social inequalities. Workers who have access to high-quality childcare, or commute by active modes and high-quality public transport, are likely to experience greater wellbeing gains. Conversely, those with more caregiving responsibilities or poorer access to infrastructure may experience lower levels of satisfaction. In this way, the shift toward digital work risks deepening inequalities between different groups, underscoring the need for policies that ensure equitable access to the opportunities and benefits of teleworking.

Based on our findings, we propose the following policy recommendations. First, since a higher telework frequency and teleworking less frequently than preferred are negatively associated with commute wellbeing, it is important to develop flexible telework schemes that align with workers' preferences. In particular, individuals who (wish to) adopt telework to avoid time-consuming, costly, or stressful commutes will benefit from increased flexibility. Second, promoting active and collective transport modes, such as walking, cycling, and train travel, can enhance commute satisfaction. Investments in infrastructure, comfort, and reliability, alongside financial incentives (e.g., reimbursements when using active modes, flexible public transport subscriptions, e-bike leasing systems), can encourage employees to adopt these modes for commuting. This

would not only improve commute wellbeing but also reduce traffic congestion, peak-hour traffic, and greenhouse gas emissions. Importantly, teleworkers should also be included in these schemes by providing more flexible arrangements that reflect their different commuting patterns. Finally, since teleworking in combination with caring for young children was associated with significantly lower life satisfaction, the provision of sufficient, high-quality, and affordable childcare is crucial. In Flanders, childcare supply has for years lagged behind demand, with over 30% of parents of young children unable to find a place in 2024 (Lamote, 2025). This shortage can force parents, often women, to reduce working hours, take leave, or combine working from home with childcare duties, which negatively impacts wellbeing. This underlines the importance of sufficient childcare provision, or better coordination between school and working hours. Employers can support work–life balance by encouraging clear boundaries between work and personal time, for example, through a right to disconnect or meeting-free time slots in the morning or late afternoon.

Furthermore, there are several study limitations that must be addressed. First, the sample is not representative of the general working population of East Flanders. The recruitment method resulted in an overrepresentation of highly educated, high-income, and female respondents with above-average telework opportunities. Consequently, findings may not be generalizable to sectors with lower telework feasibility, such as manual labour or service industries. Second, the cross-sectional design limits the ability to infer causal relationships. Associations between telework frequency, wellbeing, and life satisfaction capture correlations at one point in time without the opportunity to assess how these relationships evolve alongside hybrid work norms. In addition, gender and parental status are likely to interact with other forms of inequality, for example, age, migration background, and economic or educational status, in shaping telework uptake and wellbeing. Finally, while the study controlled for several sociodemographic, work-related, and commute-related variables, unobserved factors (such as job satisfaction, management support, home working conditions, or mental health) may also influence wellbeing outcomes.

Future research can address these limitations and build upon these findings in several ways. First, longitudinal studies should track changes in telework frequency, commute patterns, and wellbeing over time to capture adaptation effects and potential for long-term consequences. Second, more diverse and representative samples across industries, income groups, and spatial contexts would help assess equity impacts of teleworking and generalise findings beyond high-skilled sectors. Third, future studies should integrate qualitative or mixed-methods approaches to explore how individuals experience telework in relation to family dynamics, work–life boundaries, and emotional wellbeing.

Overall, our findings highlight the importance of aligning telework policies with the diverse needs of workers and ensuring that the digital transition of work does not come at the expense of equity. As this transition continues, addressing uneven impacts will be crucial to safeguard wellbeing and equitable work environments.

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Conflict of Interests

The authors declare no conflict of interests.

Data Availability

The data that has been used is confidential.

LLMs Disclosure

ChatGPT has been used for language polishing and generating code.

Supplementary Material

Supplementary material for this article is available online in the format provided by the author (unedited).

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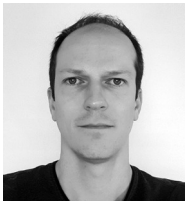

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Does Telework Make People Experience More Segregation in Daily Activity Spaces?

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Abstract

Telework reshapes daily mobility, but its implications for lived social exposure remain underexplored. This study examines whether and how telework affects experienced racial segregation by integrating socioeconomic characteristics, built-environment context, and activity–travel behavior in a structural equation modeling analysis. Using pooled cross-sectional data from the Puget Sound Regional Travel Surveys (2017, 2019, 2021), we distinguish residential segregation (home census block group) from experienced segregation measured across non-work activity destinations using an entropy-based index of multi-group racial diversity. Results show that telework is associated with an increase in experienced racial segregation, primarily through mobility reorganization: Telework increases non-work activity participation but reduces the spatial extent of daily activity spaces, and the localization effect dominates. Residential segregation remains a strong baseline determinant, yet telework contributes additional exposure differences beyond the residential context. Telework adoption is structurally patterned by socioeconomic and built-environment conditions, while density and accessibility shape exposure indirectly via activity behaviors. These findings imply that telework policy is not socially neutral; hybrid arrangements and compact, mixed-use, amenity-rich environments may mitigate telework-related exposure segregation.

Keywords

activity space; mobility; segregation; telework; travel behavior

1. Introduction

Understanding how people encounter—or avoid—social diversity in everyday life is central to debates on urban inequality and spatial justice. Yet segregation research has long been dominated by residential measures derived from static census geographies. This perspective can miss an important dimension of social separation: Individuals are mobile, and their lived exposure to (non-)diversity is produced not only where they live, but also where they routinely go and spend time. Building on time–geographic and mobility-based scholarship, we conceptualize experienced segregation as the degree of social diversity embedded in the set of places individuals visit during daily life (Farber et al., 2015; Wong & Shaw, 2011). Prior work shows that activity spaces can either mitigate or reproduce segregation, depending on how urban opportunities and mobility constraints shape daily routines.

A major post-pandemic transformation with the potential to restructure such exposure is telework. Remote and hybrid work reduces or eliminates routine commuting, alters time budgets, and reorganizes daily activity scheduling. A growing literature documents telework's implications for travel demand (e.g., reduced peak-hour travel and fewer commute trips), but far less is known about its consequences for social exposure through everyday mobility. Telework may contract activity spaces and increase reliance on nearby destinations, which could heighten experienced segregation when surrounding neighborhoods are socially homogeneous. At the same time, telework could also increase temporal flexibility and enable engagement with a wider range of destinations. Whether telework ultimately increases or decreases experienced segregation is therefore an empirical question that depends on the opportunity landscape and individuals' activity–travel responses.

This study addresses this gap by examining whether and how telework is associated with experienced racial segregation in daily activity spaces, and through which behavioral pathways this relationship operates. Focusing on the US context—where racial segregation remains spatially and historically salient—we operationalize experienced segregation using a multi-group entropy-based index that captures the racial diversity of the places individuals encounter through their everyday activities. By conceptualizing segregation as an exposure outcome rather than an individual attribute, the analysis centers on how telework-induced changes in daily activity behavior—such as activity frequency and spatial extent—translate into systematic differences in exposure to racial diversity across urban environments.

Empirically, we use travel-survey data from the Puget Sound region (three pooled cross-sectional waves: 2017, 2019, and 2021) to measure both residential segregation (home census block group) and experienced segregation (the set of non-work activity destinations visited). We estimate a structural equation model that treats telework as an intermediate mechanism linking socioeconomic characteristics and built-environment context to two key activity-behavior dimensions—activity frequency and spatial extent—and, ultimately, to experienced segregation. This approach allows us to quantify both direct and mediated pathways, while keeping the residential context conceptually distinct from mobility-based exposure.

The contribution of this article is twofold. First, it advances mobility-based segregation research by explicitly linking experienced segregation to a major contemporary shift in work organization—telework—rather than treating activity-space segregation as a descriptive outcome alone. Second, it provides an integrated behavioral account of how telework reshapes exposure through changes in daily activity participation and travel range, net of residential segregation, socioeconomic characteristics, vehicle ownership, and built environment.

The remainder of the article is structured as follows. Section 2 reviews research on experienced segregation and telework-related mobility change. Section 3 describes the study area, data, and variables. Section 4 presents the segregation measurement and SEM approach. Section 5 reports results. Section 6 discusses theoretical and policy implications and outlines directions for future research.

2. Literature Review

2.1. Experienced Segregation in Daily Life

Segregation is increasingly understood as a mobility-based and multi-contextual phenomenon, shaped not only by where people live but also by where they routinely go in daily life. In contrast to traditional residential measures derived from static census geographies, experienced segregation (or activity-space segregation) captures the degree of social diversity individuals encounter across the locations they access through everyday activities (Farber et al., 2015; Wong & Shaw, 2011). This perspective is behavior-based and exposure-oriented, reflecting daily mobility patterns rather than a single residential context, and offering a more direct lens on lived social separation. Empirical studies consistently show that activity spaces are often socially homogeneous—even in residentially diverse regions—because daily mobility is structured by time constraints, uneven opportunity distributions, and selective destination choices (Farber et al., 2015; Müürisepp et al., 2022; Wang et al., 2016). As a result, experienced segregation may either mitigate or reinforce residential segregation, depending on how mobility expands or constrains exposure. These findings highlight that the relationship between residential and activity-space segregation is context-dependent rather than deterministic. Methodological advances using travel surveys, GPS tracking, and mobile phone data have enabled increasingly fine-grained measurement of such exposure, while also underscoring that experienced segregation is sensitive to how exposure is defined and weighted (Pereira et al., 2019).

2.2. Telework and Daily Activity–Travel Behavior

Telework represents a major transformation in the organization of daily activities and travel. By reducing or eliminating routine commuting, telework alters time constraints, scheduling flexibility, and destination needs. Existing research consistently documents reductions in commute trips and peak-period travel (Mokhtarian & Salomon, 1997; Ory & Mokhtarian, 2006), but its effects on non-work travel are more mixed. Some studies find overall reductions in mobility, while others observe substitution and rescheduling effects, whereby time saved from commuting is reallocated to discretionary or maintenance activities (de Abreu e Silva & Melo, 2018; Zhu, 2012). Telework adoption is also socially stratified, strongly associated with occupation, income, education, and access to digital infrastructure. Consequently, its mobility impacts are heterogeneous and embedded within broader socioeconomic and urban contexts, with implications that extend beyond travel demand alone.

2.3. Telework as a Mechanism Reshaping Experienced Segregation

By reorganizing daily mobility, telework has direct implications for experienced segregation. The removal of routine access to centralized and potentially diverse workplaces may contract activity spaces and increase reliance on nearby destinations, thereby amplifying exposure to socially homogeneous environments—particularly in segregated residential contexts (Elldér, 2020; Mouratidis & Peters, 2022). At the same time,

increased temporal flexibility may enable more discretionary mobility and access to a wider range of environments, depending on local opportunity structures and individual mobility resources. Despite these conceptual links, empirical evidence remains limited. Telework studies rarely examine exposure-based outcomes, while activity-space segregation research has seldom treated telework as a central mechanism reshaping daily exposure. It therefore remains unclear whether telework increases, decreases, or redistributes experienced segregation, and through which behavioral pathways. This study addresses this gap by examining how telework influences experienced segregation through changes in activity frequency and spatial extent, while accounting for residential context, socioeconomic characteristics, and the built environment.

3. Research Data

This study uses data from the Puget Sound Region Travel Surveys collected between 2017 and 2021. The Puget Sound region in Washington State—covering the King, Kitsap, Pierce, and Snohomish counties and including the city of Seattle (Figure 1)—is home to over 4 million residents and 1.5 million households. The survey provides detailed information on individual and household sociodemographics, geographic context, and daily travel behavior, including trip frequency, travel time, and mode choice. A stratified sampling design was used, with recruitment quotas by county, household characteristics, and demographic composition, and survey weights were applied to align the sample with American Community Survey population benchmarks. The survey oversampled block groups with policy-relevant characteristics, including low-income households, zero-vehicle households, non-auto commuters, and younger households. In this study, we focus on working individuals who either commute or telework.

Figure 1. Spatial distribution of sampled households in the Puget Sound region.

The US provides an analytically salient context for examining experienced segregation given its persistent patterns of racial and spatial inequality. Within this setting, the Puget Sound region offers a particularly informative case. The region combines substantial sociodemographic heterogeneity, mixed land use, and a highly polycentric urban structure, generating meaningful variation in daily activity spaces. Its economy is

strongly oriented toward technology- and knowledge-intensive industries, where telework is both feasible and prevalent. At the same time, pronounced racial and socioeconomic divides—such as those between more diverse, lower-income areas in South Seattle and South King County and wealthier, predominantly White suburban areas in the northern suburbs and Eastside cities—reflect long-standing patterns of housing inequality, income stratification, and uneven transit access. These regional characteristics provide critical context for interpreting how telework reshapes daily mobility and experienced segregation.

The dependent variable is racial segregation, operationalized in two forms: residential segregation and mobility-based experienced segregation, both measured using an entropy-based index. Residential segregation is calculated from the racial composition of an individual's home census block group, capturing the immediate residential social environment (the choice of spatial unit and MAUP [modifiable areal unit problem] considerations are discussed in Appendix A in the Supplementary File). Experienced segregation is derived from the racial diversity of all census block groups visited during daily activities, reflecting exposure beyond the residential context. Together, these measures enable a direct comparison between static residential segregation and dynamic, mobility-based social exposure (see Figure 2 and Section 4.1).

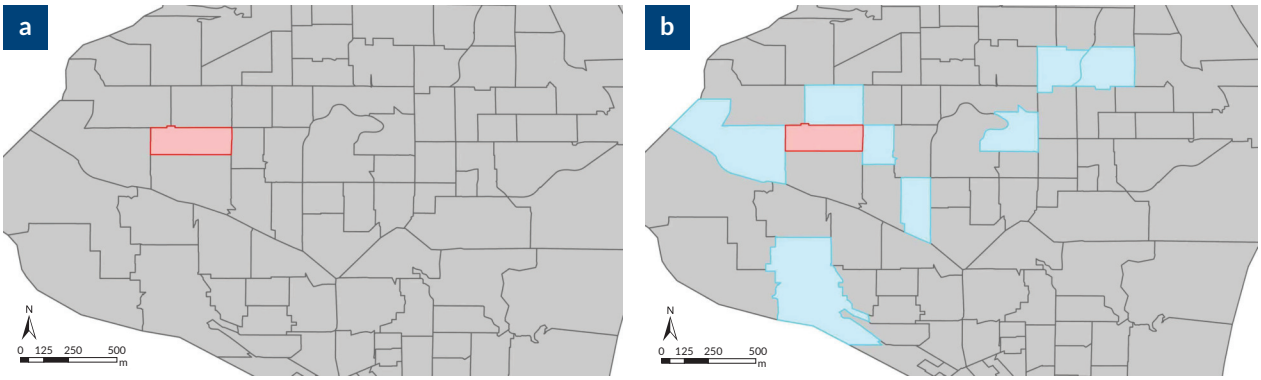

Figure 2. Illustrations of individuals' home neighborhoods and visited activity spaces: (a) residential neighborhoods; (b) visited non-work activity spaces. Notes: The red region is the census block group of people's home address, and the blue regions are the neighborhoods that people visited for their daily activities; work-related activities are excluded, as they typically involve fixed destinations and limited personal choice, whereas non-work trips better reflect voluntary engagement with diverse social environments.

Explanatory variables include built-environment characteristics and individual, socioeconomic, demographic, and household factors. The inclusion of built-environment variables is motivated by the extensive literature demonstrating their role in shaping activity participation and travel behavior. Telework, as a form of activity organization, is embedded within the surrounding urban context rather than an isolated behavioral choice. We adopt the 5D built-environment framework—Density, Design, Diversity, Distance to transit, and Destination accessibility—to capture key spatial attributes in a parsimonious manner. Rather than modeling direct effects on segregation, the analytical framework emphasizes indirect pathways, whereby the built environment influences telework adoption and activity behavior (activity frequency and spatial extent), which in turn shape experienced segregation. Descriptive spatial distributions of the 5D measures are provided in Appendix B in the Supplementary File.

Individual- and household-level data are drawn from the Puget Sound Regional Travel Survey, while built-environment indicators are compiled from multiple external sources, including the Environmental Protection Agency Smart Location Database, OpenStreetMap, the General Transit Feed Specification data,

and regional land-use datasets. All built-environment variables are aggregated to the census block group level to ensure spatial consistency with the survey data. Table 1 reports variable definitions and descriptive statistics for the segregation outcomes, activity measures, and explanatory variables (including the 5D built-environment indicators), by telework status.

Table 1. Variable definition and descriptive statistics.

		Teleworker	Non-teleworker	Full sample
		(*n* = 2,473)	(*n* = 8,962)	(*n* = 23,794)
Endogenous variables				
Residential segregation	Residential race segregation index	0.40	0.40	0.41
Experienced segregation	Experienced race segregation index	0.37	0.35	0.37
Radius of activities	The average distance of non-work daily activities (km)	4.72	5.72	5.72
Number of activities	The frequency of non-work daily activities per day	2.73	2.27	2.70
Independent variables				
Socioeconomic variables				
Age	16–34	37%	48%	36%
	35–54	48%	40%	31%
	55+	16%	12%	34%
Gender	Male	46%	51%	48%
	Female	53%	49%	52%
Household income	Under $49,999	15%	17%	19%
	$50,000–$99,999	24%	29%	27%
	$100,000 or more	61%	53%	54%
Vehicle ownership	Yes	87%	86%	87%
	No	13%	14%	13%
Racial ethnicity	White	75%	77%	81%
	African American	3%	3%	2%
	Asian	17%	15%	13%
	Hispanic	5%	5%	4%
Built-environment variables (census block group level)		Teleworker	Non-teleworker	Full sample
		(*n* = 849)	(*n* = 1,231)	(*n* = 2,926)
Density	Population density (1,000 persons/km^2)	5.90	6.67	5.76
Design	Intersection density (100 counts/km^2)	0.72	0.78	0.71
Diversity	Land-use entropy [a] normalized	0.77	0.79	0.76
Destination accessibility	Job accessibility (10^5 jobs reached by public transit within 45 minutes)	3.46	3.73	3.33
Distance to transit	Transit service frequency (100/within a 0.25-mile [approximately 400 meters] buffer of the CBG boundary)	0.92	0.96	0.87

Notes: For the calculation of the entropy index, please refer to Section 4.1; CBG = census block group.

4. Methodology

4.1. Entropy-Based Segregation Index

To measure experienced segregation in individuals' activity spaces, we employ an entropy-based diversity index. This measure is particularly suitable for the present study because it captures multi-group social diversity across individuals' visited locations, rather than focusing on pairwise relations between specific social groups. Moreover, entropy-based indices have been widely applied in prior research on experienced and exposure-based segregation, facilitating comparability with existing studies. Alternative segregation measures, such as isolation, exposure, and dissimilarity indices, are also commonly used in the literature. However, these measures are typically designed to capture pairwise group interactions or residential sorting patterns and are therefore less well suited for assessing overall diversity within multi-group activity spaces. While exposure-based indicators (e.g., exposure-to-nonself indices) can provide valuable insights into specific intergroup exposure dynamics at the individual level, we adopt the entropy-based index as our primary measure given the study's focus on overall experienced diversity. Future research may complement this approach by incorporating exposure-based measures to examine more fine-grained intergroup exposure processes.

To measure entropy index, the entropy value (H) is calculated by summing the negative product of the proportion of each racial group (p_i) and the logarithm of that proportion across all k racial groups (Equation 1). This value reflects the level of diversity: Higher entropy indicates greater racial mix. To standardize the measure across contexts with different numbers of racial groups, the entropy is normalized (H_{norm}) by dividing by the maximum possible entropy ($\log(k)$; Equation 2). Finally, the segregation index is derived as 1 minus the normalized entropy ($1 - H_{\text{norm}}$), such that values close to 0 indicate low segregation (high diversity), while values close to 1 indicate high segregation (low diversity or racial homogeneity; Equation 3). This index can be applied to both residential neighborhoods and visited activity spaces to assess segregation in static and dynamic contexts:

$$H = -\sum_{i=1}^{k} p_i \log(p_i) \quad \text{(Equation 1)}$$

where k: number of groups (e.g., racial categories); p_i: proportion of group i in the observed population (e.g., population from group i among all population); the logarithm is typically base 2 (for bits) or base e (natural log).

$$H_{\text{norm}} = \frac{H}{\log(k)} \quad \text{(Equation 2)}$$

$H_{\text{norm}} \in [0, 1]$, where 0 indicates complete segregation (only one group present), and 1 indicates maximum diversity (all groups equally represented).

$$\text{Segregation Index} = 1 - H_{\text{norm}} \quad \text{(Equation 3)}$$

where 0 represents no segregation (full diversity), and 1 represents full segregation (only one group present).

4.2. Structural Equation Modeling

Structural equation modeling (SEM) allows for the simultaneous estimation of multiple linked regression equations, often referred to as a "structural" or "path" model, where causal relationships between variables are represented as paths. Variables that are independent of others in the model are termed exogenous, while those serving as predictors in one equation and dependent variables in another are called endogenous. SEM also accommodates "latent" or "unobserved" variables, which are defined by underlying indicators known as manifest variables. The measurement model specifies the relationships between latent variables and their indicators, while the structural model captures the relationships between exogenous and endogenous variables.

SEM can depict both direct effects between variables and indirect effects mediated by other variables, such as the impact of attitudes on travel behavior through residential choice. Understanding SEM results often involves calculating direct and indirect effects. A direct effect occurs when one variable influences another without mediation, while an indirect effect involves mediation by one or more variables. The total effect of one variable on another is the sum of its direct and indirect effects. The standardized total effects are displayed in this study, which means the sum of the direct and indirect standardized effects. Standardized effects illustrate how much one unit change in the standard deviation of an exogenous/endogenous variable can lead to the number of unit changes in another interested endogenous variable.

Figure 3 presents the conceptual framework guiding the SEM, which formalizes how telework reshapes experienced segregation in daily activity spaces through changes in mobility behavior, while accounting for residential context, socioeconomic characteristics, and the built environment. At the core of the framework, experienced segregation (Exp_Seg) is conceptualized as an outcome of both contextual exposure and behavioral exposure. Contextual exposure is captured by residential segregation (Res_Seg), reflecting the social composition of individuals' home neighborhoods. Behavioral exposure is captured through daily activity patterns, measured by the number of non-work activities (Num_act) and the spatial extent of activities (Radius_activity). Telework plays a central mediating role by restructuring these activity behaviors and directly influencing experienced segregation.

Formally, the model specifies the following structural relationships:

$$\text{Exp\_ Seg} = f(\text{Res\_ Seg} + \text{Telework} + \text{Num\_ act} + \text{Radius\_ activity} + \text{Vehicle} + SE + BE)$$

Experienced segregation (Exp_Seg) is modeled as a function of residential segregation (Res_Seg), telework status, activity frequency (Num_act), activity-space extent (Radius_activity), vehicle ownership (Vehicle), socioeconomic characteristics (SE), and built-environment attributes (BE). This specification captures both direct effects (e.g., telework directly altering exposure) and indirect effects operating through mobility behavior and transport resources.

$$\text{Telework} = f(\text{Vehicle} + SE + BE)$$

Telework adoption is modeled as an endogenous behavior shaped by vehicle ownership, socioeconomic status and the built environment. This reflects well-documented structural inequalities in access to telework opportunities and the role of urban context in enabling or constraining remote work.

$$\text{Num\_act} = f(\text{Telework})$$

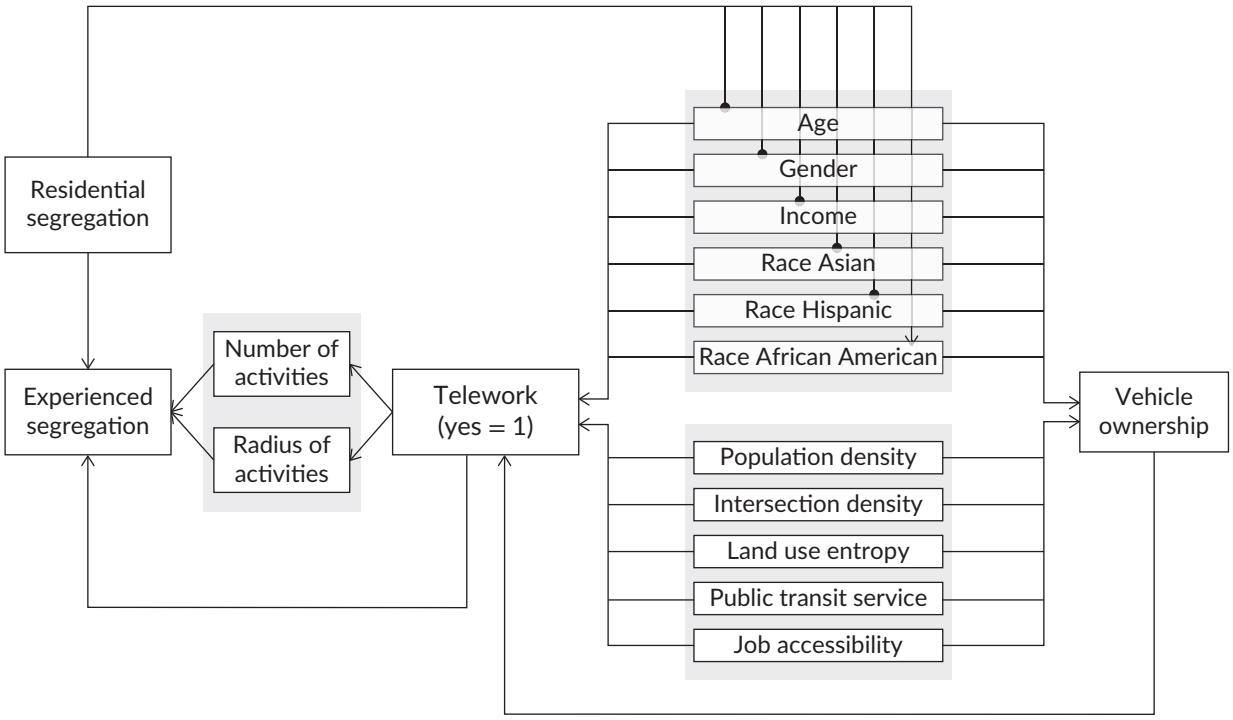

Figure 3. Research framework of the SEM model construct. Note: Each arrow in the figure represents a hypothesized directional relationship between two variables, where the variable at the tail of the arrow serves as the explanatory variable and the variable at the arrowhead represents the outcome.

The number of non-work activities is specified as a function of telework, capturing how remote work reorganizes daily activity participation by reducing time constraints associated with commuting and reshaping discretionary travel.

$$\text{Radius\_activity} = f(\text{Telework})$$

The spatial extent of daily activity spaces is modeled as a function of telework, reflecting the contraction or localization of mobility patterns when routine commuting is reduced or eliminated.

$$\text{Vehicle} = f(SE + BE)$$

Vehicle ownership is modeled as a function of socioeconomic characteristics and the built environment, acknowledging that access to private vehicles is jointly shaped by individual resources and urban form (e.g., density, transit provision).

$$\text{Res\_Seg} = f(SE)$$

Residential segregation is specified as a function of socioeconomic characteristics, reflecting structural sorting processes that link income, race, and demographic attributes to residential location patterns.

In all equations, $f(\cdot)$ denotes a structural relationship estimated within the SEM framework, rather than a specific functional form. Each function represents a linear structural equation capturing the net direct effects of the included predictors on the outcome variable, while allowing indirect effects to propagate through the system of equations. This formulation enables the simultaneous estimation of multiple, interdependent pathways linking telework, activity behavior, and experienced segregation.

4.3. Modeling Performance

The model demonstrates an acceptable overall fit to the data based on multiple complementary goodness-of-fit indices (see Appendix C in the Supplementary File for additional details). The root mean square error of approximation (RMSEA = 0.046) is below the commonly recommended threshold of 0.06, indicating a close fit between the specified model and the observed data (Browne & Cudeck, 1993; Hu & Bentler, 1999; Kline, 2016). The standardized root mean square residual (SRMR = 0.042) is also well below the recommended upper limit of 0.08, providing further evidence of good absolute model fit. Although the comparative fit index (CFI = 0.440) and Tucker–Lewis index (TLI = 0.821) fall below conventional cutoffs (CFI/TLI $\geq$ 0.90), this outcome is not unexpected in large-sample SEMs with categorical variables, multiple observed predictors, and diagonally weighted least squares estimation, where the independence baseline model often fits poorly (Kline, 2016). In such contexts, absolute fit indices such as RMSEA and SRMR are considered more informative for assessing model adequacy than incremental fit measures. The chi-square statistic is significant (χ^2 = 1,182.6, $p < 0.001$), which is expected given the large sample size and does not, by itself, indicate poor model fit.

5. Results

5.1. Descriptive Analysis of Segregation in the Puget Sound Region

Figure 4 presents four spatial distributions of segregation in the Seattle metropolitan area, comparing residential segregation and experienced segregation in activity spaces across different population groups. All panels are based on a normalized racial entropy index, where darker shades indicate higher levels of segregation (i.e., lower racial diversity and more homogeneous neighborhood contexts). Figure 4a shows residential segregation, capturing the racial composition of individuals' home census block groups. High levels of residential segregation are observed in peripheral and suburban areas, particularly in parts of Snohomish County and eastern King County, while more central areas around Seattle exhibit comparatively lower residential segregation. Figure 4b displays experienced segregation in activity spaces for all respondents, reflecting the racial diversity of neighborhoods individuals visit for non-work activities (i.e., only the home census block group itself). Compared to residential segregation, experienced segregation in activity spaces is generally lower and more spatially dispersed, indicating that daily activities expose individuals to a broader range of neighborhood contexts than their residential locations alone. Figure 4c focuses on on-site workers. Their experienced segregation in activity spaces shows a wider spatial spread and lower overall segregation levels than the residential pattern, suggesting that regular commuting and out-of-home activities increase exposure to more diverse neighborhood environments. Figure 4d presents experienced segregation in activity spaces for teleworkers. In contrast to on-site workers, teleworkers exhibit higher levels of segregation in several suburban and peripheral areas. This pattern warrants further investigation into how telework affects experienced segregation, a topic discussed in the following section. We also computed global spatial autocorrelation indicators (Moran's I) to assess clustering intensity. The results show that residential segregation exhibits the strongest spatial clustering (Moran's I = 0.5461), followed by experienced segregation for all individuals (0.4358). Clustering is weaker for activity-space segregation among non-teleworkers (0.3515) and teleworkers (0.3399), indicating that experienced segregation is more spatially dispersed than residential segregation.

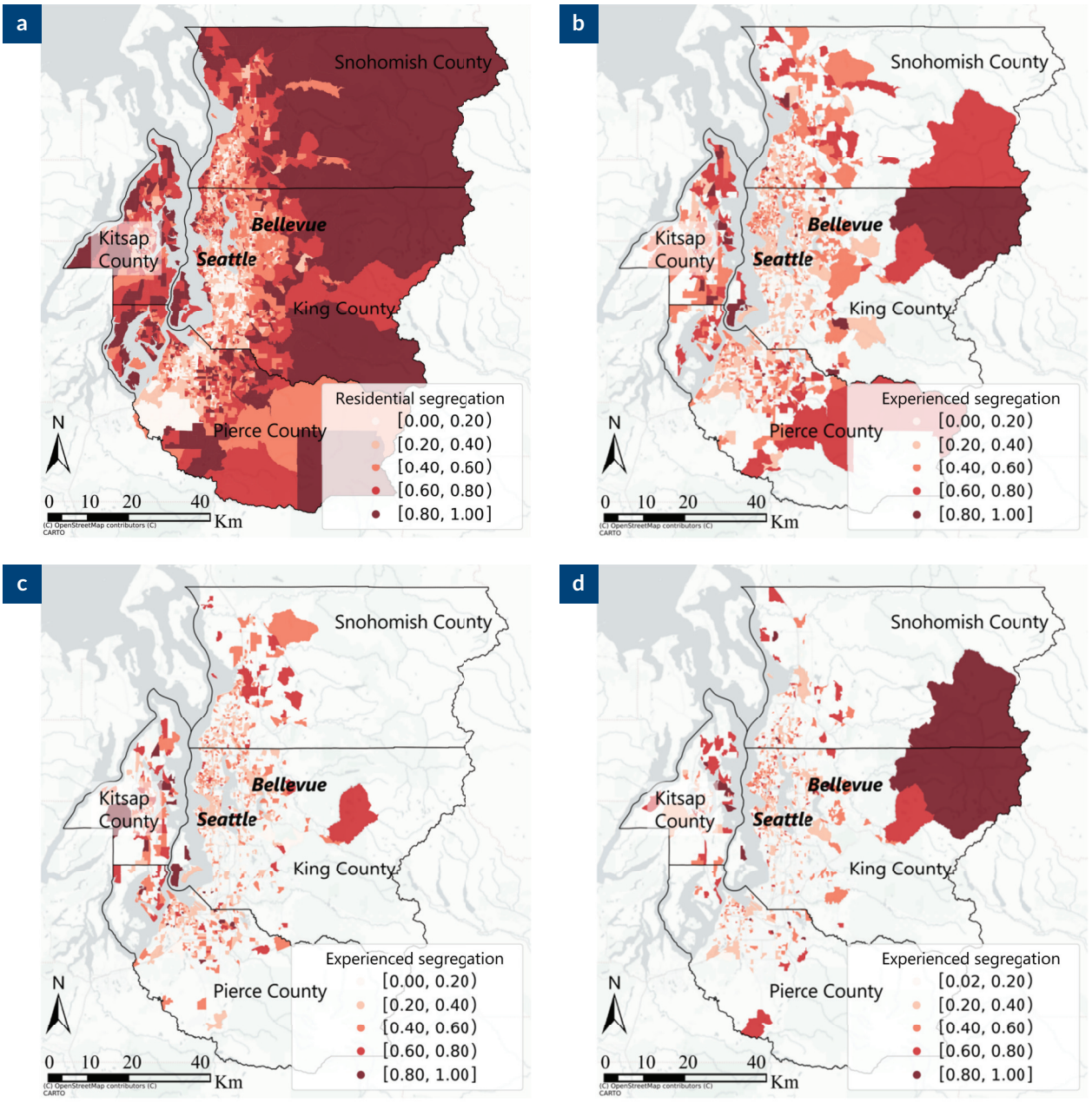

Figure 4. Spatial distribution of (a) residential segregation; (b) experienced segregation (all people); (c) experienced segregation (on-site worker); and (d) experienced segregation (teleworker).

5.2. SEM Results

The SEM reveals several key patterns in how individual attributes, travel behaviors, and built-environment factors contribute to both residential and experienced racial segregation. While the explained variance remains modest for most behavioral outcomes, the interrelationships among predictors offer valuable insight into the mechanisms that underlie segregation in everyday mobility (Figure 5 and Table 2). The results at the census tract level are attached in Appendix D in the Supplementary File.

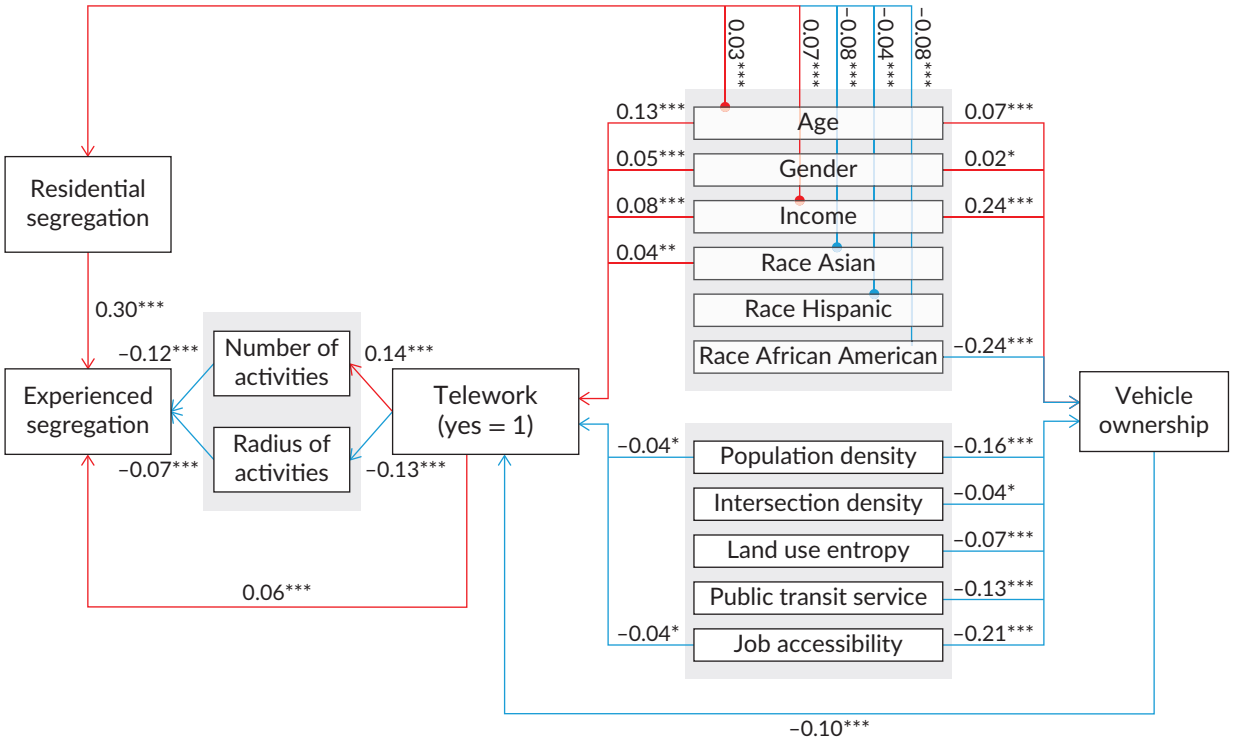

Figure 5. Illustration of how telework influences experienced segregation. Notes: Activity here means non-work activity A path represents a hypothesized directional relationship between two variables, where the variable at the tail of the arrow serves as the explanatory variable and the variable at the arrowhead represents the outcome; for clarity of presentation, all standardized coefficients are rounded to two decimal places; significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table 2. SEM results.

	Vehicle ownership	Telework	Number of activities	Radius of activities	Residential segregation	Experienced segregation
Telework			0.1373 (0.1373)	−0.1283 (−0.1283)		0.0507 (0.0577)
Number of activities						−0.1193 (−0.1193)
Radius of activities						−0.0731 (−0.0731)
Residential segregation						0.2958 (0.2958)
Vehicle ownership		−0.0985 (−0.0985)	0.0076	0.0126		−0.0050
Age	0.0748 (0.0748)	0.1265 (0.1339)	0.0174	−0.0162	0.0339 (0.0339)	0.0164
Gender		0.0536 (0.0536)	0.0070	−0.0066		0.0026
Income	0.2441 (0.2441)	0.0554 (0.0794)	0.0076	−0.0071	0.0668 (0.0668)	0.0226
Race Asian		0.0361 (0.0361)	0.0049	−0.0046	−0.0804 (−0.0804)	−0.0220

Table 2. (Cont.) SEM results.

	Vehicle ownership	Telework	Number of activities	Radius of activities	Residential segregation	Experienced segregation
Race Hispanic			0.0021	−0.0020	−0.0371 (−0.0371)	−0.0102
Race African American	−0.0432 (−0.0432)		0.0011	−0.0010	−0.0780 (−0.0780)	−0.0227
Population density	−0.1641 (−0.1641)	−0.0227 (−0.0389)	−0.0031	0.0029		−0.0012
Intersection density	−0.0357 (−0.0357)	0.0035	−0.0008	0.0007		−0.0003
Land use entropy	−0.0718 (−0.0718)	0.0210	−0.0013	0.0012		−0.0005
Public transit service	−0.1306 (−0.1306)	0.0129	0.0045	−0.0042		0.0017
Job accessibility	−0.2132 (−0.2132)	0.0210	−0.0026	0.0024		−0.0010
R^2	0.331	0.032	0.019	0.016	0.021	0.110

Notes: Values in parentheses represent direct effects; cells report the total effect; when shown, the value in parentheses is the direct effect; the indirect effect is computed as *total minus direct*; if no parenthetical value is provided, the direct effect is zero, and thus the total effect equals the indirect effect; all effects reported in Table 5 are statistically significant at $p < 0.10$; for the exact significance levels, please refer to Figure 5.

5.3. Telework, Activity Behavior, and Experienced Segregation

5.3.1. Behavioral Pathways Linking Telework to Experienced Segregation

The central result of this study is that telework is systematically associated with higher levels of experienced segregation in daily activity spaces, and that this association operates primarily through reorganization of daily activity behavior rather than residential context alone. As shown in Figure 5 and Table 2, telework exhibits a positive total effect on experienced segregation (total effect = 0.051), even after controlling for residential segregation, socioeconomic characteristics, vehicle ownership, and built-environment conditions.

This effect is largely behaviorally mediated. Telework reshapes daily activity organization in two opposing ways. On the one hand, telework is associated with a higher number of non-work activities (0.137), reflecting increased temporal flexibility and greater engagement in discretionary or maintenance activities. On the other hand, telework is associated with a substantial contraction of activity-space extent, as indicated by a negative effect on the distance between home and non-work activity locations (−0.128). These two mechanisms have contrasting implications for exposure: While greater activity frequency tends to broaden social exposure, more localized activity spaces restrict access to socially heterogeneous environments. The results show that the localization effect dominates, leading to a net increase in experienced segregation among teleworkers.

Daily activity behavior itself plays a key role in shaping experienced segregation. A higher number of non-work activities is associated with lower experienced segregation (−0.119), suggesting that participation across multiple destinations increases exposure to diverse social contexts. Similarly, a larger activity-space radius is associated with lower experienced segregation (−0.073), underscoring the importance of spatial

reach for social exposure. Together, these findings demonstrate that experienced segregation is not simply a function of who individuals are or where they live, but of how daily mobility is organized.

Residential context nevertheless remains a strong baseline determinant. Residential segregation exerts a large and positive direct effect on experienced segregation (0.296), confirming that individuals living in more segregated neighborhoods tend to encounter more homogeneous social environments in their daily activities. Importantly, however, the effect of telework persists after accounting for residential segregation, indicating that changes in daily mobility introduce additional layers of segregation beyond the residential domain.

5.3.2. Structural Conditions Shaping Telework

Telework adoption is not random, but is systematically structured by socioeconomic characteristics, transport resources, and the built environment. Older individuals and those with higher incomes are more likely to telework, reflecting occupational and institutional inequalities in access to remote work opportunities. Vehicle ownership is negatively associated with telework (total effect = −0.098), suggesting that telework is more prevalent among individuals less dependent on private automobiles.

Built-environment characteristics further condition telework adoption, primarily through their influence on mobility resources. Higher population density is negatively associated with telework, indicating that telework is more common in lower-density or suburban contexts. At the same time, built-environment attributes such as higher population density, better public transit service, and greater job accessibility are all associated with lower levels of vehicle ownership. These relationships highlight how urban form indirectly shapes telework participation by structuring transport resources and mobility constraints.

5.3.3. Socioeconomic and Built-Environment Effects on Experienced Segregation

Once residential context and daily activity behavior are explicitly modeled, socioeconomic characteristics exhibit relatively modest total effects on experienced segregation. Income shows a small positive association with experienced segregation, while racial minority status—particularly African American and Asian—is associated with lower experienced segregation net of residential segregation. These effects are substantially smaller in magnitude than those associated with residential segregation, telework, and activity behavior.

Built-environment characteristics also display systematic but modest total effects on experienced segregation. None of the built-environment variables exert strong direct effects; instead, their influence operates entirely through indirect pathways involving vehicle ownership, telework adoption, and daily activity organization. Higher density, better transit provision, and greater job accessibility primarily affect exposure by conditioning whether daily mobility is localized or spatially expansive.

Together, these patterns indicate that experienced segregation is not driven primarily by individual socioeconomic attributes or urban form alone, but emerges from how social position and the built environment jointly shape daily mobility behavior. This finding reinforces the conceptual distinction between segregation as an exposure outcome and socioeconomic or spatial characteristics as upstream structural conditions.

5.4. Summary of Results

In summary, the results demonstrate that telework functions as a key mechanism reshaping experienced segregation, operating primarily through changes in daily activity frequency and spatial extent. While residential segregation remains a dominant determinant of exposure, it does not fully account for differences in experienced segregation. Instead, contemporary work arrangements reorganize daily mobility, altering how far people travel, how frequently they engage in activities, and which social environments they encounter. These findings highlight the importance of integrating telework into mobility-based and multicontextual frameworks of segregation.

6. Discussion and Conclusion

6.1. Theoretical and Policy Implications

By explicitly modeling telework as a mediating mechanism between structural conditions and social exposure, this study advances mobility-based and multi-contextual theories of segregation. Telework reshapes experienced segregation by altering activity frequency and the spatial extent of daily mobility, increasing the relative importance of proximate environments in shaping everyday exposure. In residentially homogeneous contexts, this localization effect amplifies exposure-based segregation even without residential relocation. Experienced segregation thus emerges from the interaction of socioeconomic position, urban form, and telework-induced mobility reorganization rather than from any single factor.

Telework adoption is itself socially structured, reflecting occupational inequalities, access to mobility resources, and the built environment. As such, telework functions as a transmission channel through which broader structural inequalities are translated into differentiated mobility patterns and unequal exposure to social diversity. This perspective challenges interpretations of telework as an individual lifestyle choice detached from socio-spatial structure. The findings also clarify the distinct roles of socioeconomic characteristics and the built environment. Socioeconomic factors such as income and race exert stronger marginal effects on experienced segregation, reflecting persistent inequalities in residential sorting and resource access. Built-environment characteristics, by contrast, operate primarily through indirect pathways: Density, transit provision, land-use diversity, and job accessibility shape vehicle ownership, telework adoption, and activity organization, thereby conditioning whether mobility localization leads to social isolation or continued exposure to diverse environments.

From a policy perspective, the results suggest that telework has social consequences that extend beyond travel demand and environmental outcomes. While telework increases flexibility and reduces commuting, it may also reinforce localized forms of segregation by contracting daily activity spaces. Hybrid work arrangements or periodic on-site work may help sustain access to more socially diverse environments associated with workplaces and commuting corridors. At the same time, compact urban form, mixed land use, and accessible public amenities can mitigate telework-related segregation by increasing the likelihood that localized activities still involve exposure to heterogeneous social environments. Telework policy and urban form therefore jointly shape the social implications of post-pandemic work arrangements.

6.2. Conclusion and Future Research Directions

The implications of reduced exposure to diversity extend beyond abstract metrics and into concrete urban inequality. When daily activity spaces grow more homogeneous, opportunities for bridging social capital decline, limiting informal learning, awareness of public goods and services, and access to broader job, education, and civic networks. Telework's localization can also yield benefits—stronger neighborhood attachment, routine stability, and local cohesion—but these gains are uneven. In marginalized areas with weak services or amenities, localization can reinforce cumulative disadvantage by further isolating residents from resource-rich environments.

These findings speak to the digital transition's reshaping of spatial inequality. As an ICT-enabled behavior, telework contracts spatial exposure and concentrates mobility within local—and often segregated—settings. In doing so, it can reproduce or intensify inequalities, not only by curbing access to diversity but by embedding new patterns of exclusion into digitally mediated work–life arrangements. Mitigation requires mobility policies that widen not only physical access but also experiential exposure and equity in everyday spatial interactions.

Although this study focuses on Puget Sound, the mechanisms have broader—yet context-dependent—implications. The positive link between telework and experienced segregation is likely stronger in low-density, car-oriented metros where fragmentation, zoning, and weak multimodal options limit cross-group contact. By contrast, transit-rich, mixed-use cities (e.g., Amsterdam, Paris, Seoul) can sustain diverse encounters even within localized routines due to compact form and dense amenities. Institutional and cultural factors—workplace norms, housing markets, and digital infrastructure—also condition telework uptake and its spatial effects; in settings with stronger planning and equity agendas, localization need not increase segregation.

For future research, several avenues are suggested. First, there is a need to explore how different occupational sectors and employer policies, as well as the access to ICT services, shape people's telework behaviors. Second, while this study focuses on racial segregation, future research could extend the analysis to include income segregation or develop a comprehensive indicator that captures exposure to both racial and income-based segregation. Third, more nuanced mobility data—such as GPS trajectories or mobile phone records—can help better capture the temporal and spatial dynamics of exposure to diversity. More specifically, future research could distinguish between different forms and intensities of teleworking to assess whether mobility-centered cocooning effects on experienced segregation vary across institutional settings, neighborhood contexts, and types of daily activities (Boterman & Musterd, 2016). Finally, the mechanisms and magnitude of telework effects may differ between pre-pandemic and pandemic contexts, as well as geographic contexts, which could explicitly examine whether and how the relationship between teleworking and experienced segregation varies across different temporal or institutional settings, including pandemic versus non-pandemic periods. To conclude, this study provides empirical evidence that telework is associated with higher levels of experienced racial segregation, even after accounting for residential patterns and built-environment factors. While telework modestly increases non-work activities, it also reduces travel distances, thereby limiting individuals' exposure to racially diverse environments. These findings underscore the need to integrate mobility-based exposure into frameworks of spatial segregation, moving beyond traditional residential-only analyses.

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Conflict of Interests

The authors declare no conflict of interests.

Data Availability

The R script with processed aggregated data is made publicly accessible through the Open Science Framework. The link is https://osf.io/n458d/overview?view_only=cd5770cbc678471e92c69d0cc32d05f9. The raw research data are available upon request.

LLMs Disclosure

LLMs were used in a limited capacity to assist with language polishing and stylistic refinement of the manuscript. All scientific content, analyses, interpretations, and conclusions were conceived, conducted, and validated by the authors. The authors take full responsibility for the integrity and originality of the work.

Supplementary Material

Supplementary material for this article is available online in the format provided by the authors (unedited).

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Commuting Burden Distribution: The Equity Effects of the New Work Dynamics on the Lisbon Metropolitan Area

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Abstract

Transport-related equity is gaining increasing attention, highlighting the need for a system that is equitable, accessible, and affordable for all. From a spatial perspective, the spatial distribution of transport infrastructure plays a key role in mitigating socio-spatial inequalities. Since Covid-19, teleworking has become more prominent across sectors, raising questions about the equity implications of remote work. This study examines the spatial distribution of commuting burden (CB), as the ratio of travel costs to wages, across the Lisbon Metropolitan Area and tests the hypothesis that telework increases inequality in CB distribution rather than alleviating it. We analyse CB before and after increased telework adoption, integrating occupational typologies, wage levels, and telework potential at the civil parish level. Generalised commuting costs are estimated using travel time and distance by mode, fare structure, and value of time. An adapted Palma index assesses the equity impact of telework on CB distribution, identifying areas of compound burden or benefit. The findings confirm that despite a general decline in average CB under the telework scenario, inequality increases, as measured by the Palma index. High-wage workers in skilled occupations, predominantly located in more central or well-connected areas which already have a lower CB, gain disproportionate advantages from telework. Conversely, low-wage workers in peripheral areas face both higher CB and limited telework capacity. This suggests telework, in its current distribution logic, exacerbates rather than mitigates socio-spatial disparities. The study underscores the need to embed telework within equitable urban planning frameworks that address the structural causes of socio-territorial fragmentation.

Keywords

commuting burden; equity; telework; transport justice

1. Introduction

The transport justice approach advocates that all members of society should have equitable access to safe and affordable transport options (Gössling, 2016; Pereira et al., 2017). From a spatial perspective, transportation resources and infrastructure distribution should address and alleviate spatial inequalities (Haxhija et al., 2024; Wu & Liu, 2022), since spatial and social inequalities mutually influence each other, and the transportation system can potentially impact this dynamic (Preston & Rajé, 2007). Equity in transportation typically refers to the fair distribution of transportation outcomes, materialised through accessibility levels (Amorim & de Abreu e Silva, 2024). Consequently, transport policies have increasingly focused on equity issues, aiming to ensure that the transportation system is accessible to all individuals, regardless of socioeconomic characteristics (Martens, 2017). Therefore, transport equity could be explored through distributive justice principles, identifying disparities in accessibility, or through restorative justice, redressing marginalisation through recognition processes.

Commuting can substantially impact individuals' quality of life, productivity, and well-being. Thus, commuting plays a central role in discussions about equity in transportation, particularly regarding time and monetary costs (Maheshwari et al., 2024). In metropolitan areas, urban sprawl and congestion impose a substantial commuting burden (CB), due to increased travel times and monetary costs (Schleith & Horner, 2014; Zhao, 2015). For instance, public transit (PT) commuters often face overcrowding, delays, and limited connectivity and coverage, while private car users encounter fuel and toll expenses. CB reflects these challenges through the travel cost-to-income ratio, in other words, the relationship between the cost incurred by workers to access their jobs and the income they generate (T. Li et al., 2021). Strategies to reduce CB may include improving PT infrastructure, fostering mixed land use, or promoting telework to reduce the need for commuting, especially for long-distance commuters.

Since the Covid-19 pandemic, new work dynamics and, in particular, teleworking have gained importance across both private and public sectors (Sostero et al., 2020). Telework has become increasingly relevant for certain professional sectors, offering flexibility and potentially reducing commuting expenses. As those living farther from work are more likely to telework due to higher commuting costs, this shift may impact CB distribution (de Abreu e Silva & Melo, 2018). However, CB is not evenly distributed among socioeconomic groups and neighbourhoods, raising concerns about transport equity. Disadvantaged groups and low-income areas are more likely to face higher levels of transport burden, limiting their access to employment opportunities and essential services (Zhang et al., 2018). Meanwhile, wealthier populations, often located in central and/or well-connected areas, benefit from better transit supply. Additionally, these groups also frequently own private vehicles and enjoy more flexible work schedules or remote work opportunities. This disparity exacerbates existing social and economic inequalities, making equitable transportation policies critical to ensure fair and efficient commuting for all workers. Therefore, analysing CB distribution by considering telework adoption helps identify overlapping disadvantages or benefits—an equity dimension often overlooked in studies focused on productivity, mental health, and environmental effects.

This study examines the distribution of CB across the Lisbon Metropolitan Area (LMA) and how increased telework adoption could affect this distribution, with particular attention to equity implications. Given that existing inequalities in commuting costs, travel time, and transport supply are deeply embedded in the socio-spatial urban structure, often reflecting wage disparities and social segregation, we investigate whether telework adoption exacerbates or alleviates CB disparities.

Because teleworking propensity varies across occupations and socioeconomic groups that are unevenly distributed throughout the LMA, its adoption is expected to imply changes in the spatial distribution of CB. We compare the CB distribution before and after teleworking became widespread, calculating it by civil parish based on the proportion of different professional occupations, which determines average wages and teleworking potential. We employ the concept of generalised commuting costs (GCC), combining financial and time factors into a unified measurement parameter estimated using travel time by mode, PT fares, road travel costs, and the value of time (VoT) from existing literature. Through an equity index, the Palma Index (PI), we assess whether telework adoption increases or decreases CB disparities, mapping its spatial impact and revealing whether individuals with lower CB are more likely to telework while those unable to telework face higher CB.

2. Literature Review

2.1. Transport Equity

Transport equity and justice are concepts commonly found in policy documents. However, both concepts can be relatively vague and subject to different interpretations. Policies and interventions in the transportation system inevitably impact population groups and areas differently, creating a relationship between social and spatial inequalities and the transportation system (Preston & Rajé, 2007). This results from the unequal distribution of resources and infrastructures, leading to different levels of access to employment opportunities. Inadequate transport services can directly affect community livelihoods and contribute to social exclusion (Lucas, 2012).

Equity refers to the fairness in how benefits and costs are distributed (Litman, 2022) and can also be understood as treating disadvantaged groups advantageously and fairly (Romero-Lankao & Nobler, 2021; Silva, 2016). The operationalisation of the concept typically includes three components: the distribution of costs and benefits, the population groups involved (those favoured and those harmed), and the distributive principle used to justify and assess the intervention (Di Ciommo & Shiftan, 2017). Transport equity mainly concerns the fair distribution of transportation outcomes across spatial or sociodemographic groups (Di Ciommo & Shiftan, 2017; Martens, 2017; Pereira & Karner, 2021; Pereira et al., 2017), typically approached through vertical equity from the perspective of distributive justice, comparing basic access, affordability, travel time, distance, or the job–housing mismatch.

Distributive justice is the most used framework in transport equity analysis, stressing the need for all individuals, regardless of socioeconomic status, to access employment opportunities. Whether viewed from a spatial justice perspective, which focuses on the distribution of resources in space (Madanipour et al., 2022), or from an equity perspective, which emphasises individuals' ability to access opportunities (Romero-Lankao & Nobler, 2021), both perspectives underscore the centrality of distributive justice in transport equity analysis. The job–housing mismatch amplifies CB inequalities, disproportionately affecting low-wage workers who face poor PT, long travel distances, and limited affordable housing near employment hubs (Schleith & Horner, 2014; Zhao, 2015).

In today's urban context, employment and other opportunities remain highly concentrated in the central areas of large cities and metropolitan regions. Thus, ensuring an equitable transportation system, particularly PT

networks, is crucial for individual well-being (Guzman & Oviedo, 2018). In peripheral areas, residents without access to private vehicles face isolation or limited access to services, goods, and employment opportunities (Rodrigue et al., 2017). A fair transport system should ensure a sufficient level of basic access for everyone in most situations (Martens, 2017), especially for socioeconomic groups that rely on PT.

2.2. CB

Commuting significantly impacts well-being, as the time spent represents a substantial part of the daily routine (Maheshwari et al., 2024). CB refers to the cumulative costs individuals incur while travelling between home and work (Zhao, 2015), including travel time, distance, psychological stress, financial costs, and effort (C. Liu et al., 2022; Zhao & Cao, 2020). It can also be perceived as the ratio between commuting costs and income (T. Li et al., 2021). In metropolitan areas, high CBs affect quality of life and may contribute to the social exclusion of disadvantaged groups. From a transport equity perspective, identifying areas or groups with high CB levels is essential to understanding distributive inequalities.

Socioeconomic groups experience these burdens differently (Zhao & Li, 2016). The unfair CB distribution particularly impacts disadvantaged groups through longer travel times resulting from heightened job–housing spatial mismatches (Zhou et al., 2013). For low-wage workers, the absence of a private vehicle or a poor job–housing match is the main factor influencing CB (Zhang et al., 2018; Zhao & Li, 2016; Zhou et al., 2013). High CB can limit participation in various daily activities, particularly for disadvantaged groups (Zhang et al., 2018).

From a metropolitan perspective, commuting time has emerged as a key indicator of CB, given that origin–destination pairs can yield significantly different durations depending on the transport mode (Zhao & Cao, 2020). However, time alone is insufficient to capture CB's full extent. Financial costs associated with commuting (e.g., transit fares, fuel, tolls) must also be considered (C. Liu et al., 2022; Zhao & Cao, 2020). In the absence of car ownership and given dependence on PT, travel distance has less impact on CB than travel time. Commute duration and GCC are the primary variables used to measure CB levels (Tong et al., 2022). Because travel times for the same distance vary drastically across transport modes (Zhao & Cao, 2020), the VoT (Choudhury et al., 2018) is incorporated into CB to represent the monetary equivalent of travel time.

2.3. Telework

Telework as a concept emerged during the first oil crisis and the rise of mobile digital technologies in the 1970s, primarily linked to issues related to commuting and its connections to traffic problems and fuel consumption (Allen et al., 2015; Nilles, 1975). Telework can be defined as work carried out partially or totally away from a workplace, often from home, using information and communication technologies (ICTs; Allen et al., 2015). The EU defines telework as a form of organising and/or performing work using ICTs, in the context of an employment contract, where work that could be performed at the employer's premises is carried out away from those premises on a regular basis (Eurofound, 2020).

Improvements in ICTs have made telework a viable alternative for several jobs, serving as a mechanism for controlling or reducing commuting expenses (Kazekami, 2020). One of teleworking's main advantages is the

time savings from reduced or eliminated commuting (Nagler et al., 2024). There is a potential two-way relationship between telework and travel distance: Teleworkers tend to live farther away from the workplace (Zhu, 2013), and those who live farther away are more likely to telework (de Abreu e Silva & Melo, 2018).

Recently, the widespread adoption of hybrid and remote work has transformed commuting patterns in metropolitan areas, challenging long-established assumptions about commuting and infrastructure needs. For instance, Dingel and Neiman (2020) estimated that around 37% of US jobs could be performed entirely remotely, mostly in white-collar sectors associated with higher wages and predominantly white workers. In the EU, Sostero et al. (2020) found a similar proportion (37%) concentrated in high-paid jobs.

However, whilst this flexibility benefits knowledge-based professionals, it does not extend to lower-wage manual and frontline occupations, which require physical presence (Florida et al., 2023). The adoption of teleworking has not only altered commuting patterns but also deepened socio-spatial inequalities, offering flexibility mainly to already privileged workers (Gokan et al., 2022). Therefore, the uneven distribution of CB across wage-related social groups is a key layer of transport inequality, as these studies collectively illustrate that this disparity contributes to a cycle where CB reinforces economic inequality, with CB being deeply intertwined with wage inequalities and spatial mismatch, which in turn contribute to the urban socioeconomic divide.

2.4. Measuring Transport Equity

Mapping high-burden commuters is the starting point for exploring transport equity issues (Tong et al., 2022). Equity indicators can be used to evaluate the distribution effects of attributes (mostly income) and access to opportunities (goods and services) within a population. These metrics reveal spatial and modal disparities in resource allocation. However, there is no consensus on the ideal equity measurement (Amorim & de Abreu e Silva, 2024; Di Ciommo & Shiftan, 2017; Karner et al., 2024; Pereira & Karner, 2021; Pereira et al., 2017).

The Gini index and Lorenz curve, widely used in economics, are also applied to accessibility inequity analysis (Ben-Elia & Benenson, 2019; Guzman & Oviedo, 2018; Kaplan et al., 2014; Welch & Mishra, 2013). The PI (Palma & Stiglitz, 2016), originally developed to measure income inequality, compares the income share of the top 10% to that of the bottom 40%, where higher values indicate higher inequality. Unlike the Gini index, it is sensitive to changes on the extremes of the distribution, is easier to communicate, and has been used in assessments in different contexts (Guzman & Oviedo, 2018; Herszenhut et al., 2022; W. Li et al., 2023; D. Liu et al., 2022; Oviedo & Guzman, 2020; Pritchard et al., 2019).

3. Methodology

3.1. Case Study

According to the 2021 Census (Instituto Nacional de Estatística [INE], 2022), commuting patterns in the LMA are characterised by a predominance of private transport and a significant disparity in access to PT among different municipalities (Figure 1), despite the fully integrated PT network. Although cars account for 58% of commuting trips and PT (bus, train, subway, and ferry) for only 25%, the LMA has the lowest car-use proportion in the country. This discrepancy is evident in the time spent on daily commutes, with employed

residents using cars averaging 18.8 minutes, while those using PT average 43.5 minutes. Moreover, 44% of the LMA population works in a municipality that is different from their place of residence, implying daily commutes that are more costly in terms of time, distance, or money. Lisbon residents have the lowest percentage of commuting outside their municipality, which is due to Lisbon being the central hub of the metropolitan area and having a greater supply of job opportunities, associated with higher levels of accessibility and PT availability.

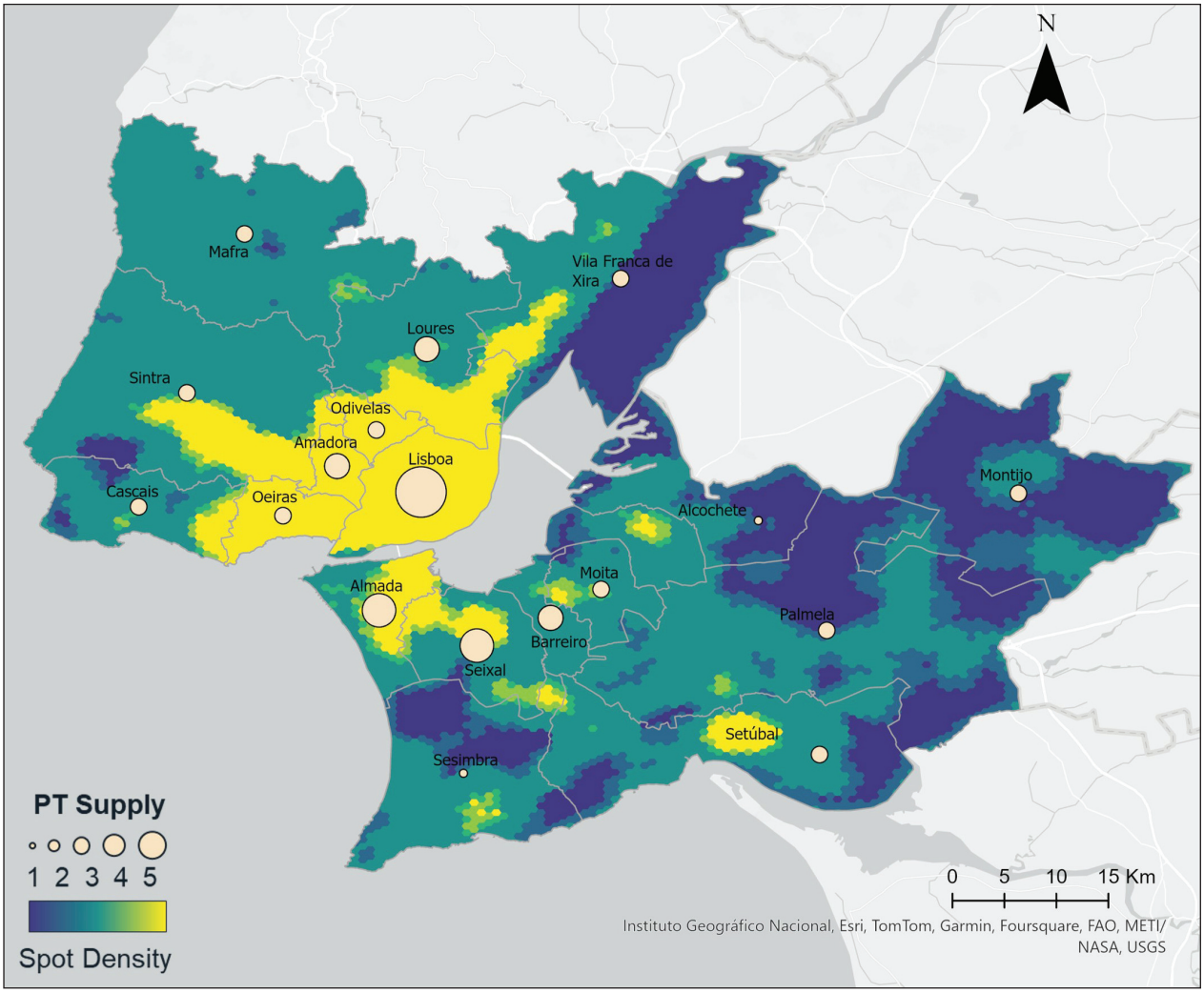


Figure 1. PT supply and access points density by municipality in the LMA. Source: Map created using ArcGIS Pro (Esri, 2023), using data provided by the authors.

CB is not experienced uniformly; rather, it is stratified by income level, occupation, and consequently by the possibility of teleworking. According to the latest Labour Force Survey (LFS; INE, 2024), Portugal had 21.5% of the population employed in full or partial telework. The LMA presents the highest values when compared with the national average, accounting for approximately 31%. Within the Portuguese classification of occupations (CPP; INE, 2010), telework can be effectively adopted by a range of professionals, particularly workers in the ICT and knowledge-intensive sectors, whose tasks can be performed digitally (Table 1). The CPP system uses a 5-digit code corresponding to five levels. In our case study, we use the first level of disaggregation, resulting in 10 major occupational groups (INE, 2010).

Table 1. CPP, percentage of telework adoption, and average weekly number of telework days.

Code	CPP	Telework Adoption	Telework Days
0	Armed forces occupations	20.0%	0.46
1	Representatives of the legislative and executive bodies, directors, officers, and executive managers	34.5%	0.78
2	Specialists in intellectual and scientific activities	50.0%	1.44
3	Intermediate-level technicians and professions	25.8%	0.70
4	Administrative staff	14.4%	0.41
5	Personal service, security, and safety workers and salespeople	4.1%	0.11
6	Farmers and skilled workers in agriculture, fisheries, and forestry	5.0%	0.11
7	Skilled workers in industry, construction, and crafts	4.6%	0.12
8	Plant and machine operators and assembly workers	1.5%	0.05
9	Unskilled workers	0.9%	0.01

Source: INE (2024).

3.2. Conceptual Framework

Our main objective is to evaluate the equity of CB distribution across workers in the LMA and assess the role of telework adoption on that distribution. The conceptual framework presented in Figure 2 describes our multidimensional construct of CB, integrating economic capacity (commuting costs and wage), mobility patterns, and employment structures. CB is an individual-level measure shaped by GCC and worker wage. GCC consists of two principal components: monetary costs (encompassing fuel, tolls, and transit fares) and the monetary equivalent of travel time (VoT). These costs are contextualised relative to worker wages to understand the unequal impact of commuting costs across different populations. Additionally, different employment types are associated with different telework potentials and wages, introducing variability into individual CB values (acting as moderating variables), either exacerbating or mitigating them. Finally, the PI (Palma & Stiglitz, 2016) is used for assessing inequality in the distribution of CB values between employment and wage groups across the LMA.

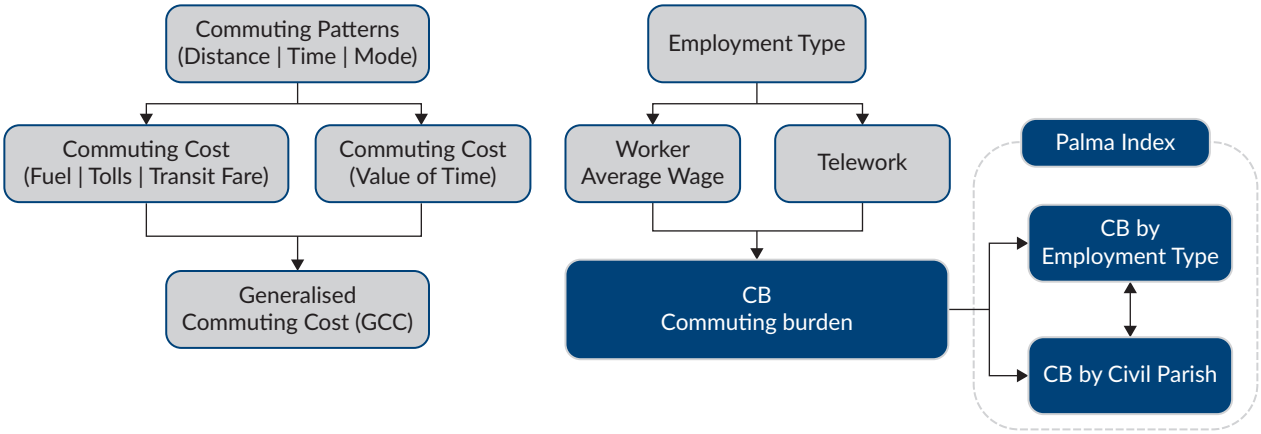


Figure 2. Framework of data analysis.

3.3. CB

The CB is estimated as the ratio between GCC and average wage (equation 1). GCC is a composite measure that estimates the monetary costs of commuting by transport mode, calculated for working days only to capture the influence of teleworking. CB is calculated for each transport mode and the average wage for each CPP, with civil parishes as the spatial unit of analysis. Since CB relates to monthly wages, it's calculated on a full-month basis, while GCC considers only actual working days:

$$\mathrm{CB}_{y}^{nx} = \frac{\mathrm{GCC}_{y}^{x}}{\mathrm{AvgWage}_{x}^{n}} \tag{1}$$

Where GCC is the generalised commuting cost, n is the occupation, x is the spatial unit, and y is the transport mode.

Thus, the daily commuting cost (two-way) for private transport (car) is calculated based on commute distance, fuel price, and toll values, plus the monetary cost of travel time (MCTT), then multiplied by the number of working days. For PT, the commuting cost includes the monthly transit pass plus MCTT. For active modes, the GCC consists solely of MCTT. The MCTT for all modes is calculated using the VoT based on Choudhury et al. (2018) multiplied by travel time. The GCC is presented in equations 2–4:

$$\mathrm{GCC}_{\mathrm{car}}^{x} = Wd[(\mathrm{Dist} \cdot \mathrm{Fuel})_{x} + \mathrm{Tolls}_{x} + (\mathrm{VoT}_{x} \cdot Tt)] \tag{2}$$

$$\mathrm{GCC}_{\mathrm{PT}}^{x} = \mathrm{TransitFare}_{x} + Wd(\mathrm{VoT}_{x} \cdot Tt) \tag{3}$$

$$\mathrm{GCC}_{\mathrm{Soft}}^{x} = Wd(\mathrm{VoT}_{x} \cdot Tt) \tag{4}$$

Where Wd is the number of working days, VoT is the MCTT, and Tt is the travel time.

3.4. Equity Index: PI

In transport-related equity evaluations, the PI is a valuable tool for measuring distributional disparities by isolating extremes of the distribution through the ratio of the top 10% to the bottom 40% of earners (Palma & Stiglitz, 2016). However, this study adapts the PI to reflect the characteristics of our variable by inverting its logic. Since higher CB values indicate a greater disadvantage level (unlike income, where higher values indicate an advantage), we redefined the PI as the mean CB of the 40% of most burdened individuals divided by the mean of the 10% least burdened individuals. Because CB represents an individual-level cost or constraint rather than a share of total resources, we use average CB levels for the top and bottom. This inversion preserves the original index's interpretative integrity, where higher values represent greater inequality between privileged and disadvantaged groups. The interpretation of the adapted index follows the logic: A value of 1 indicates no inequality between the two groups, meaning that the average CB is the same for both, while values above 1 indicate that the most burdened face disproportionately higher CB than the least burdened, implying greater inequality. In this CB context, higher PI values indicate more severe distributional inequalities. The adapted PI is thus formulated as presented in equations 5–7:

$$P_{\mathrm{index}} = \frac{\mathrm{CB}_{\mathrm{bottom40\%}}}{\mathrm{CB}_{\mathrm{top10\%}}} \tag{5}$$

$$CB_{top10\%} = \frac{1}{\left|I_{top10\%}\right|} \sum_{i \in I_{top10\%}} CB_i \quad (6)$$

$$CB_{bottom40\%} = \frac{1}{\left|I_{bottom40\%}\right|} \sum_{i \in I_{bottom40\%}} CB_i \quad (7)$$

Where P_{ratio} is the adapted PI, $CB_{bottom40\%}$ is the average CB of the 40% most overburdened ($I_{bottom40\%}$ is the subset of individuals with the highest values), and $CB_{top10\%}$ is the average CB of the 10% least overburdened ($I_{top10\%}$ is the subset of individuals with the lowest values).

4. Data Collection

4.1. Travel Time and Distance

To calculate the distances and travel times between the different civil parishes of the metropolitan area, we build origin–destination (O/D) cost and travel time matrices for each mode (car and PT). We use General Transit Feed Specification (GTFS) in a geographic information system (GIS) environment to generate optimised routes for each O/D pair, estimating travel time from average travel speeds and distances (Farber & Grandez, 2017; Farber et al., 2014; Fransen et al., 2015). The values were estimated for a Monday during the morning peak hour. In the O/D matrices, the centroids of each civil parish were used as origin and destination points. The LMA road network is used for the time and distance estimation by car, while for the PT measures, the PT network (ferry, bus, subway, train, and tram) was used. The average travel time in active modes was obtained from the LFS and the 2021 Census (INE, 2022, 2024).

4.2. Commuting Costs

The commuting costs were calculated for each transport mode: private transport (cars), PT (ferry, train, bus, subway, and tram), and active modes (walking and cycling). In addition, for the GCC, the VoT for each mode of transport was established based on the work of Choudhury et al. (2018) for the LMA (PT 2€/h; car 5€/h; and active modes 2€/h) and multiplied by the commuting duration. The GCC considers the average number of working days (21 working days in a month; D. Liu et al., 2022) for individuals who do not telework, while for those who do telework, we deduct the telework days from that total (for more details, see Table 1).

The commuting costs using a car were estimated based on distance, fuel price, fuel consumption per km, and toll prices. In the LMA, fuel prices have minimal variations; we adopted 1.707€/L and 1.586€/L for regular gasoline and diesel, respectively, based on the values presented by the Direção-Geral de Energia e Geologia (2025). Additionally, we use the average fuel consumption of a standard car (0.06 L/km; Dodson et al., 2020; International Energy Agency, 2021). The fuel price is multiplied by the average consumption of a standard vehicle to generate the monetary cost of each trip based on the distance travelled, and toll prices were incorporated into the trip cost when applicable. The GCC for cars is obtained through the sum of the commuting out-of-pocket cost (fuel and tolls) and the VoT for private transport.

The commuting costs using PT were estimated based on the PT fare system. In the LMA, there are basically two modalities of monthly PT passes, the first allowing unlimited trips originating and ending within each municipality of the LMA for 30€, and another allowing unlimited trips between all zones of the LMA for 40€.

The VoT for PT and commuting time was incorporated into the calculation of the GCC. The costs for the active modes include only the VoT for active modes multiplied by the commuting duration.

4.3. Wages and Telework

Income distribution directly affects the perception and construction of commuting costs among different socioeconomic groups. Thus, the economic perspective of CB is calculated by the ratio between the GCC and the individual wages. For our case study, we use the average wages for each occupation provided by the LFS (INE, 2022). It is worth noting that these data are only available at the municipal level; therefore, we assume that the average wages for each occupation type are uniform within the same municipality. Finally, CB was calculated for each civil parish in the LMA, in global values and disaggregated by occupation and transport mode. Given that CB is wage-dependent, the analysis accounted for the distribution of the working population across different job categories.

To evaluate the potential impact of telework on CB distribution, two scenarios were considered: (a) a baseline scenario in which no workers engage in telework, and (b) a scenario reflecting the potential prevalence of teleworking within the LMA. Therefore, for our teleworking scenario, the probability of engaging in telework is defined for each type of occupation based on the LFS. The telework adoption (for more details on telework adoption, see Table 1) data are provided by the specific survey (ad hoc "working from home" module) from the LFS (INE, 2024). The telework adoption rate was used to determine the number of individuals in each civil parish who are potential teleworkers.

5. Results

5.1. Spatial Distribution of CB Across the LMA

Figure 3 illustrates the distribution of the CB global values, considering all transport modes and CPPs, across each civil parish. A clear pattern of spatial disparity emerges, where CB is lower in central (Lisbon) civil parishes and increases towards the periphery. In the absence of telework (Figure 3a), Lisbon civil parishes reveal significantly lower CB levels (< 10%). This can be explained by the fact that jobs are more centralised than the population, combined with a denser and more efficient PT network serving the urban core of the LMA.

Conversely, peripheral civil parishes (e.g., civil parishes of Mafra, Montijo, and Sesimbra municipalities) show higher CB levels (> 25%), suggesting structural dependence on long commutes or limited integration into the LMA labour market. Moreover, a relationship can be established between CB (Figure 3) and PT supply (Figure 1); outlying municipalities with lower PT supply are associated with higher GCC, since commuting costs by car are usually higher, especially given the LMA's integrated PT network with a dual multimodal transit pass tariff scheme.

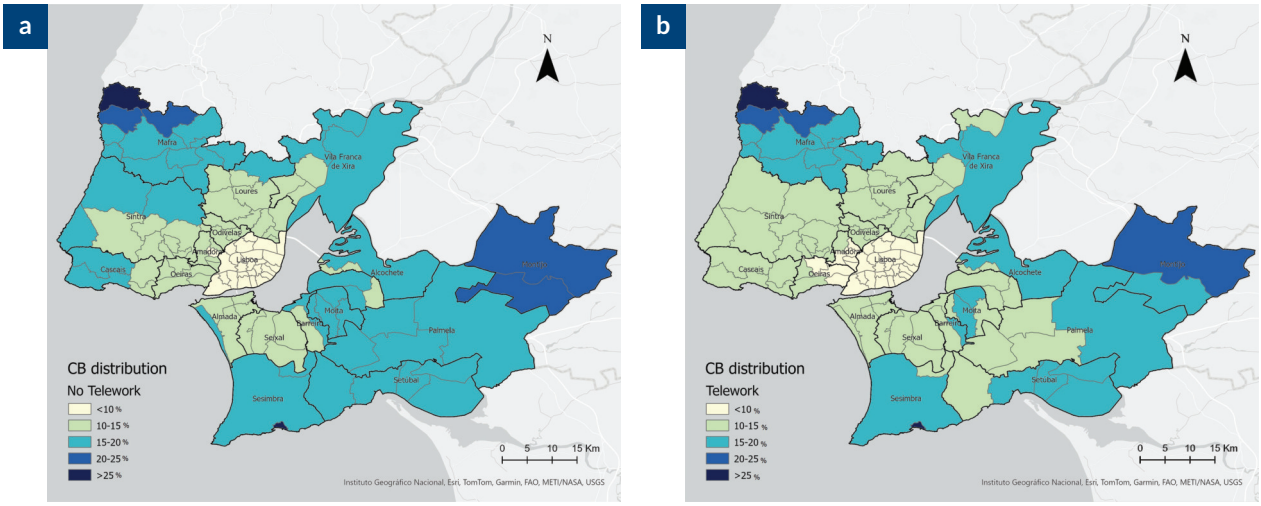


Figure 3. CB distribution across the LMA: (a) no telework; (b) telework. Source: Map created using ArcGIS Pro (Esri, 2023), using data provided by the authors.

5.2. CB and Occupational Characteristics

The distribution of CB levels across CPP categories (Table 2) reveals a pronounced socio-occupation stratification in the LMA. Higher-level professionals (CPP1 and 2) experience significantly lower average CB levels in both scenarios. These results could reflect the association of two factors: first, their greater capacity for telework adoption and spatial flexibility (Eurofound, 2020; Sostero et al., 2020); second, their higher wages compared to other occupations. In contrast, occupations related to services, sales, and manual labour (CPP5, 7, and 9) experience higher CB levels, reflecting both lower telework adaptability and some level of spatial anchoring of these job positions.

Table 2. CPP and the relation with average distance to the central business district (CBD), average wage, and the impact of telework.

	Avg Wage (€)	Avg Distance to CBD (km)[1]	No Telework		Telework		CB Variation (%)	Range Variation (%)
			Avg CB	Range[2]	Avg CB	Range[2]		
CPP0	1,551.0	14.7	15.74	24.95	15.47	25.05	−1.70	0.37
CPP1	3,294.4	12.9	9.64	16.63	9.15	15.78	−5.07	−5.12
CPP2	2,131.8	11.9	12.96	24.44	11.21	21.05	−13.47	−13.89
CPP3	1,835.5	13.5	15.14	30.56	14.66	29.52	−3.20	−3.41
CPP4	1,242.3	14.0	20.07	32.06	19.86	31.70	−1.05	−1.13
CPP5	1,026.5	13.9	21.50	37.92	21.49	37.89	−0.08	−0.09
CPP6	974.2	20.6	21.42	32.37	21.40	32.34	−0.10	−0.10
CPP7	1,133.4	15.4	20.83	35.79	20.81	35.76	−0.10	−0.10
CPP8	1,244.3	15.5	19.84	31.01	19.84	31.00	−0.01	−0.03
CPP9	965.5	14.6	22.54	35.61	22.54	35.61	0.00	0.00
Global	1,574.7	13.67	18.41	42.80	18.08	42.90	−1.81	0.23

Notes: [1] average distance between the civil parishes' centroids and LMA centroid; [2] range is the difference between the maximum and minimum CB values.

It is also possible to identify a clear pattern, where high-wage occupations (particularly CPP1 and CPP2) tend to live closer to the central business district, and lower-wage occupations (CPP6–CPP9) are generally located

farther away. The case of CPP6 (on average 20.6 km from the central business district) may reflect the original ruralisation dynamics in the peripheral municipalities of the LMA.

The three scatter plots (Figure 4) illustrate a negative correlation between CB and occupational structure indicators: average wage, percentage of high-wage workers, and telework incidence. Higher CB levels are consistently associated with lower wages or a lower incidence of telework. As CB increases, average monthly earnings decline, with a relatively strong correlation ($r = -0.65$; $R^2 = 0.493$), suggesting a disproportionate burden borne by individuals with lower socioeconomic status who often face greater mobility constraints and longer commutes due to spatial mismatch dynamics. The percentage of high-earning workers drops as CB rises ($r = -0.55$; $R^2 = 0.383$), and telework incidence also declines with increasing CB ($r = -0.56$; $R^2 = 0.387$). These trends indicate that civil parishes with higher CB tend to have their population employed in occupations with lower teleworkability and lower wages, likely reflecting structural inequalities in the labour force distribution.

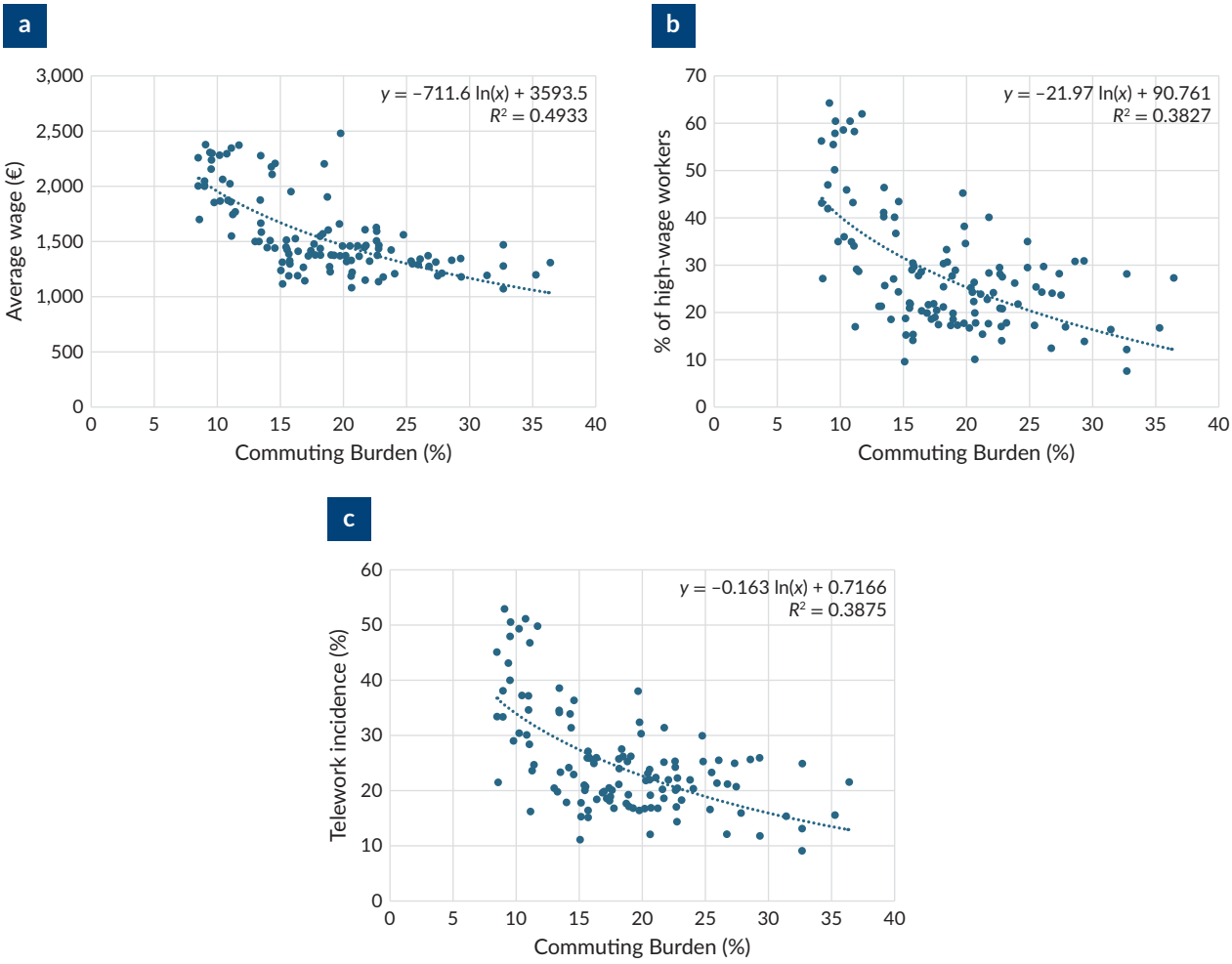


Figure 4. CB's scatterplots: (a) CB and average wage; (b) CB and % high-wage workers; (c) CB and telework incidence.

The high concentration of workers with high-skilled occupations in central civil parishes contrasts with the peripheralization of low-skilled jobs, predominantly located in outlying suburban civil parishes (Figure 5). The CB distribution reflects this pattern: The outlying civil parishes disproportionately concentrate the most

burdened commuters, while central civil parishes, often characterised by higher socioeconomic status and proximity to employment hubs, account for significantly lower CB levels. Thus, the spatial distribution of the different CPPs in the LMA reveals some level of socioeconomic segmentation, as reflected in the CB inequalities, which are captured by the adapted PI.

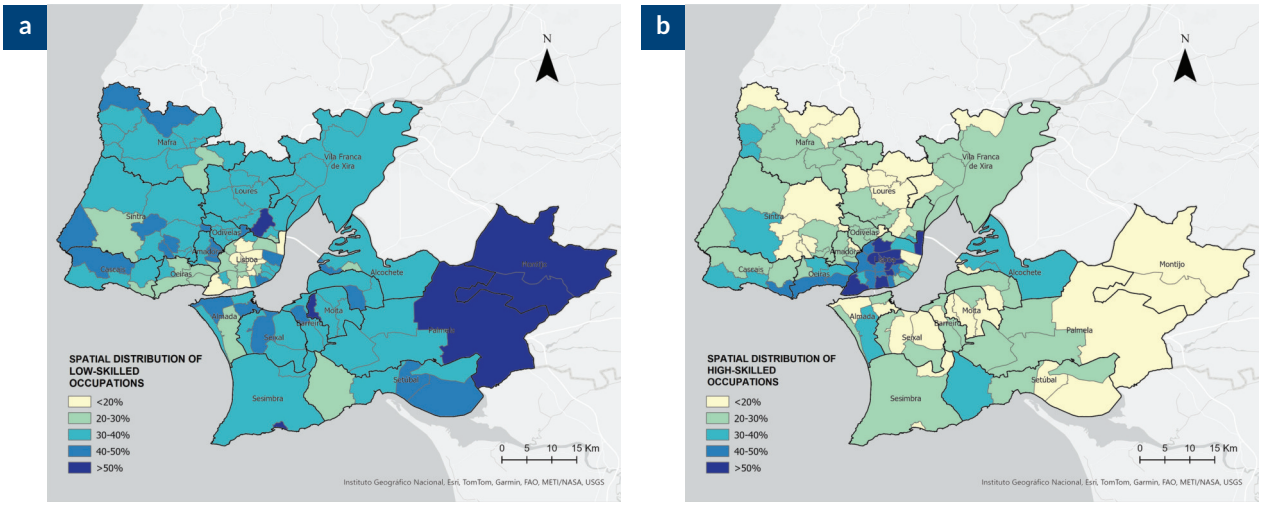


Figure 5. Spatial distribution of (a) low- and (b) high-skilled occupations. Source: Map created using ArcGIS Pro (Esri, 2023) using data provided by the authors.

From an equity perspective, these disparities suggest a spatial mismatch between affordable residential areas and workplaces for lower-wage workers, reinforcing structural labour market segmentation and contributing to the peripheralisation of unskilled or low-wage workers (Zhang et al., 2018; Zhao & Li, 2016; Zhou et al., 2013). In other words, the uneven distribution of transport-related time and financial costs disproportionately affects the more socioeconomically vulnerable worker groups. The elevated CB values among manual and unskilled workers may exacerbate social exclusion risks resulting from the daily commuting implications on household budget and well-being (Lucas, 2012). Such workers are unlikely to be able to reduce their CB by engaging in telework.

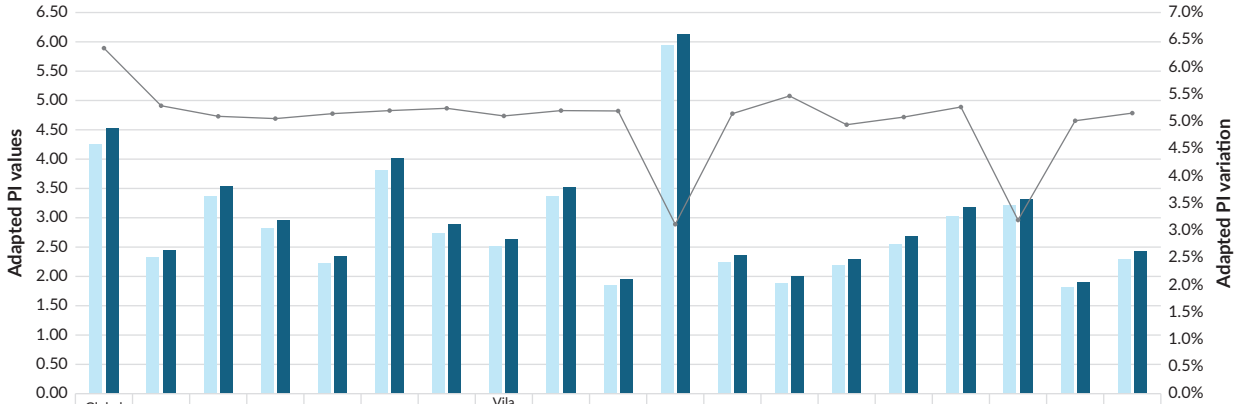
5.3. Impact of Telework on CB Distribution

Table 2 reveals significant disparities in how different CPPs benefit from teleworking. Teleworking appears to disproportionately benefit more highly skilled and higher-wage occupations. Workers with the highest wages show significant CB reduction with telework (CPP1: −5.07%; CPP2: −13.47%), whilst low-wage occupations (CPP5–CPP9) show virtually no reduction (ranging from −0.10% to 0%).

The adoption of telework (Figure 3b) alters this spatial distribution, increasing the number of civil parishes in the two lower CB brackets. However, two patterns remain stable: CB increases towards the periphery, and civil parishes with the highest CB remain almost exactly the same. Thus, fulfilling the potential for telework adoption does not appear to contribute to mitigating spatial differences in CB. The persistence of high CB in LMA borders even under the telework scenario could reflect occupational rigidity due to sectoral occupation group patterns that limit remote work flexibility, as shown in Table 1.

5.4. Equity Assessment

Applying the adapted PI to CB levels across all civil parishes and CPP categories in the LMA offers a critical lens to examine spatial and socio-professional commuting inequalities. Figure 6 presents the values of the adapted PI for the CB in the LMA municipalities, comparing two different scenarios (without telework and with telework), highlighting the disparity levels of CB among different municipalities. The results reveal that, despite the telework effect on average CB levels (Table 2), its implementation tends to increase the PI by 5%, on average, and, consequently, the inequality compared to the no telework scenario. However, the magnitude and spatial distribution of this effect vary considerably across municipalities.



	Global (LMA)	Cascais	Lisboa	Loures	Mafra	Oeiras	Sintra	Vila Franca de Xira	Amadora	Odivelas	Alcochete	Almada	Barreiro	Moita	Montijo	Palmela	Seixal	Sesimbra	Setúbal
No telework	4.26	2.34	3.38	2.82	2.24	3.82	2.75	2.52	3.36	1.86	5.95	2.24	1.89	2.20	2.56	3.02	3.22	1.82	2.31
Telework	4.53	2.46	3.55	2.97	2.35	4.02	2.89	2.64	3.53	1.95	6.13	2.36	2.00	2.30	2.69	3.18	3.32	1.91	2.43
Variation	6.35%	5.28%	5.10%	5.05%	5.14%	5.20%	5.24%	5.11%	5.20%	5.19%	3.12%	5.15%	5.47%	4.94%	5.08%	5.26%	3.18%	5.01%	5.16%

Figure 6. PI for average CB distribution across the LMA municipalities.

Initially, telework was conceived and explored as a commuting equaliser. Contrary to these expectations, Figure 6 reveals that the benefits of telework may be disproportionately accruing to populations already less burdened by commuting, which aligns with our hypothesis that these new work dynamics (teleworking) end up accentuating the inequality in the distribution of CB: In other words, digitalisation exacerbates disparities. Typically, higher-wage, white-collar professionals who are more likely to have telework-compatible positions (Eurofound, 2020; Sostero et al., 2020) also tend to live in central or well-connected areas. In contrast, low-wage workers are often more concentrated in peripheral areas and have low or no telework compatibility, concentrating the burden among the more socioeconomically fragile groups.

This occupational geography directly relates to the adapted PI results shown in Figure 7. Although telework adoption reduces overall commuting times and costs, it disproportionately benefits high-skilled workers in central areas, who can more easily telework, while low-skilled or presential-bound workers, often in peripheral zones, experience relatively fewer or no gains. Consequently, the adapted PI increases, reflecting a widening inequality in CB distribution.

Another analytical perspective examines the relationship between the inequality of CB and the spatial distribution of the CPPs. The adapted PI reveals significant disparities in CB in the LMA, with these levels increasing in the telework adoption scenario. However, high levels of inequality, as captured by the PI, are not necessarily aligned with high average levels of CB.

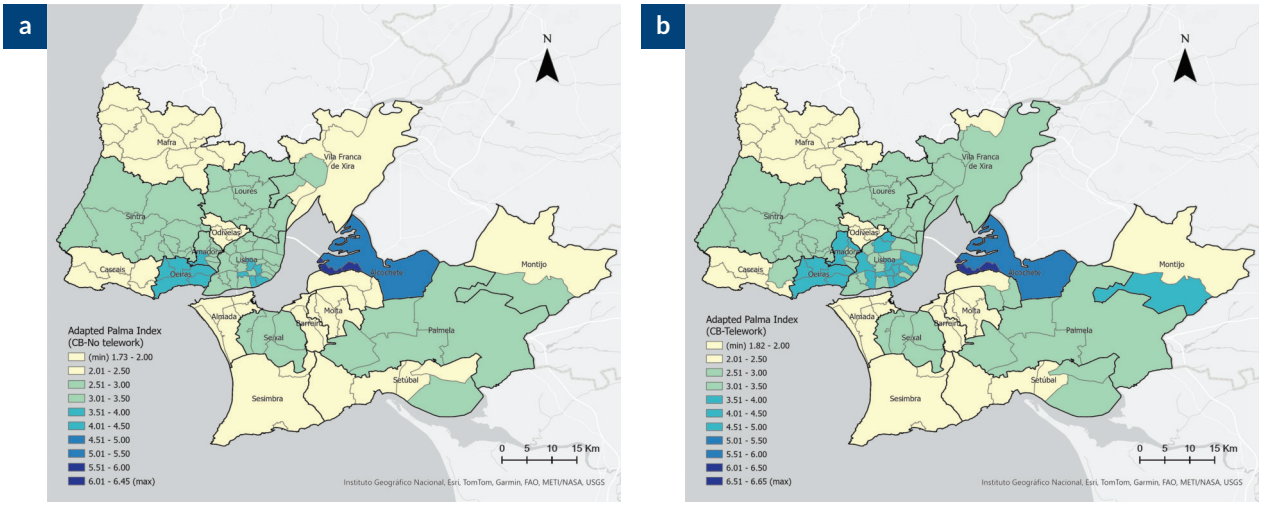


Figure 7. Adapted PI for the CB distribution across the LMA: (a) no telework; (b) telework. Source: Map created using ArcGIS Pro (Esri, 2023), using data provided by the authors.

For example, the municipality of Lisbon, despite having a relatively low average CB, shows PI values among the highest in both scenarios. Similarly, the Alcochete civil parishes, which present only moderate levels of CB, are among those with the highest PI values. These two realities may reflect pronounced inequalities among their residents, possibly due to the urban sprawl in previously rural areas facilitated by the construction of the Vasco da Gama Bridge, which may have attracted wealthier population groups, leading to a change in the socioeconomic characteristics of this municipality.

High-skilled occupations, higher wages, and greater adaptability to telework are closely interrelated and tend to be associated with lower CB levels. These characteristics generally follow a centre–periphery spatial distribution. However, the adapted PI does not always mirror this pattern. Central areas (particularly Lisbon and its surroundings) tend to display higher PI values, a tendency that appears to have been further reinforced by the growth of teleworking. In contrast, peripheral zones with a high concentration of low-skilled workers often register both elevated CB levels and greater inequality in their distribution, as reflected in the PI. The adapted PI captures the extent of the disparity between the opposite extremes of the sample, workers classified by CPP, highlighting how job type, location, and transport infrastructure influence the equity of urban mobility. While telework has the potential to reduce CB, in the absence of inclusive urban planning and mobility policies, it risks reinforcing the existing socio-spatial inequalities within the LMA.

6. Discussion and Conclusion

This study examined the spatial distribution of CB across the LMA and tested the hypothesis that new work dynamics, particularly teleworking, increase inequality in CB distribution. In broader terms, it examined whether digitalisation exacerbates existing socio-spatial disparities. Using integrated geospatial CB indicators, occupational typologies (CPP), and an adapted PI, we assess how teleworking reshapes, but does not necessarily resolve, pre-existing mobility inequalities.

The findings confirm our hypothesis that while telework reduces overall commuting demands, its benefits are unequally distributed. The PI increased by 5% on average under the telework scenario despite reducing average CB levels, indicating that telework exacerbates rather than mitigates CB inequality. This challenges the notion that telework acts as a commuting equaliser and aligns with recent studies exploring how digitalisation can deepen socio-spatial disparities (Florida et al., 2023; Gokan et al., 2022).

This amplification of inequality can be understood through two aspects: First, telework capacity is strongly mediated by occupation and income, where high-skilled and white-collar occupations (CPP1–2) show CB reductions of 5–13%, whilst low-skilled workers (CPP5–9) experienced virtually no change. This aligns with findings from Dingel and Neiman (2020) and Sostero et al. (2020), who identified that around 37% of jobs are teleworkable, concentrated in high-wage sectors. Second, this occupational stratification has a clear spatial expression: High-skilled workers are predominantly located in central, well-connected areas with lower CB, while low-skilled workers are concentrated in peripheral areas with limited PT infrastructure and higher CB. This creates a "double advantage" for privileged workers, as existing spatial advantages are associated with new flexibility advantages, and conversely, a "double burden" for peripheral, low-skilled workers, who are both excluded from telework opportunities and face poor transport access.

The spatial analysis revealed a persistent centre–periphery gradient in CB that telework adoption cannot disrupt. Peripheral civil parishes maintained CB levels exceeding 25% even under the telework scenario, while central Lisbon parishes remained below 10%. This reflects what Preston and Rajé (2007) described as the relationship between social and spatial inequalities in the transportation system, where unequal distribution of resources and infrastructures leads to differential job access opportunities. Interestingly, the analysis also reveals that high levels of inequality in the CB distribution are not necessarily associated with higher CB values. The Lisbon municipality demonstrates low average CB but high PI values, while municipalities like Alcochete present both high CB and high PI values. These contrasting patterns suggest significant intra-municipal disparities, underscoring the importance of disaggregated spatial analysis, as argued by Pereira and Karner (2021).

The job–housing mismatch identified by Zhang et al. (2018) and Zhou et al. (2013) as a key driver of CB inequality remains fundamentally unchanged by telework adoption. The occupational and spatial mismatch observed in the LMA reinforces the centre–periphery divide, where physical distance from economic hubs intersects with structural barriers to telework adoption. The persistence of such patterns likely reflects structural constraints that go beyond individual travel behaviour and enter the domain of systemic spatial injustice.

From a distributive justice perspective, our findings reveal that telework, in its current pattern, while offering new opportunities for reducing commuting-related pressures, risks amplifying existing socio-spatial inequities due to its uneven diffusion across CPPs and the uncritical implementation of policies. To harness telework as a tool for equity, policy efforts should encompass inclusive mobility strategies, such as improving the PT network in peripheral areas to reduce CB for non-teleworkers; developing targeted upskilling programmes to expand access to teleworkable occupations for disadvantaged workers; promoting mixed land-use and affordable housing close to employment centres to address job–housing mismatches; and implementing regulatory frameworks that extend telework options more equitably across occupational categories where feasible.

Several limitations should be acknowledged. First, our CB calculations assume that workers bear the full financial burden of their commute. While Portuguese labour law does not mandate employer reimbursement of regular commuting costs in the private sector, and there is no legal obligation to cover PT passes or fuel expenses, some employers voluntarily provide full or partial transport subsidies. Second, the CB concept focuses solely on out-of-pocket and travel time costs rather than subjective travel experiences. Third, the cross-sectional nature limits causal inference; longitudinal data would strengthen claims about telework's impact.

An important consideration beyond this analysis concerns potential feedback effects between large-scale adoption of telework and PT demand and supply. Most literature focuses on emergency pandemic responses rather than structural adjustments to sustained telework. As such, future research should address these limitations through comparative studies across metropolitan areas, longitudinal CB evolution with sustained telework, and the feedback effect on PT.

In conclusion, this study contributes to transport equity literature by demonstrating how ostensibly progressive innovations can inadvertently deepen inequalities when their diffusion follows existing lines of privilege. Without inclusive urban planning and integrated policy approaches addressing the root causes of socio-territorial fragmentation, telework risks entrenching existing disparities across the metropolitan context rather than mitigating them. The benefits of labour digitalisation must be contextualised within broader planning frameworks to ensure equitable outcomes for workers, regardless of occupation, income, or residential location.

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Conflict of Interests

The authors declare no conflict of interests.

Data Availability

The data presented in this study are available upon request.

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Flexible Work, Constrained Mobility: Spatiotemporal Barriers to Teleworkers' Daily Travel

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Abstract

Just as the spatial and temporal flexibility offered by telework and flextime can bring autonomy and a greater sense of control over an individual's time–space behavior, it can also reveal hurdles that limit and modify this behavior. The objective of this research is to examine the time–space barriers that result from these work arrangements, as well as how these barriers may affect everyday mobility and its planning. The analysis draws on 13 semi-structured interviews with Czech teleworkers who also use flexible work schedules. In doing so, this study complements the plethora of predominantly quantitative studies that deal with the impact of these work arrangements on mobility. Time barriers can be attributed to the tendency to align the flexible rhythm of teleworkers with that of colleagues or the predominantly fixed working patterns inherent in the Czech work environment. Conversely, space barriers emerge from the disadvantageous policies of certain establishments (e.g., cafés) and from the need to negotiate reasonable distances between home and potential secondary workplace. This ultimately prompts teleworkers to seek the most effective means of optimizing their time–space behavior—and while the time barriers presented mainly affect planning when, with whom, and whether their non-work trips will take place at all, spatial barriers mainly affect the formation of work-related travel and movement between home and alternative workplace.

Keywords

daily mobility; flexible work; flextime; spatiotemporal barriers; telework

1. Introduction

Teleworking has been a subject of interest for academics in various fields for several decades. Thulin et al. (2023, p. 2) discuss research focusing on its role in reshaping the time–space of everyday life as a journey

"full of high hopes and disappointments," as the expected impacts (reduced work-related travel, fossil fuel use, air pollution) have not been as significant as originally anticipated. However, one of the advantages attributed to telework is that, in conjunction with flextime, it can be characterized as a form of flexible work arrangement (Wöhner, 2022). Such arrangements enable workers to have greater autonomy and flexibility in planning not only their work, working hours, and place of work, but also their non-working life, activities, and travels. This ultimately provides greater freedom to decide when, where, and what activity will be performed. Although such an arrangement may seem beneficial at the individual level, this article aims to highlight the problems and spatiotemporal barriers that teleworkers who also utilize time flexibility may face in their daily lives, particularly concerning their (non-)work travel. Therefore, the study examines how spatially and temporally flexible work can also create barriers and constraints in teleworkers' daily mobility.

The space-time barriers that are the main subject of this research have been discussed explicitly and implicitly in geographical literature and beyond, but their conceptualization varies depending on the field and the research's specific focus. These barriers are often perceived as obstacles to accessibility (transport, healthcare, public space, etc.), from which other types of barriers are then derived, such as transport or social barriers (Dodge & Nelson, 2023; Maleki & Smith-Colin, 2025). Spatial barriers can be created by physical objects and obstacles, as well as by the conditions of one's surroundings. These barriers can lead to different perceptions of place (Friman et al., 2020). Kwan (2013) argues that an individual's everyday spatiotemporal behavior depends on accessibility, which is perceived not only in terms of locational proximity but also in terms of temporal and individual accessibility (e.g., gender, age, and disability). The limits and boundaries in the formation of an individual's time–space are also often discussed through the time–space constraints known from time-geography (see Section 3). However, Fischer (2004) does not view barriers as insurmountable limitations. Instead, he views them as challenges that can lead to opportunities to improve a situation or solve a problem. This article does not consider the various physical barriers teleworkers face, such as obstacles in their environment that they need to navigate around or adapt to. Here, barriers are defined as perceived and experienced impediments and hurdles arising from conflicts between different settings, norms, or planning at the individual level. These barriers thus hinder the effective implementation of spatially and temporally flexible work of teleworkers and influence their everyday mobility.

Although there is no consensus on the definition of "telework" and, as Lamond et al. (1997) put it, there may be no one form of teleworking, the term can be defined as "a form of organizing and/or performing work, using information technology, where work, which could also be performed at the employer's premises, is carried out away from those premises on a regular basis" (European Social Partners, 2006, p. 4). However, telework is often confused in studies with the terms "telecommuting," "remote work," "virtual work," "flexible work," "flextime," or "distance work" (Allen et al., 2015). In this article, telework refers to work arrangements that allow the traditional workplace, particularly the office, to be replaced by another location, thanks to ICTs, which enable people to work and communicate remotely without direct contact with the workplace or other colleagues, which points in particular to the spatial component of work flexibility. This research, however, focuses on teleworkers who also take advantage of time flexibility (see Section 2) and thus have the opportunity to adapt their work in terms of time. The analysis, therefore, takes into account both spatial and temporal flexibility, but for the sake of simplification and standardization, the term telework is used, and interviewees are referred to as teleworkers.

Telework can also be distinguished based on its temporal and spatial components. While spatial classification specifies, for example, home-based, center-based, or mobile telework (Helminen & Ristimäki, 2007), in terms of time, a distinction can be made between full-time/part-time teleworkers, or full-day/part-day teleworkers (Antunes et al., 2023; Asgari et al., 2019). The predominant alternative work environment is the home, although other locations include cafés, libraries, coworking spaces, and separately rented offices. It is evident that the original correlation between place of residence and workplace, as well as the fixed working hours and subsequent commuting between the two locations, is no longer applicable. In this regard, Elldér (2017) points out that if an individual's daily spatial patterns are not tied to their place of work, this can lead to the creation of new mobility strategies that contribute to spatial heterogeneity, ones based more on individual needs than on the structure of the city.

A study by Luca et al. (2025) demonstrated that individuals with a higher propensity for teleworking are predominantly those employed in the information and communication, insurance, and finance sectors, as well as in scientific, technical, and educational fields. The COVID-19 pandemic has brought about a significant change in the introduction and acceptance of telework across sectors, especially working from home, with telework often being referred to as the predominant work mode in the post-COVID era due to positive responses from both employees and employers (Eurofound, 2020; Zhu & Guo, 2022). Among the self-employed, the transition to more flexible arrangements was already underway prior to the pandemic, largely because they were not restricted by employers who, at that time, were less willing to allow employees to work outside the office (Luca et al., 2025).

However, the perception of telework is not uniformly positive or negative (Cañibano & Avgoustaki, 2022) and can therefore be described as a "balancing act" (Thulin & Vilhelmson, 2021). Research on telework and flextime frequently concurs that teleworkers possess greater personal time and time for their families, more time to fulfill household responsibilities, reduced stress (partly due to the absence of commuting), and a superior work-life balance compared to on-site workers. Conversely, there is a possibility of a violation of personal space and a blurring of the boundaries between personal and professional life (Erdoğdu & Watson, 2022). Long-term telework can also cause employees to feel isolated due to a lack of social interaction with colleagues (Chen & Zheng, 2023).

2. Temporal Flexibility at Work

As previously defined, telework constitutes the spatial dimension of work flexibility. Conversely, the concept of flextime embodies the temporal dimension, signifying the absence of clearly predetermined working hours and workers being permitted to exercise greater or lesser flexibility in daily planning (Wöhner, 2022). Temporally and spatially flexible work can thus be described as progressive and enabling the time–space autonomy of the individual, but on the other hand, it can result in constant work availability and ease of access to work (Kotýnková Krotká, 2025; Thulin & Vilhelmson, 2021), which are further enhanced through the use of ICT, online communication platforms, and virtual offices. However, these arrangements are most likely to be beneficial if employees feel more control over when and where they work (Kelly & Moen, 2007).

Time-flexible work enables workers to control their working hours, which can lead to a reduction in their schedule (e.g., to meet family demands; Chung & van der Lippe, 2020), and on the other hand, to an increase in overtime (Erdoğdu & Watson, 2022) and a shift of unworked hours to the evening/night part of the day.

Such an arrangement can not only reinforce expectations of constant availability but ultimately also break down the boundaries between work and personal time, creating specific conditions for the emergence of time poverty, the final extent of which may also depend on who sets the main rhythm of an individual's life (Kotýnková Krotká, 2025). Rhythms are an essential part of everyday life (Ingold, 2000, as cited in Kaaristo, 2020, p. 63), and Honing (2001) sees them as a temporal structuring device. Time-flexible work can enable "following of one's rhythms" (Thulin & Vilhelmson, 2021) and, in such cases, bring time freedom and autonomy to the individual. However, if it is necessary to negotiate time with others (colleagues, family, clients, institutions, etc.) who set the dominant rhythm to which one must adapt, then there is a heightened likelihood of encountering time poverty (Kotýnková Krotká, 2025).

3. Spatiotemporal Constraints and ICTs

The ICTs, in conjunction with working arrangements such as telework and flextime, are gradually weakening the traditionally strong association between place, time, and activity, and so the former "tell me where you are, and I'll tell you what you are doing" no longer applies, and given that many activities are performed digitally and in virtual space, researchers encounter the limits of traditional time geography (Couclelis, 2009). From the perspective of time geography, an individual's daily activities are constrained not only by the limited time in the day, but also by time–space limitations imposed by mandatory (and often fixed) activities (Asgari et al., 2019), which have a fixed location and time and function as anchor points in an individual's daily routine (Zhang et al., 2024).

In the academic literature concerning telework and flextime, the concept of time–space constraints is a subject of extensive discussion, partly due to the fact that ICTs enable individuals to communicate without the need to physically move (Ellegård, 2019), and thanks to communication platforms and social media, they are able to communicate at any time, thereby transforming or eliminating traditional time–space constraints (the constraints of authority, coupling, and capability). In addition to the dissolution of these constraints (e.g., commuting to a specific place at a specific time, the fixed location of the workplace), there is also an increase in the availability of time for non-work activities or the possibility of choosing new locations based on personal preferences rather than geographical proximity (Elldér, 2017). The final degree of spatial and temporal flexibility may therefore reflect specific time–space constraints at the individual level. For instance, Black (2001) has noted that full-day teleworkers may have no time–space constraints, and consequently, their time–space behavior may vary across individuals. A comprehensive understanding of the spatiotemporal constraints and rhythms to which teleworkers are exposed, and which they must adapt to and take into account in their daily lives, may ultimately influence the spatiotemporal barriers they face.

Examples of time constraints include demands for constant availability (Sewell & Taskin, 2015), scheduling limitations such as rigid core hours (Kelly & Moen, 2007), or cultural-cognitive constraints (e.g., procrastination) related to a lack of external time structures (Lehdonvirta, 2018). Conversely, spatial constraints may arise from physical distancing between the remote worker and the team members in the office (Sewell & Taskin, 2015) or from the negotiation of workspace limitations (e.g., in the case of working from home; Waismel-Manor et al., 2021). The sources of such constraints can vary and may include both employer control and client requirements, as well as individual limitations from the perspective of a decision-maker who influences their own time–space behavior.

4. The Influence of Telework and Flextime on Daily Mobility

A significant body of research has identified the impact of telework on daily mobility, individual travel, and, notably, commuting to work. Telework reduces (but does not eliminate) the need for commuting in everyday life. Nevertheless, most research and studies in this area focus on the quantitative side of the issue—the frequency of telework during the week, the total number of teleworkers, the total time spent traveling, and the effect on morning and evening rush hours.

However, as Allen et al. (2015) suggested, the impact of telework and flextime on daily commuting should be distinguished, because, as Wöhner (2022) noted, telework cannot completely replace commuting, while flextime can influence it by spreading it more evenly throughout the day and thus have a positive effect on traffic congestion during rush hours. Nonetheless, changes in behavior and habits associated with telework can alter workers' mobility decisions. Since they are not forced to commute to their workplace every day and waste time in traffic, they become much more sensitive to the time spent in it (Erdoğdu & Watson, 2022).

While telework is often linked to an increase in non-work-related trips, as measured by the number of trips, total travel time, or total distance traveled (Kiko et al., 2024), the necessity of commuting to work remains consistent and may vary among different categories of teleworkers. For individuals who exclusively work from home, this type of commute can be completely eliminated. For teleworkers who work from locations other than their homes (e.g., coworking spaces, cafés, etc.), the need to commute to work remains. However, as Ellegård (2019) points out, the original idea that the use of ICT would lead to less travel has not ultimately come to fruition.

The objective of this article is not to differentiate between the effects of telework and flextime on daily commuting, as previously explained, but rather to examine time–space flexibility in its entirety. Through the analysis of specific time–space barriers, the article aims to elucidate how it is reflected in and affects daily (not solely work-related) commuting and mobility at the individual level.

5. Flexible Work Arrangements in the Czech Republic

The following time–space barriers are based, in many respects, on the manner in which flexible working arrangements are approached in the Czech Republic and how (un)usual they are perceived. Full-time employment with fixed working hours and location remains the major employment type in the Czech Republic. Flexible working arrangements, in general (not exclusively as referenced in this article), are still uncommon in the country, for various reasons. Firstly, there is a discrepancy between the demand and supply of such arrangements (Plasová, 2008, as cited in Formánková & Křížková, 2015, p. 229). Flexible working arrangements, such as part-time jobs, job sharing, and the option to change work agreements, are still very much in the minority in the country. While one-third of companies in the EU offer these arrangements, less than one-tenth of companies in the Czech Republic do so (UZS, 2019). Of the available part-time jobs, most are occupied by individuals who are marginalized in the labor market (disabled people, people of pre-retirement age, or low-educated people; Hora, 2009). Secondly, part-time employment frequently entails work of a lower quality and less favorable working conditions (Vohlídalová & Formánková, 2012). Finally, the low supply of flexible arrangements may stem from the prevailing tradition of long (three years) parental leave, which can isolate women in particular from the labor market (Formánková & Křížková, 2015).

Employees in the Czech labour market are then more often allowed to work from home, but this does not necessarily involve time flexibility. According to statistics from the Czech Statistical Office (2025), in 2024, 59% of Czech companies allowed their employees to work from home occasionally, but only 21% of employees took advantage of it. According to remote workers, their proportion in the pre-Covid era in the Czech Republic was around 5%, and even during the pandemic in 2021, it did not exceed 10%. By contrast, countries such as the Netherlands, Finland, and Sweden had values above 20% in the same year, with Ireland exceeding 30% (Luca et al., 2025).

6. Methods

The present study is based on 13 semi-structured interviews with teleworkers (six women and seven men from the Czech Republic and Slovakia) working in the Czech Republic (see Table 1). The selection of interviewees was primarily based on the flexible nature of their work, characterized by autonomy in terms of time and place of work, i.e., that their working hours were primarily subject to their personal settings and preferences, and that they had the same freedom of choice regarding their place of work. In this selection, an effort was also made to achieve representation of different industries associated with telework and flextime. Interviewees could be either self-employed (i.e., economically dependent self-employed people and freelancers) or employed. The places where they performed their work could also vary. These places were often combined (during the week, but also within a single day). Some teleworkers still had the option of using company office space, even though they were not required to do so. Although there are differences among individual teleworkers, the presented space-time barriers do not stem from differences in job sectors, types of employment, or managerial levels. Therefore, the primary aim of this research is to highlight the spatial manifestations that arise from experienced and perceived flexibility.

The majority of the interviews were conducted online (Google Meets, MS Teams), while two interviews were conducted in person. All interviews were recorded for subsequent transcription and analysis. The interviews ranged in length from approximately 35 to 70 minutes, with an average length of approximately 47 minutes. Prior to each interview, the interviewees were informed about the content of the interview, its purpose, and the subsequent processing and use of the data in the form of informed consent. In the case of face-to-face interviews, informed consent was signed by the interviewees; in the case of online interviews, consent was given verbally after the recording began. The audio recordings of the interviews and their respective transcripts were stored in a private repository, and pseudonyms were assigned to the interviewees to preserve their anonymity.

The recruitment of interviewees was primarily carried out using personal contacts and contacts of acquaintances. This selection was always monitored to ensure that the final sample corresponded to the above-mentioned variability and did not lead, for example, to the overrepresentation of a particular sector. Concurrently, recruitment took place in Facebook groups where people with the required criteria could come together (e.g., remote work, home office groups, etc.). Ultimately, only one interviewee emerged from this form of recruitment. The initial series of interviews was conducted during January and February of 2025. Subsequent to the transcription, preliminary readings, and rudimentary thematic analysis, the remaining interviews were conducted by the end of April 2025. These subsequent interviews were undertaken with the objective of both addressing thematic gaps identified in previous interviews and supplementing the sample of interviewees in accordance with the aforementioned criteria. After these interviews, data

collection was concluded, as thematic saturation was reached and no new topics expanding on the original research questions arose from them.

The subject of time–space barriers was not a central theme in the interviews from the outset. The objective of the interviews was to understand how temporal and spatial flexibility is reflected in the everyday mobility of teleworkers. Consequently, the preliminary analysis of the interviews (using Atlas.ti) was not guided by a predefined theoretical framework to emphasize the individual perceptions and narratives of the interviewees. For this reason, open coding was used in the initial phase of the analysis as a way to discover new units of meaning across the data (Řiháček et al., 2013). This phase of the analysis was therefore more descriptive in nature (e.g., work vs. personal boundaries, domestic mobility, shift in working hours, meanings of mobility, etc.). It was at this stage of the analysis that the topic of time–space barriers emerged as a salient theme in the data. Consequently, a more selective coding approach was employed, with a focus on this specific topic to better address the narrowing research question (e.g., time/space constraints, time freedom/poverty, pace-setters, change of workplace, restrictions by other people, travel efficiency). Attention was therefore directed toward the time–space barriers that emerge from the time and space flexibility of interviewees, impeding or constraining their ability to fully utilize the flexibility of their work, and, last but not least, where, when, and with whom they experience and undergo their daily mobility. The objective of this article is to respond to the research question: How does spatially and temporally flexible work create barriers and constraints in teleworkers' daily mobility? While teleworkers perform many activities, notably work itself, in virtual space, this article focuses exclusively on their movement in physical space.

Table 1. Basic information about interviewees.

Name	Gender	Age	Job	Workplace	Employed/self-employed
Adam	M	27	IT (security expert)	solely HO	employed
Irena	W	43	online news editor	solely HO	self-employed
Jakub	M	24	entrepreneur (software development)	solely HO	self-employed
Jitka	W	28	clinical trial monitor	HO, office, cafés	employed
Kamila	W	25	editor of an online magazine	cafés, libraries, HO, houses of friends	employed
Martina	W	30	learning and development partner	HO, office, cafés	employed
Matěj	M	35	accounting firm owner	HO, office	self-employed
Marek	M	34	IT (architect for data storage)	solely HO	employed
Oskar	M	42	financial advisor	HO, individually rented office	self-employed
Radek	M	34	IT (application engineer)	individually rented office	employed
Samuel	M	27	IT specialist	HO, office, cowork	employed
Valerie	W	25	IT architect	solely HO	employed
Vilma	W	32	accountant	HO, office	employed

Note: HO = home office.

7. Results

In interviews, work flexibility was presented not only as flexibility in working hours and the possibility of choosing a place of work, which were the main criteria in selecting interviewees, but also as the ability to plan work and non-work activities individually and not having to report absences (e.g., doctor's appointments). As Matěj articulated: "I can adapt it to what I want and need." When asked whether their work flexibility allows them more flexible daily mobility, the interviewees responded positively without hesitation. However, a thorough examination of the data reveals that although the work schedule of teleworkers appears to be adaptable, in reality, it encompasses a number of time–space barriers and conflicts that are incongruent with such a work arrangement.

7.1. Navigating Flexibility Through Time

The experience of time is generally influenced by a combination of cultural meanings, social conditions, and personal agency, and is further shaped by its implicit understandings (Ravenelle & Kowalski, 2023). These cultural meanings were conveyed during the interviews, primarily through the lens of entrenched fixed working hours (mostly 8–4) within the Czech work environment. This became the predominant time constraint that was reflected in individual interviews. Interviewees frequently contrasted their own flexible schedules with these fixed routines, referring to workers on standard hours as "normal people" or "the majority of Czech workers." However, this contrast between flexible and fixed settings may contribute to creating barriers to daily non-work trips:

> I know that most of my colleagues from Czechia are simply green and connected, and they will see that I am simply not connected. So I tend to always be online, even though I know I don't have to be. But I have this stupid feeling that I have somehow programmed into myself that on a weekday morning, I should just be working. And even though I know I don't have to, I often can't help myself, and just like I'm connected, I can't really enjoy the morning. (Martina)

This statement underscores the potential for harmonizing one's personal rhythm, characterized by temporal flexibility and planning, with the rhythm of others. This rhythm is further exemplified by the work of colleagues (who "are green"), but also by the ingrained rhythm of Czech society (where it is customary to work on weekday mornings). As Martina notes in another section of the interview, she could allocate the morning time she references in the above excerpt for personal leisure activities (e.g., pedicures, brunch), postpone the start of her workday (at the expense of working late into the evening), and thus benefit from the flexible arrangements her occupation permits. However, the conflict with the aforementioned rhythms precludes her from doing so.

The rhythm of colleagues is represented here by visual information in the form of icons displaying their status on the communication platform (i.e., available, appear offline/away, be right back, etc.). While the working hours are not known, the important information that is reflected in Martina's plans is the currently displayed status, i.e., that someone "is green." However, this dynamic gives rise to an effort to synchronize with the rhythm of these colleagues. When a person is not connected and is not showing "green," there is a deviation from the belief that "on a weekday morning, one should be working," and, as Martina mentions, feelings of guilt may arise related to the belief that she is not working at the time or during the time others are working, even though this is contrary to the flexibility allowed in her work.

Conversely, the rhythm of society is shaped by fixed working hours. Radek, from the perspective of transcending the conventional boundaries of working hours and thinking about when he should (or should not) work, says: "It's perhaps about some kind of inner feeling, some kind of subjectivity. Like, it's 11 am on Tuesday, and how come I'm actually at home? Yeah, it's a strange feeling." In interviews with other interviewees, it was mentioned that engaging in non-work activities and related trips during traditional working hours is not "mentally right," "not something they can justify to themselves," or they "feel bad" about it. In other words, this ingrained (subconscious) relationship to traditional working hours prevents them from leaving work and the workplace (home office, as in Martina's case) between 8 am and 4 pm.

However, the conflict between these rhythms can impede daily mobility associated with leisure activities, as individuals tend to adapt to the more dominant rhythm. Despite the absence of an obligation to adjust their work schedules to align with this rhythm, the ingrained nature of this setting in their environment, society, and, to a large extent, in themselves, ultimately prevents them from taking full advantage of their work arrangements, as they subconsciously continue to follow work patterns that do not apply to them. The temporal boundaries that impede their engagement in non-work activities and travel, therefore, stem from the intersection of distinct work environments and the need to adapt to schedules with which interviewees, due to the nature of their work settings, are not obligated to comply. While their daily routine and subsequent journeys are not based on fixed anchor points (especially the start and end of working hours), they may ultimately be strongly subordinate to them.

However, the analysis also demonstrates that variations in work schedules influence not only the negotiation of interviewees' independent leisure time and associated non-work trips, but also the negotiation of shared leisure time and non-work trips with their acquaintances, who are, in turn, subject to fixed working hours:

> It's still strange that I have a lot of friends who have time, as far as I know, from 8 pm onwards, and I've just realized that I don't even have a chance to meet up with them, because when they go for a beer at 9 pm, I say no, I have to go to bed. (Samuel)

In this excerpt, Samuel's flexible rhythm stands in contrast to that of his colleagues, who are more influenced by the spatiotemporal constraints inherent to their work. Due to the adaptable nature of Samuel's work, he is able to start his leisure time earlier than his peers. However, his peers' schedules are fixed and finish later than his own. As Samuel also notes in another part of the interview, this ultimately results in him spending his leisure time with individuals who have a similar schedule to his, sharing their leisure time with each other, during which they can plan joint activities and trips. In terms of planning daily trips and activities, the issue in this case is not whether the trip or activity will take place, as discussed above, but who can or cannot participate. Such an experience may ultimately lead to a tendency to carry out these plans with people who have the same or similar rhythm, which makes it easier to realize these plans and removes barriers to daily travel.

When assessing the impact of work flexibility on daily travel, it is essential to recognize that interviewees must always take into account the schedules of others (colleagues, family, friends), their rhythms, and the spatiotemporal constraints (primarily fixed working hours) to which they are subject. The conflict between these rhythms and different time settings then leads to the creation of barriers, which necessitate adjustments to or the complete cancellation of this travel. Consequently, their daily flexibility and time–space behavior are not solely dependent on themselves, but rather, it appears that this flexibility diminishes during negotiations

with others, thereby showing that the discrepancy between following one's own rhythm and following others' rhythms (Kotýnková Krotká, 2025; Thulin & Vilhelmson, 2021) can have spatial consequences as well.

7.2. Navigating Flexibility Through Space and Distance

While teleworking reduces or eliminates the need to commute when working from home (Zhu & Guo, 2022), the need to commute persists when choosing other alternative locations. Nevertheless, the considerable distances that must be traversed to commute may be perceived as a significant impediment by teleworkers. This may result in the adoption of varied strategies with regard to the planning of work trips and the selection of their place of work:

> Maybe I would find a coworking space that is further away, but I like it better. If I only go there four times a month, then it's probably fine. But if I go there every day, then I'll look for something closer to where I live. (Valerie)

The irregularity of commuting when teleworking, and the associated reduction in time spent traveling to work, can lead to a more sensitive perception of the time spent commuting (Erdoğdu & Watson, 2022). Consequently, the regularity and duration of this commute can serve as significant factors in the perceived efficiency of the journey and the ultimate selection of workplace location. As Valerie, who is considering replacing her home office with cowork, notes in the aforementioned statement, the more frequent her commute, the closer she'll want the coworking space to be. This is primarily due to the time expended on commuting to a specific location, as she thinks about "how not to waste too much time on inefficient mobility." Concurrently, the data indicates that when the commute time to a prospective workplace is minimal, interviewees regard working time to be more productive and efficient, and as Vilma points out: "I actually save the time I would have spent traveling, and that way I can get more done." However, interviews with Valerie and other interviewees demonstrate that the duration and overall perceived efficiency of the journey, as well as the selection of where the work will ultimately be performed, are fundamentally influenced by the extent to which time spent at a potential workplace outside the home (coworking space, office, café, etc.) is used sufficiently and effectively:

> If I went to that coworking space and knew that I would spend several hours there, then the 40-minute time investment wouldn't seem so bad to me, unlike if, I don't know, I decided to go dancing or swimming for an hour and had to travel there for 40 minutes. That's nonsense. (Irena)

The aforementioned excerpt from Irena signifies a scenario in which commuting to an alternative workplace is both rational and effective, resulting in a favorable ratio between the time invested in the journey and the time allocated to the work itself. However, the interviews also indicated a contrary scenario. The interviewees talked about how "it doesn't make sense to go to the office for one meeting" or "unless it's absolutely necessary," or "to travel somewhere [outside the home office] separately" without the possibility of combining the trip with other duties and activities. Consequently, the content and duration of work performed outside the home must offer greater advantages and meaning for teleworkers compared to the time spent commuting. Therefore, if the efficiency of the journey, or rather its final purpose, does not exceed the time required to commute to the given location in the eyes of the interviewees, working from home is preferred, which ultimately eliminates the need for commuting. From the perspective of planning teleworkers' commutes and their overall implementation, an excessively great distance, which would have to be covered on a daily or more regular basis, can act as a barrier. As Valerie's statement above indicates, this

may result in locations closer to the individual's place of residence being selected for more frequent teleworking, thereby reducing the time spent on commuting.

The barriers to planning and carrying out work trips for teleworkers may not only be the distance to an alternative workplace, but also the location itself:

> My biggest enemy is when cafés simply ban computers or don't have Wi-Fi. Not having Wi-Fi is okay, I understand that, but it really happened to me a lot that they just didn't want [laptops] there anymore, which I honestly don't really understand. But it just really annoyed me sometimes that I needed to work, I found a café, I got there, and I discovered that I couldn't stay. (Kamila)

Kamila's professional role as an editor for an online magazine entails the utilization of Wi-Fi and a laptop, which have become indispensable for her work. Cafés are thus the typical place where she works. However, the above statement raises the issue of places in urban space that lack reliable Wi-Fi access and exclude teleworkers like Kamila, making it difficult for them to do their work and plan it at a given moment. This can be attributed to the policies of specific establishments, which may either lack internet connectivity or prohibit the use of laptops altogether. However, as Kamila further elaborates in the interview, this barrier forces her to "walk around the city looking for the right café," which consequently increases her commute time, thereby reducing the time she spends working, and in her words, this "reduces [her] productivity."

Places such as cafés, pubs, and restaurants are often referred to in literature as "third places," with "first place" representing home and "second place" representing the workplace (Oldenburg, 1989, as cited in Kviat, in press, p. 1). Third places were designated for informal meetings, relaxation, and socializing with friends and family. However, the advent of ICT, the increasing demand for Wi-Fi availability, and the disruption of the original spatial constraints associated with the workplace have collectively transformed the nature of these spaces. Consequently, the original purpose of these spaces is beginning to dissipate, and, as in Kamila's case, cafés are becoming a common place for performing work instead of serving as a place for rest and socialization. Working in a café may be a preferred option, mainly because of the lack of distractions at home (e.g., housework), as it provides a distraction from the daily routine and promotes creativity and productivity (Henriksen & Tjora, 2018). In this regard, interviewees have identified several advantages. For instance, they have noted the potential benefits of modifying the work environment or integrating work in a café with other errands in the area, which would otherwise require a separate commute. This possibility means that workplaces, represented by public spaces such as cafés, are expanding into areas where they did not exist before (or were not utilized for such purposes), and their increased number and proximity make them more accessible to workers. According to Couclelis (2000), this fragmentation of activities and spatiotemporal plasticity leads to planners having reduced control over where, when, and what activities take place. Compared to coworking spaces, as other alternative places to work, a further advantage of cafés can be the absence of space rental or reservation fees.

In such instances, the predominant barrier is the setting that restricts work performance (prohibition of laptop use or limited access to Wi-Fi), making it impossible to perform work at a given moment and subsequently resulting in additional and unplanned commuting beyond the scope of teleworkers' plans. Ultimately, this results in the displacement of teleworkers from suitable locations for their work, the need to identify an alternative workplace, and a perceived decline in the efficiency and productivity of their work.

Elldér (2017) mentions that new everyday practices and strategies resulting from telework and flexible working arrangements may blur traditional spatiotemporal constraints, increase the availability of time for non-work activities, and the possibility of choosing new locations based on personal preferences rather than geographical proximity. Conversely, these findings suggest that geographical proximity continues to play a significant role in shaping the daily lives of teleworkers. In this regard, time is a critical factor, which, as Jakub points out, "is extremely valuable." This value is twofold: First, it seeks to reduce the time spent commuting; and secondly, it aims to optimize that time for work activities. The interviews demonstrate that the time and space flexibility enjoyed by the interviewees leads to efforts to optimize and streamline their daily routine (both work and non-work) and related travel as much as possible, thus finding "options that fit nicely into [their] daily schedule."

8. Conclusion

While the presented research supports and builds on earlier studies in many respects, it also offers a new perspective on how teleworkers experience, limit, and modify their temporal and spatial flexibility when commuting. The presented space-time barriers disrupt and subsequently reshape the form of teleworkers' daily journeys, but also when and with whom they can plan their daily mobility. Furthermore, the data demonstrate that telework does not necessarily lead only to feelings of isolation and a lack of social interaction with colleagues (Chen & Zheng, 2023), but in conjunction with flextime, it can also result in isolation from acquaintances whose schedules and rhythms differ from those of teleworkers. This may ultimately result in the undertaking of trips with individuals with whom this rhythm is more readily synchronized. Although Allen et al. (2015) posit the necessity for distinguishing between the impact of telework and flextime on commuting, this research demonstrates the need for further distinction between the impact of such work arrangements on work and non-work trips. The time barriers resulting from these work arrangements can primarily affect the planning of non-work trips and activities that teleworkers wish to undertake (e.g., going out for brunch), while space barriers, conversely, have a more significant impact on work trips and commuting to alternative work locations. As Elldér (2017) observes, whilst geographical proximity may no longer exert the same influence as it once did, the presented data show that proximity to an alternative workplace remains a significant factor influencing the time–space behavior of teleworkers, particularly in cases of regular or daily commuting. The findings of this research suggest that commuting, the selection of an alternative place of work, or the time during which commuting occurs, are influenced not only by sensitivity to time spent on transport (Erdoğdu & Watson, 2022) or efforts to avoid rush hours (Wöhner, 2022), but are also a reflection of the subjectively perceived efficiency of such a journey. This is represented by a balanced ratio between the length of the journey, the amount of work done, and the time spent working at the alternative place of work.

In alignment with Fischer (2004), this research does not perceive the presented time–space barriers as insurmountable hurdles or as an unchangeable consequence of time–space conflicts that interviewees have to deal with. The barriers presented here may have solutions. Nevertheless, the transformation of time barriers and the elucidation of their origins may present a considerable challenge, as they are rooted in deeply entrenched preconceptions and subjective perceptions of when work should be performed. However, once such barriers are overcome, there may be no feelings of guilt stemming from the preconception that this norm is being deviated from. A partial yet positive change in the general support for more flexible work in the Czech labour market in this regard may be, for example, the amendment to the

Labour Code. Coming into effect in June 2025, this amendment aims, among other things, to improve the reconciliation of work and non-work/family life (MPSV, 2025). Whilst the present amendment will not resolve the source of the temporal barriers presented, and the consequences of the changes it will bring can only be assessed over time, it may be an important driver in setting a new work standard—one that is essential for overcoming the aforementioned barriers. Furthermore, the solution to the spatial barrier associated with the absence of an internet connection or the prohibition on the utilization of laptops is chiefly a matter of the specific settings and rules elected by the establishments (e.g., cafés). In order to reach a compromise between the establishment and its users in this regard, possible solutions to overcome these barriers may include introducing free internet access for a limited time, designating separate work zones, setting specific days (e.g., weekends) during which laptops cannot be used, or setting a minimum spend that ensures the business profits from the space used by the teleworker. Nevertheless, this measure may result in disadvantages, as previously discussed in relation to cowork spaces, and may consequently lead to additional (financial) barriers. However, such measures would empower teleworkers to select workplaces based on their preferences, thereby eliminating the need to seek alternative workplace opportunities, extend their commuting times, and experience a decline in productivity, as evidenced by Kamila. Conversely, by modifying their rules, such establishments could potentially appeal to new clientele while preserving the character of a "third place" that serves for relaxation and socialization.

However, the presented research has several limitations and thus leaves room for exploring spatiotemporal barriers in different contexts and other forms of flexible work arrangements that have not been addressed. For example, the research did not deal with digital nomads, who are characterized by hypermobility and free choice in shaping their everyday lives (Mancinelli, 2020), or primary caregivers working part-time (e.g., mothers on maternity leave), for whom childcare may be associated with a number of spatiotemporal constraints in their daily routine and mobility. A further limitation of this research is that it focused exclusively on barriers affecting physical mobility in physical space. Consequently, virtual mobility, which has the capacity to influence physical mobility (Konrad & Wittowsky, 2018), was disregarded. And although this article presents time and space barriers as separate entities, future research could explore the influence of one entity on another, and whether they further influence the time–space behavior of individuals who are affected by them.

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Conflict of Interests

The author declares no conflict of interest.

Data Availability

The datasets analyzed in this study are not publicly available due to interviewees' anonymity and data protection requirements. A de-identified summary of the data is available from the corresponding author upon reasonable request.

LLMs Disclosure

No LLMs tools were used in the writing of this manuscript.

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ARTICLE

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Where the Grass Is Greener: Deconcentration Mobility and Activity Space Changes Among Remote-Worker Families

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Abstract

Digital change—most notably advances in digital tools, infrastructure, and the widespread adoption of remote work—has increasingly shaped residential mobility decisions. Alongside shifting attitudes toward remote work and the expansion of e-services, these developments have reduced the importance of workplace proximity in residential choice. This changing context has opened new decentralised residential pathways from urban cores to suburban, peri-urban, and rural areas, as residential decisions are increasingly shaped by digitally mediated connections to activities and places. Drawing on a qualitative study of remote workers relocating from Tallinn to its hinterland and beyond, this article examines how digital transition influences residential decision-making, daily activity spaces, and subsequent lifestyle changes following relocation. The analysis is framed within a life course approach, which conceptualises residential relocation as an event embedded within interconnected dimensions: the individual (situated within an individual's lifeworld), the relational (shaped by linked lives and social ties, especially among the household members), and the structural (conditioned by institutional, technological, and economic contexts). The findings show that the ability to work remotely enables greater freedom in choosing where to live while maintaining employment, particularly where considerations of housing affordability, environmental quality, and family-oriented lifestyles intersect. However, traditional life course factors remain important, and the ability to work from home primarily acts as an enabler for realising existing residential preferences rather than fundamentally altering them.

Keywords

activity space; digital change; linked lives; remote work; residential mobility

1. Introduction

The development of digital technologies over recent decades—particularly the expansion of remote working opportunities—has generated a growing body of scholarship examining the implications of digital change for residential mobility and spatial settlement patterns (e.g., Gallent et al., 2022; Tammaru et al., 2023; Zālīte et al., 2025). A critical acceleration of digital transition from the perspective of residential mobility occurred during the global Covid-19 pandemic, when remote work became widely normalised, allowing housing preferences and residential mobility behaviour to reflect lifestyle considerations and wellbeing aspirations (Goodwin-Hawkins et al., 2023; Incaltarau et al., 2024; Maclaren et al., 2024). Most importantly, the digitally mediated opportunities to work from home have reduced long-standing place-bound constraints associated with the need to live close to the workplace. Residential considerations can take diverse forms, ranging from traditional urbanisation, suburbanisation, and counter-urbanisation, to emerging patterns of multi-local living (Di Marino, 2022), as well as transnational lifestyles and digital nomadism (Henkens, 2025; Mancinelli, 2020). By decoupling home and workspaces, the boundary between urban and rural spaces has become increasingly blurred as well, with cities, their hinterlands, as well as remote areas growing functionally intertwined. The combination of expanded remote work opportunities with persistent housing shortages and affordability pressures in attractive urban areas—partly driven by the digital transition and the related commodification of housing—encourages households to consider moving away from major cities and towards lower levels of the urban hierarchy through a complex set of push and pull factors shaped by both housing-related preferences and constraints. Families with young children in particular reconsider the advantages of suburbs and smaller settlements, due to more space, greenery, and a safer living environment, coupled with better affordability of larger homes (Jansen, 2020).

Despite growing evidence of digitally induced opportunity structures for residential mobility, we still know little of what the effects of these new residential locations are—for activity spaces and other daily practices as well as well-being. Also, the question of how these migration processes are embedded in individual life course dynamics and personal aspirations remains insufficiently explored. Furthermore, existing research on the role of remote work opportunities yields mixed findings (Hook et al., 2025; Vilhelmson et al., 2026). In this context, the aim of this study is to shed new light on how remote work shapes the residential decision-making and activity spaces of families with children and at least one adult working from home. The study moves beyond traditional explanations of residential mobility to capture the household-level interplay between work and family life, housing conditions, and location-based factors, including how family members' activities are anchored to the home location.

The study builds on the traditional life course framework, which conceptualises residential relocation as an event embedded within broader life trajectories (e.g., Bernard, 2022; McCollum et al., 2020) but reconceptualises residential mobility for families in the context of digitally transforming societies. First, it offers qualitative insights into the motivations, within-household negotiations, and lived experiences of families relocating from a major metropolitan centre. Second, it seeks to better understand how new opportunity structures for residential decision-making, driven by digital change, are emerging. Third, it adds new nuances to the life course framework of residential mobility by showing how digitally mediated work and social arrangements complicate residential decisions. While links between home and other activity locations—such as work, schools, services, and leisure—have become more flexible, this flexibility varies across family members and continues to shape residential decision-making.

Empirically, the article draws on 35 qualitative in-depth interviews conducted between 2024 and 2025 with households with children, who relocated from Estonia's capital city, Tallinn, to sparsely populated suburban, small-town, and rural areas while continuing to work remotely, either part-time or full-time. The qualitative approach enables an in-depth understanding of how residential decisions are made and negotiated within households, how destination locations are selected, and how residential relocations reshape everyday practices, including changes in activity spaces and community engagement.

2. A Life Course Perspective on Remote Workers' Residential Mobility

The traditional life course perspective, building on Elder's (1998) seminal work, provides the theoretical point of departure for this study. This approach emphasises that individual lives unfold through interconnected trajectories shaped by structural and socio-spatial contexts, social relationships ("linked lives"), and individual agency, while also acknowledging the biographical embeddedness of residential decisions (Giele & Elder, 1998; Shanahan et al., 2016). This traditional life course approach has long offered insights into the relationship between life stages, residential trajectories, and housing (Clark & Onaka, 1983; Rossi, 1955). It assumes a relatively linear progression from renting small apartments in urban cores after leaving the parental home to owning single-family homes in suburban areas in family-forming ages, followed by a return to smaller dwellings later in life after children leave the household. For households with children, access to family-friendly housing and residential environments, while remaining close to workplaces, has been of key importance in residential decision-making. While analytically useful, this model cannot capture the new opportunities that stem from the new digitally-mediated work arrangements that allow the decoupling of home and work locations.

To build the theoretical foundation of this study, we move beyond the traditional life course perspective and adopt a relational approach that allows for the diversity and complexity of human experiences (Berg, 2020; Steinführer et al., 2024) and is better suited to digitally transforming societies. In such contexts, the spatial fixity of activities is reduced, enabling diverse work arrangements, new place-based conditions, and the reconfiguration of activity spaces among different household members who share a home. Therefore, this perspective better captures the increased flexibility and fluidity of residential decisions that characterise less place-bound and more digitally mediated work and social arrangements (Bernard, 2022; Maclaren et al., 2024; McCollum et al., 2020). It also links residential choice strongly to the daily activity spaces of all family members, who undertake their activities across both physical and digital spaces, highlighting how increasingly diversified opportunities create a complex context for residential decision-making. More specifically, our approach is based on four analytical pillars: (a) the intersection of residential mobility and immobility with other life course trajectories in time and space, (b) residential agency within existing social and spatial structures shaped by digital transition, (c) the temporal embeddedness of residential decision-making, and (d) linked lives within households.

First, the principle of *the intersection of residential mobility and immobility with other life course trajectories in time and space* conceptualises residential mobility and immobility as a process unfolding in the life course (Figure 1). Individuals and households make simultaneous decisions in related life domains, including family events, work life, school-related considerations of children, accompanied by place-related considerations both regarding home location and other activities (Tammaru et al., 2021). Digitally mediated work and social relations shape how these decisions are made, extending the distance between places of work and residence (Coskun et al., 2026). For example, in families with sustained remote work arrangements, a family-related life event—such

as the birth of a child—may increase the need for a larger dwelling and thereby trigger a residential move. Moreover, the ability to work remotely may allow for a geographically wider residential choice set. At the same time, this shift from on-site to remote work can increase demand for spacious housing due to the need for a dedicated home office space, thereby simultaneously enabling and motivating residential mobility.

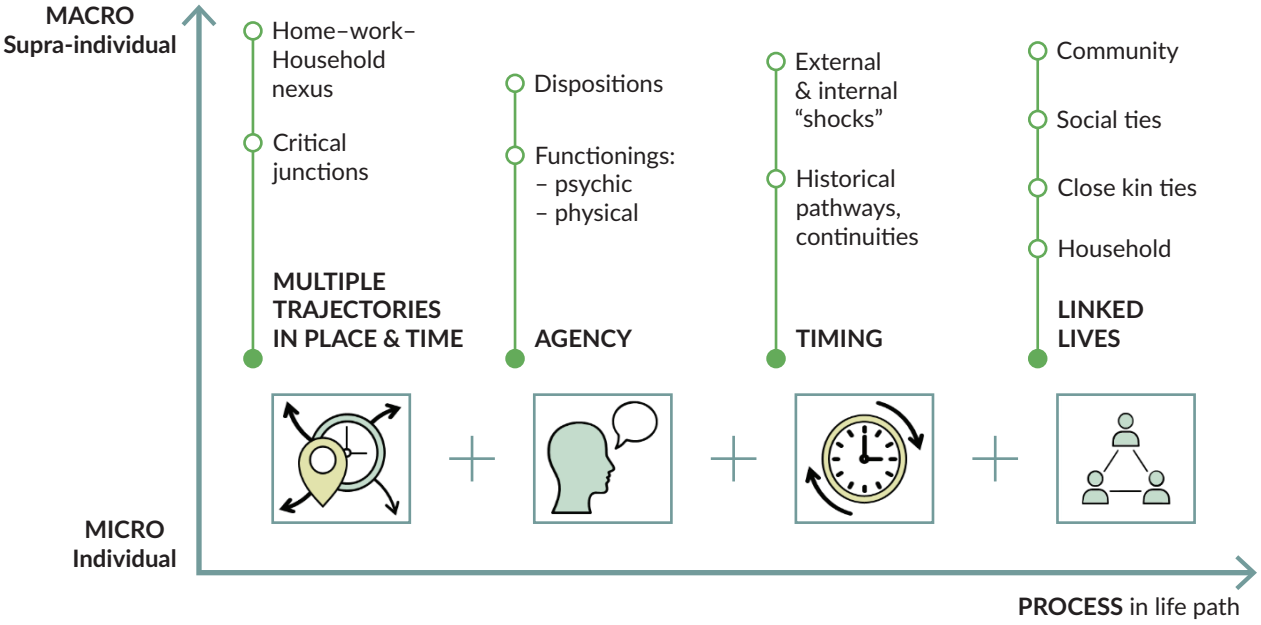

Figure 1. Adopted framework of the life course perspective.

Second, the principle of *residential agency within existing social and spatial structures* highlights how individuals and households exercise choice while navigating contextual constraints and opportunities. The shift from place-bound to digitally mediated work and social relations has reshaped these opportunities and constraints associated with residential decision-making. For example, remote work technologies may function as structural enablers that expand residential options, allowing the distance between places of work and residence to increase (Coskun et al., 2026). However, the ability to take advantage of these opportunities varies across households depending on many factors such as occupational position, skills, income, health, and household composition (Asmussen et al., 2024; Siegert et al., 2025). These micro-level factors are further shaped by organisational cultures including openness to remote work arrangements at the intermediate level (organisations) and by digital infrastructure availability at the macro level (landscape of opportunities). The parallel rise in house prices, partly driven by the digital transition, introduces new constraints on residential decision-making, too.

Third, the principle of *the temporal embeddedness of residential decision-making* emphasises that residential decisions are shaped by concrete historical moments, biographical precedents, and place-specific considerations. The Covid-19 pandemic represents a critical temporal juncture that normalised remote work and expanded flexibility in residential choice. Yet, little is known about the continuities and discontinuities the pandemic introduced into residential mobility. Findings from quantitative studies range from strong (Hook et al., 2025) to modest effects (Vilhelmson et al., 2026) of remote work opportunities on residential decision-making.

Fourth, the principle of *linked lives within households* emphasises that household members may live in the same home but have individual activity needs and patterns influencing residential decision-making (Moen & Hernandez, 2009; Settersten, 2015; Tammaru et al., 2021). In the context of remote work and the expanded flexibility of home search, mobility decisions are best understood as part of wider household and family strategies shaped by partners' work requirements, children's educational needs, caregiving responsibilities, the maintenance or reconfiguration of social ties, and related activity spaces (Vilhelmson et al., 2026). The concept of "social convoys" (Kahn, 1980) is particularly useful for capturing how individuals and households carry existing social networks across residential moves while simultaneously developing new local attachments.

3. Digital Transformation and Changing Social and Spatial Activity Patterns Among City Leavers

The expansion of remote and hybrid work, alongside the growth of online services and e-commerce, has reduced the necessity of living close to employment centres and service hubs (Coskun et al., 2026; Rowe et al., 2022). As the spatial link between home and workplace loosens and distance increases, individual agency is reshaped by new socio-environmental conditions, while individual decisions may simultaneously contribute to reconfiguring settlement patterns (Halfacree, 2008; McManus, 2022). The pandemic also reshaped housing aspirations by increasing time spent at home and redefining the dwelling as a multifunctional space for living and working, thereby intensifying demand for larger homes and higher-quality residential environments beyond cities (Cuerdo-Vilches et al., 2021; Gallent et al., 2022; Vogiazides & Kawalerowicz, 2022). At the same time, rising housing prices in large cities—particularly for family-sized dwellings—act as a push factor, increasing the attraction of suburban and counter-urban areas (Delventhal et al., 2022; Denham, 2020; Gallent & Madeddu, 2021).

The Covid-19-driven "panic exodus" from cities observed in 2021 has since subsided, and urban out-migration is shaped by traditional lifestyle and environmental preferences, including air quality, noise, access to green space, and perceived safety (Rowe et al., 2022; Stawarz et al., 2022). Facilitated by digital opportunities and work arrangements, people can better realise their preferences and leave cities for less densely populated areas (McManus, 2022). Families with children have been particularly prominent among city leavers, seeking calmer, greener, and more affordable living environments (Colomb & Gallent, 2022; Gallent et al., 2022). New life arrangements may emerge as the distance between work and home increases (Coskun et al., 2026), while other activity places become strongly anchored around home (Vilhelmson et al., 2026). Suburban locations may thus be preferred over distant rural areas to avoid a complete disconnect from urban amenities and workplaces—especially in cases of hybrid work (Asadieh & Neisch, 2025; Korczyński & Kajdanek, 2025; Tan et al., 2023). Such suburban development has also been conceptualised through the "donut effect" metaphor that depicts areas surrounding large cities as the most attractive destination for remote workers, while distant rural areas receive a much smaller number of out-migrants from cities (Ramani et al., 2024).

These relocations to more distant locations, beyond the suburban ring, are conceptualised as counter-urbanisation, often associated with aspirations for a quieter lifestyle, closer contact with nature, the pursuit of gardening and growing one's own food, and community-oriented living (Herrero-Jáuregui & Concepción, 2023; Nofsinger, 2012). The environment in these destinations is usually perceived as greener,

safer, and child-friendlier (Jansen, 2020; Vogiazides & Kawalerowicz, 2022), as well as retirement-friendlier (Ubarevičienė et al., 2024). Furthermore, people tend to be inspired by the sense of community that is created in smaller villages, which contrasts with the sense of individualism and anonymous way of living in the cities. Evidence suggests that counter-urbanisation has intensified alongside the digital transition, with the composition of movers shifting towards families with children and knowledge workers in response to remote work opportunities and urban housing pressures (Eliasson, 2025; Karsten, 2020; Tammaru et al., 2023). According to Thulin et al. (2023), counter-urbanising remote workers tend to lead mono-local lives anchored around home, in contrast to suburban movers, who are more likely to retain multilocal ties. Today, remote work enables households attracted to counter-urban residential environments to act upon these preferences at earlier life stages than prior to the acceleration of the digital transition (Correa, 2025). Return migration of educated families to their home regions outside large cities has also been identified as an important component of this trend (Sandow & Lundholm, 2023). These emerging residential mobility patterns suggest that digitally enabled mobility intersects with life course transitions in ways that warrant systematic investigation.

4. Socio-Spatial Context of the Study

We draw our empirical evidence from Tallinn, Estonia's capital and the country's primary economic and employment centre, with approximately 461,000 residents in 2025 (Tammaru et al., 2025). Estonia is well known for its digital advancements (Aasa et al., 2026). Widespread high-speed internet coverage, extensive public and private e-services, and strong support for digital entrepreneurship have positioned Estonia as a leading digital society. Central to this transformation is the concept of the "digital citizen," which is structured around the national data infrastructure X-Road and a compulsory national digital ID (Kattel & Mergel, 2019). This infrastructure provided a strong platform for the acceleration of digital change following the outbreak of the global Covid-19 pandemic, including the rapid uptake of remote work (Piirsalu-Kivihall et al., 2023). By 2024, the total share of remote workers—defined as those with the opportunity to work remotely (for methodology see the description of Figure 2)—increased to around 25% in Estonia and 30% in the Tallinn urban region. Nevertheless, access to remote work remains highly uneven, varying strongly by education, occupation, field of activity, and other individual characteristics. For instance, while 42% of the managers and professionals can work remotely, this is true for only 14% of the middle occupations, with numbers sinking even further (to 8%) for those within the blue-collar workers' category.

Tallinn also has the highest housing prices in Estonia (Kährik et al., 2025), and the ability to work remotely provides the opportunity to seek homes outside the city. Register-based analysis of remote workers' residential choices reveals that suburbanisation has strengthened alongside the digital transition (Figure 2). Suburbanisation is dominated by young and family-aged households (up to their 50s), who account for around four-fifths of such relocations, typically moving from urban apartments to detached houses in suburban areas (Kährik et al., 2025). Remote and non-remote workers moving to the suburbs have similar age profiles (averaging 40 and 41.3 years, respectively). A portion of city-leavers relocate beyond the urban region to regional towns or attractive natural areas (e.g., coasts or islands). Counter-urban movers are slightly older than suburbanisers, averaging 45 years for remote workers and 46.3 years for non-remote workers. Remote workers are more likely to move out of Tallinn (15.9%) than non-remote workers (12.3%).

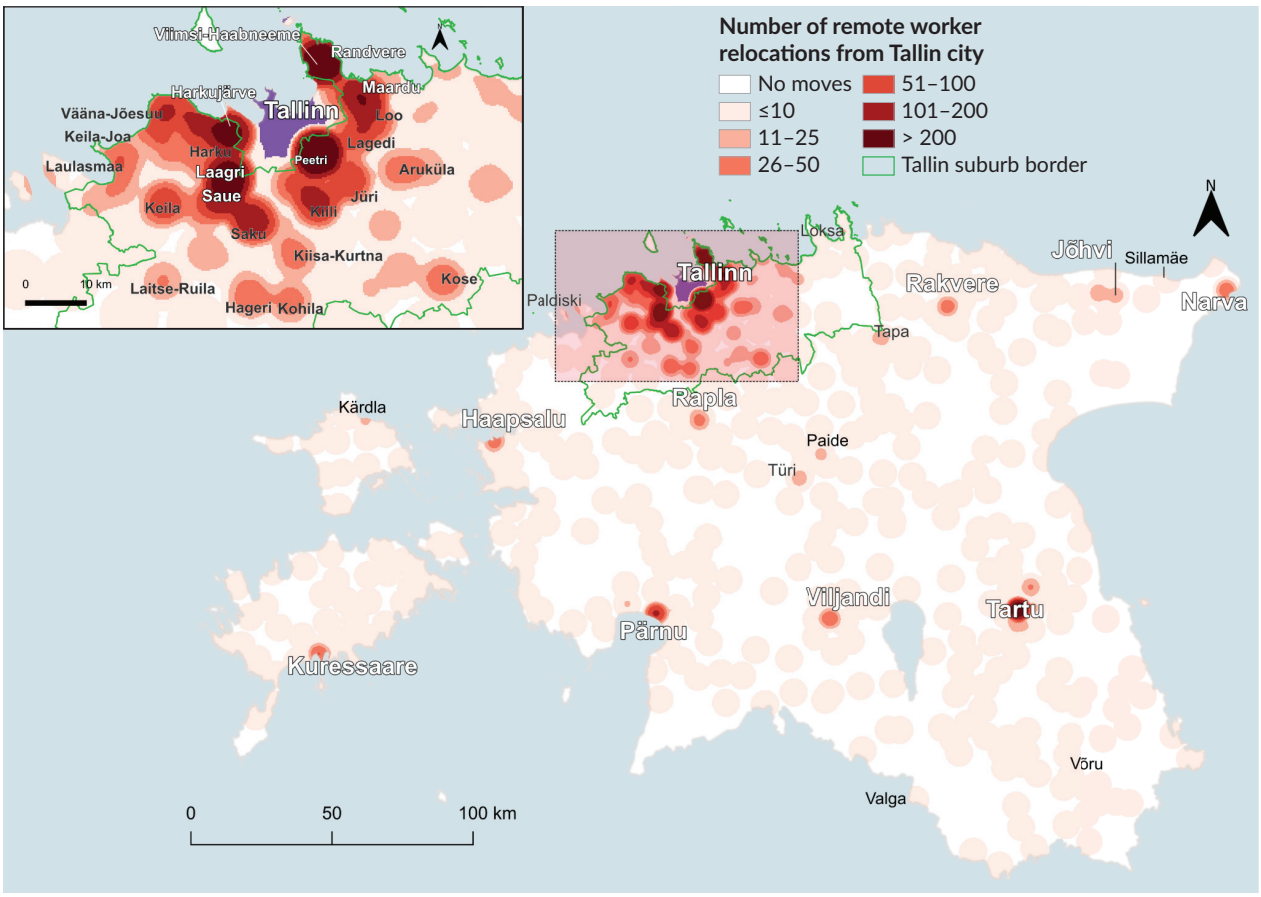

Figure 2. Residential out-migration of remote workers from Tallinn between 2019 and 2024. Notes: Remote work has been calculated as a binary synthetic variable by Statistics Estonia, linking individual-level data from the population registry to the most similar—in terms of demographic characteristics—respondent of the 2022 Labour Force Survey (Nagelkerke $R^2 = 0.45$); the map has been produced by the authors using the heatmap tool in QGIS on settlement centroid data containing the total number of relocations to each settlement. Sources: Eesti Statistika (2026a, 2026b); Maa- ja Ruumiamet (2026).

5. Methods

Between October 2024 and March 2025, 35 semi-structured, in-depth interviews with remote workers were conducted. All interviewees had relocated from Tallinn to suburban areas or more distant locations after 2019, while continuing to work in Tallinn, either fully remotely or in hybrid digitally enabled work arrangements. The qualitative approach was chosen to gain deeper insight into the motivations behind the residential moves. The interviews focused on two main themes: remote work intersecting with the life course considerations shaping the decision to relocate, and changes in the daily practices and activity patterns of the household members resulting from the move.

Drawing on earlier research on the "geographically extended donut" pattern of remote workers' residential choices and Estonian register data, we selected participants from suburban and counter-urban areas in Northern, Western, and Central Estonia (Figure 3). This also aligns with the job-related commuting field of Tallinn, which has expanded significantly, covering almost half of Estonia (Tammaru et al., 2025). These regions feature attractive natural environments, good access to Tallinn, adequate infrastructure, and more

affordable housing. Most interviewees could reach their workplaces within an hour by car, except for the Western islands (Hiiumaa and Saaremaa), where commuting can take up to four hours. Participants were recruited through Norstat's digital panel: A short questionnaire was sent to the panel, and respondents who matched the pre-set criteria were invited to an interview after providing informed consent.

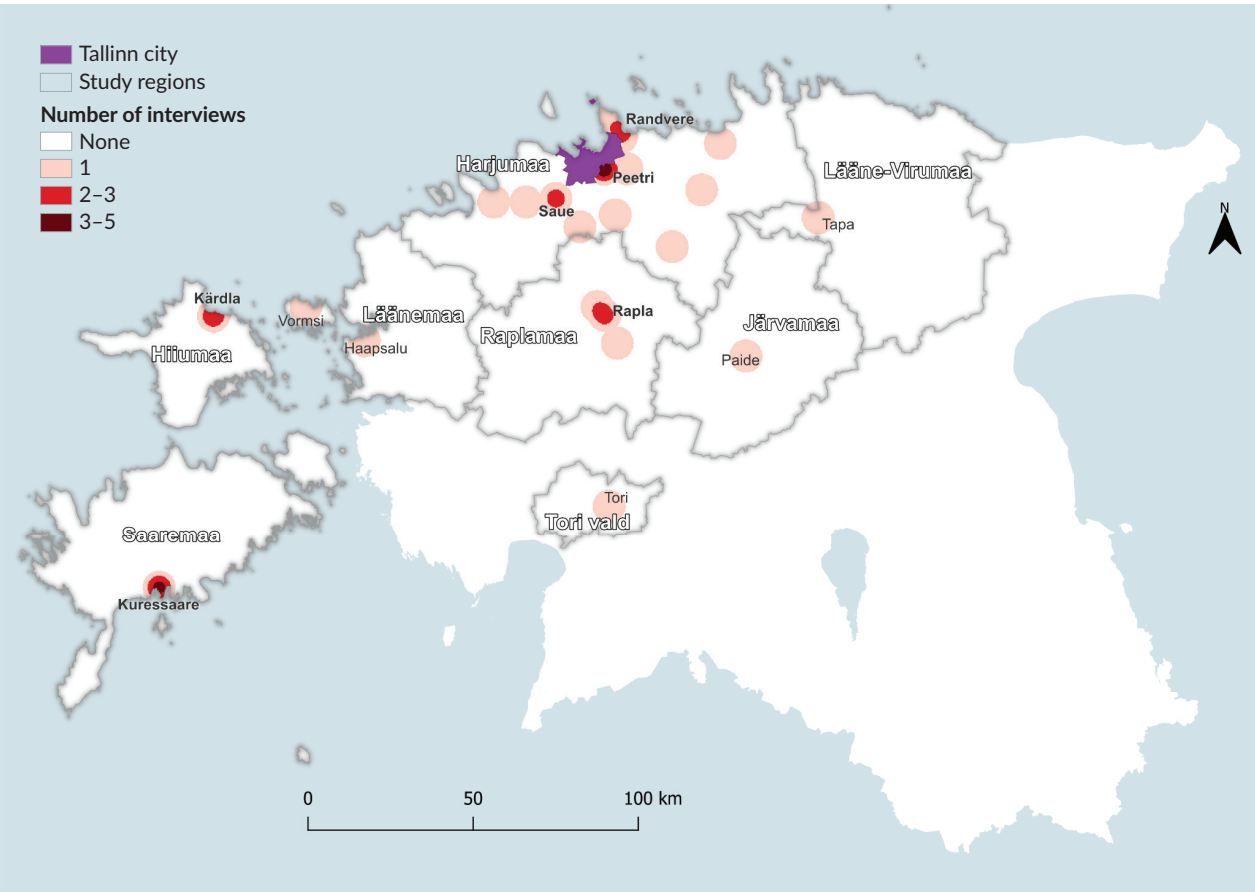

Figure 3. Home locations of interviewees (using heatmaps from settlement centroids). Data sources: Maa- ja Ruumiamet (2026).

Interviews followed a biographical life course-approach and semi-structured guide but focused on the most recent move from Tallinn to the interviewees' current place of residence (see Supplementary File 1). We focused on household negotiations around relocation and shared considerations across work, lifestyle, and daily mobility needs tied to schools, services, and leisure. In a few cases, two adults from the same household participated in a single interview, whereas most interviews were conducted with one household member at a time, either face-to-face or online, depending on interviewee preference. Nevertheless, the analytical focus remained on household-level decision-making.

Interviews were conducted in Estonian or Russian, recorded with participants' consent, and transcribed using the WebTrans tool. Analysis employed a hybrid deductive–inductive coding strategy, combining directed and conventional content analysis (Hsieh & Shannon, 2005). The research questions and the life course framework (Figure 1) guided the development of theoretical themes (Table 2), while observation codes were iteratively refined through conventional content analysis. Following abduction, predefined themes were adjusted and new themes introduced when warranted by unexpected evidence (Timmermans & Tavory, 2012). To enhance

validity, single-coder analysis was supplemented by peer debriefing and decision logs (O'Connor & Joffe, 2020). Interviewee confidentiality is maintained, with only group-level characteristics provided in Supplementary File 2; quotes and variables cannot identify individuals, thus complying with GDPR regulations.

In line with the register-based remote worker profile, most interviewees are aged 35–54, highly educated, economically resilient, and in stable employment (Table 1). The sample deliberately includes families with underage children to capture household-level decision-making. Most relocated from apartments in Tallinn to owner-occupied, typically newly built, detached houses in suburban or remote locations.

Table 1. Background characteristics of the interviewees.

Variable	% (*N* = 35)
Age	
<34	15%
35–54	70%
55+	15%
Gender	
Male	54%
Female	46%
Home language	
Estonian	86%
Russian	14%
Digital skills	
Very good/good	89%
Average	11%
Bad/very bad	0%
Type of housing	
Single-family/terraced	83%
Multi-family	17%
Type of occupancy	
Homeowner	91%
Renter	9%
Education	
High	97%
Other	3%
Economic coping	
With difficulties	20%
Well	80%
Profession (ISCO)	
1–2	60%
3–4	40%
5–9	0%

Table 1. (Cont.) Background characteristics of the interviewees.

Variable	% (*N* = 35)
Practising remote work	
Fully	47%
Hybrid	53%
Type of mobility	
Suburbanisation	54%
Counter-urbanisation	46%
Type of settlement	
Town	34%
New suburban settlement	11%
Village/small settlement	49%
Rural	6%

Notes: ISCO = International standard classification of occupations; as a determinant of socio-economic status, the ISCO division of occupational groups was used, where ISCO 1–2 describes high occupational groups (managers and professionals), ISCO 3–4 describes middle occupational groups (technicians, associate professionals, and clerical support workers), and ISCO 5–9 describes low occupational groups (service and sale workers, skilled agricultural, forestry, and fishery workers, craft workers, machine operators, assemblers, and elementary occupations).

Digitally mediated work and social relations are central for the interviewees. Over half work in hybrid arrangements, and the remainder fully from home. Digital tools are integral to everyday life: used for work, services, communication, news, and social media, and to maintain ties with colleagues, friends, and relatives—many of whom remain in Tallinn. Digital platforms also facilitate local community engagement through neighbourhood groups and forums, illustrating how digital connectivity sustains city ties while fostering new connections after relocation.

6. Results

The in-depth analysis is structured and presented below, following the conceptual framework. Under the main pillars, multiple single or intersecting factors were indicated, resulting from inductive analysis (Table 2).

Table 2. Themes and subthemes identified in the analysis (based on the interview data).

1. Multiple trajectories	Critical junctures and migration timing Digital enablers for remote work at home setting Intersect between the location and daily commuting patterns Remote work enabling holistic lifestyle
2. Agency within structure	Values, identity, and life-stage priorities Structural access to remote work availability Socio-economic position in relation to housing affordability
3. Linked lives	Within-household negotiations Family networks Community networks Other social networks
4. Temporal embeddedness	Covid-19 pandemic influence Historical pathways and biographical continuities

6.1. Alignment of Multiple Trajectories

Residential mobility occurs at critical junctures when family formation, work life considerations, and housing needs intersect in ways that make relocation both possible and desirable. For family-aged remote workers, most moves are still driven by traditional family-related reasons and shifts in residential aspirations, typically under conditions of relatively high occupational stability and sufficient financial resources to realise these aspirations. The alignment of these considerations thus reflects critical junctures in the timing of residential mobility. In particular, the birth of a child frequently triggers a reassessment of both dwelling size and residential setting. The need for more space, combined with a desire for a safer and greener living environment, is repeatedly identified as a key motivation for moving:

> The main reason was probably that our first child was on the way, so it was clear that we had to move. The previous one was a large two-room apartment, about 60 square meters, but clearly it wasn't a good living environment for a child, and it wasn't very comfortable for us either. (N2)

At this family stage, households search for a specific kind of environment described as clean, safe, walkable, with the presence of social and other services, and specific types of housing—typically an owner-occupied single-family house. Compared to renting, homeownership is often seen as providing greater "security," living space, and opportunities to spend time outdoors. Physical access to places of main daily activities is also considered critically important for all family members. As one interviewee noted: "The mobility infrastructure is well developed in every direction, so we are not living deep in the woods, but it still feels private enough" (N19). At the same time, digital infrastructure emerged both as a key enabling condition for leaving the city and as a critical factor in selecting the relocation destination. Reliable internet access is viewed as essential not only for work, but also for education, services, and social integration: "Thanks to the internet cable, there is a connection to the rest of the world so that you don't completely disappear" (N34). However, depending on professional status and position, the transition to working from a home office is sometimes perceived as challenging. In these cases, the availability of well-functioning digital tools, combined with good communication skills, enables a successful shift to new work practices:

> Of course, for me it was a big deal, being the head of the unit, in a leadership position, to be distant from the team….The tools are all available—everything is in the cloud, software is on the computers, chats, meetings, everything can be done on Teams. We do go to the office occasionally, but it's flexible. (N20)

Distance from Tallinn clearly differentiates daily work-related commuting patterns and the physical use of services, capturing what we refer to as the *intersection between location and daily commuting patterns*. Remaining connected to the capital city's infrastructure, workplaces, services, and leisure opportunities is a particularly important consideration for those relocating to suburban areas closer to Tallinn. For example, interviewees living nearer to the city commute to work more frequently, while those located farther away tend to rely more on remote work arrangements. At the same time, the widespread use of hybrid work enables greater flexibility in everyday life. It allows interviewees to become strongly anchored in local life, make greater use of local services, rely on nearby facilities, and better combine work and family life. Remote work is widely perceived as making daily routines easier and more flexible by reducing the need for physical presence at the workplace and increasing individual autonomy.

Even if the remote work option is available, it is not always applied in daily practice:

> I absolutely do not like working remotely. What I really like is that you get up in the morning, go through a phase of commuting to work, get the work done, then get in the car and close the door. (N6)

Hybrid work arrangements also translate into hybrid service use or shopping patterns. While it is important for many interviewees that their children can attend school independently close to home, larger shopping trips, cultural activities, and entertainment events continue to be concentrated in Tallinn. This illustrates how residential relocation expands the spatial reach of remote workers' activity spaces, as they do not fully detach from the city but instead reconfigure daily mobility and service use across multiple locations. Such arrangements help to "save time" and align work and family life to a greater degree: "Staying and working from home enabled me to navigate better between the household-related obligations and allowed more time to spend with family" (N22). This shift also increased the quality of time spent together, strengthening relationships within the family: "Now, since we're home…we interact enough with each other. There's no need to set aside separate time just for communication" (N22).

Yet, remote work is also perceived as blurring the boundaries between working time and personal life, making conscious boundary-setting necessary:

> Work-related matters are also on my phone, and the boundary tends to blur a bit. To avoid personal time merging with work time, I usually keep work notifications turned off, or only turn them on when I know I'm on the move and something important might come in. (N2)

For movers to remote destinations from Tallinn, the home location is typically detached from the workplace, substantially reducing commuting as people switch to full-time remote work. As one interviewee noted, "The possibility of doing remote work was one of the arguments behind that decision" (N30). By contrast, families who remain strongly engaged in regular daily commuting tend to live closer to the city and express mixed feelings. While some are dissatisfied with this time-consuming commuting pattern, others regard frequent commuting as an inevitable part of their living arrangements.

6.2. Agency Within Structure

The remote workers studied framed their residential decisions as efforts to align living environments with personal values, identities, and life-stage priorities. Again, traditional factors shaping families' decisions to move away from cities—such as environmental quality, safety, sustainability, and family well-being—emerge as central themes in these narratives. Personal values, identities, and life-stage priorities evolve over the life course, often reflecting a growing emphasis on social and mental stability and well-being. These shifts are also closely tied to biographical continuities and earlier life experiences such as being born outside the city. As one interviewee explained:

> I would consider myself a rural person. It comes naturally—I grew up in the countryside. I've lived in the city for a long time and considered myself a city dweller, but also a rural person. In that sense, now that I've come to the countryside, my identity aligns more closely with my real nature. (N22)

Values and beliefs highlight the importance of environmental quality and sustainability for remote workers, similarly to families generally. Our interviewees frequently emphasise living close to nature, valuing clean air, walkability, and a sense of safety in the neighbourhood, as well as consuming services and amenities locally whenever possible. These considerations typically become especially salient at family life stages, either at specific moments (such as when children reach school age) or generally through a desire to provide children with a high-quality living environment. As several interviewees noted, "For us, the central focus right now is the environment—environmental sustainability or a kind of eco-friendly lifestyle. Peaceful living. Overall, providing a high-quality upbringing environment for our child. Those are our core values" (N32), or "We can go for walks, there's the school park right nearby, everything is within easy reach" (N20).

Value judgements also reveal a broader set of priorities. Interviewees emphasise a preference for a peaceful and private lifestyle, alongside the importance of physical activity and maintaining good health. Everyday practices such as children walking to school instead of being driven by car, regular time spent in nature, and the preparation of healthy meals are frequently mentioned. Family values and traditions likewise play a central role in shaping residential preferences. As one interviewee explained, "We have introduced a rule here that we always eat together....Freedom, quiet, peace, nature—the opportunity to grow something yourself in the garden, it's really about the living environment" (N26).

These values sometimes evolve over the life course, signalling a transition toward greater stability, social embeddedness, and family well-being. Over time, such priorities increasingly take precedence over earlier values centred on mobility, independence, and professional advancement: "Well, I guess it comes somewhat with age, when the fast-paced and social life isn't as important anymore. Longer walks become more significant than quick club nights" (N32). Recurrently, "mental well-being" and "inner peace" are mentioned by the interviewees: "And I'm very happy. I feel that it has brought a lot of peace to my mental well-being" (N30).

Three key structural constraints continue to shape the residential choices of remote workers. First, the availability of high-speed internet is critical in conditioning residential selection. Second, housing affordability plays a decisive role. Third, physical access to other important activity locations remains essential. Within these constraints, remote work still enables relocation to places that embody valued environmental qualities, with remote work functioning as a key enabling factor for such relocation. Interviewees typically viewed their socio-economic position as strong and had accumulated significant financial resources; remote work enabled relocations that would otherwise have been infeasible. As interviewees explained, "Financially, too, it worked out. We basically traded an apartment for a house, and living in a house has its own values: having a sauna, your own garden, your own space. That is valuable for daily life" (N32); and "The resources were available to buy something larger for ourselves" (N3). In other words, for people who can work remotely, high housing prices in large cities do not necessarily act as a push-out force, especially when they are homeowners. Instead, high prices can function as enablers, allowing households to leverage accumulated housing wealth to secure better-quality housing outside the city.

6.3. Linked Lives

Residential mobility is shaped by household negotiations and family strategies, becoming feasible only when partners' work arrangements align and children's needs, caregiving, and kin proximity are considered. For remote workers, many place-bound concerns are digitally mediated, leading to varied combinations of

physical and digital arrangements in work and social life. Some households maintain strong ties to Tallinn, while others reconfigure their networks after moving. Local community integration—physical, digital, or hybrid—varies from active engagement to deliberate distance, reflecting different preferences for privacy, social interaction, and belonging. Relocating to distant areas requires particularly careful planning. As one interviewee explained, "My partner had always wanted to move back to Saaremaa, but at some point, when I stayed home with our child, I also started thinking that work is only one thing—and hopefully there would always be some options" (N18). Negotiation between adult partners is also central when considering children's needs, especially in relation to how the choice of residential location aligns with the overall organisation of daily mobility of all family members.

Despite digitally enabling factors, the physical characteristics of destinations and the possibilities for organising daily mobility routines between the key activity locations of all household members remain highly relevant. As one participant noted, "In general, we try to coordinate and adjust our plans so that trips can be combined and we don't have to make multiple separate journeys" (N25). Residential mobility is often motivated by the desire to restore or strengthen networks of care and intergenerational support, but the availability of wider social ties and face-to-face interactions in the neighbourhood are also important. Spatially proximate kin relationships become particularly salient in relocation decisions and in the organisation of everyday life for many families with young children, irrespective of the flexibility that remote work may otherwise provide. As one interviewee noted, "We were also looking for a place close to my mother, so that we would have someone to take care of the child" (N10). However, some families are accustomed to spatially detached social ties, considering spatial proximity to kin less relevant: "Changes already have brought close people far from each other" (N30).

Nevertheless, maintaining previous social networks remains important. For some interviewees, social life continues to be closely linked to Tallinn, with regular visits to the city helping to sustain established relationships and keep long-standing networks alive: "With my spouse, we still go to Tallinn, when possible, if we can find a babysitter. We go to parties—we're fans of electronic music—a few times a year" (N32). For some, strengthening previous social ties after the move is the case. As one interviewee noted, "Those [true] friends are farther away…but with some of them our connection may have even become closer. You can invite them over to the sauna now…So, in a way, our social interaction might have become livelier" (N22). For those for whom leaving Tallinn represents a return to a familiar place of residence, relocation helps to re-establish social connections in the new locality. As one interviewee explained, "All the people closest to us live in Saaremaa, so here they're much closer and more accessible" (N18).

Remote work practices affect interaction among colleagues, leading to a sense of distancing, while the office remains an important node for social capital building and keeping social ties alive: "I feel that the office still serves as an important anchor point for information exchange. Sure, various communication platforms can be set up, but face-to-face interaction clearly adds something that cannot be fully replaced" (N9), or "There has been clearly less contact with colleagues, which I would definitely consider a negative effect" (N11).

New face-to-face social interactions in the residential environment—particularly through community networks—tend to develop slowly, most often emerging through children's social interactions and their parents, or through relationships with immediate neighbours. These interactions help build trust, provide mutual support, and create opportunities for exchange and everyday chatting:

> We communicate with them [with the old couple who are neighbours] over the fence, and it's really nice. We don't exactly visit each other, but from time to time they might bring us a bunch of cucumbers, or we toss a tool over the fence, or just lean on the fence and chat. (N32)

Some individuals and families consciously choose to avoid physical face-to-face interaction to preserve privacy and autonomy as part of their preferred lifestyle: "We haven't really blended in here, because, well, we tend to keep more to ourselves" (N26); "It suits us very well this way—my spouse and I are both introverts, so we don't really need much social interaction" (N13). For others, local digital platforms—such as community-based social media groups, including those that promote sustainable and community-oriented exchanges of goods and consumption—provide opportunities for digitally mediated interaction that foster everyday social contact, build trust among neighbours, and support anchoring newcomers in local life.

6.4. (Dis)Continuity and Temporal Embeddedness

Historical pathways and biographical continuities shape both destination choices and settlement experiences among remote workers leaving Tallinn. The Covid-19 pandemic functioned as a critical catalyst, normalising remote work and enabling a closer alignment between housing/lifestyle preferences and actual residential locations. At the same time, it allowed for continuity with earlier residential experiences shaped by place attachment and prior connections to specific locations, often rooted in childhood or family histories—which turned out to be the reason for location choice especially for movers to remote areas (e.g., islands). For some, relocation represents a return to places where they lived earlier in life, to inherited properties and second homes. As one participant explained:

> Then the opportunity to build our own house arose. The plot already existed—it was my wife's grandmother's summer house, and they decided not to go there anymore. So, we got the plot, and then the decision was made to build a house there. (N6)

Another interviewee added, "This is now our home for both summer and winter—both our countryside and village home. Everything is here" (N22). Environmentally attractive areas—such as the West Coast and the islands—are particularly conducive to such moves, and many of these relocations take the form of return migration to former home regions. Remote work and digital connectivity directly enable this "back-to-the-roots" form of residential mobility, supported by existing social networks, identities, and values that reinforce the decision to return.

The Covid-19 era represented a discontinuity, a critical timing that both reshaped and allowed residential preferences to be realised due to the factors triggered by health considerations and enabled by the reorganisation of work arrangements: "Before that [Covid], the company didn't really have remote work. Covid forced everyone to work from home, and that's when we realized—oh, this can work!" (N20). The Covid-19 pandemic thus became a "catalyst" for leaving Tallinn:

> During the Covid lock-down period, we thought, "Why stay in the city when there's nothing to do? Let's go to the countryside!" This was in March 2020, a wonderfully sunny month. No planes were flying, the sun was shining, the grass was turning green—it was beautiful! We stayed there for three months, and as summer approached, we realised we could manage just fine, and we no longer wanted to return to the city. (N28)

For some, however, remote work was already a common practice before Covid-19: "During Covid, it turns out that I had already been living in a kind of quarantine even before the pandemic. Yes, it was a very familiar lifestyle, something I was used to" (N32). Covid-19 was thus a trigger, and remote work became widely accepted by society, a new "normality" for many. As one participant explained:

> In later job choices and searches I started to prefer—or rather, consider it important—that I wouldn't have to go to Tallinn to work on-site. Covid affected everyone's life and lifestyle anyway, and we started trying to work from home as much as possible. (N22)

7. Discussion and Conclusion

This study examines how remote work shapes the residential decisions and activity spaces of families with children, applying a life course framework to refine the conventional understandings of residential mobility in the context of digitally transforming societies. The framework is organised around four pillars: (a) the intersection of residential mobility and immobility with other life course trajectories in time and space, (b) residential agency within existing social and spatial structures shaped by digital transition, (c) the temporal embeddedness of residential decision-making, and (d) linked lives within households.

Overall, the findings confirm earlier research showing that remote workers' housing searches are less constrained by workplace location than before. Consistent with Delventhal et al. (2022), remote work partially decouples work and residence, allowing greater distance between home and workplace (Coskun et al., 2026). Rather than fundamentally reshaping mobility behaviour, it expands the geographic scope of housing searches and activity spaces by enabling households to align employment opportunities with preferred residential locations. At the same time, remote work is associated with reduced daily mobility and more hybridised activity spaces: Workplaces remain largely in Tallinn and are visited occasionally, while everyday services and activities—such as schools and kindergartens—are increasingly accessed locally. Residential decisions consider the linked lives within households, and therefore, the spatial flexibility of some members is often constrained by others' place-bound activities. Housing availability and affordability remain decisive, as does physical access to key activity locations and mobility infrastructure. Proximity to kin continues to shape relocation decisions and everyday practices, particularly for families with children. In addition, access to high-quality digital infrastructure has emerged as a critical new condition of residential choice.

As highly paid professionals continue to concentrate in cities, where housing affordability is under growing pressure (Lee et al., 2022), remote work broadens families' access to larger and affordable housing beyond urban cores. These expanded spatial opportunities, however, largely follow established life course patterns of residential mobility (Mulder & Hooimeijer, 1999). The age profiles and life course trajectories of remote-worker families leaving cities closely resemble those of other families, supporting an interpretation of remote work as an enabling rather than a transformative force. Nonetheless, increased work–life flexibility reshapes the context for agency, enabling families to better align housing and lifestyle preferences. Furthermore, digital enablers lead to reducing daily mobility, in most cases improving work–family balance, and engaging residents in outdoor activities close to the home environment. Increased residential choice and better alignment between values, daily practices, and preferences supports mental well-being (see also Fan & Moen, 2023). Yet, remote work is also perceived as having negative consequences for some, such as

distancing from social ties with colleagues and blurring the boundaries between working time and personal life (cf. Hook et al., 2025). Remote work has also raised expectations regarding the home, making people value the size of their homes and the opportunity to spend time outdoors.

Our results reflect that residential decision-making remains strongly anchored in life course-related and place-based factors (Müürisepp et al., 2022). Despite increased residential choice, several place-based constraints remain salient, rendering the residential behaviour of remote-worker families broadly like that of other families (cf. Kährik et al., 2012). Physical access to workplaces and services continues to matter even for remote-working families. Nevertheless, hybrid work extends spatial flexibility, enabling relocation somewhat farther from cities, to amenity-rich locations with adequate digital and mobility infrastructure. However, consistent with the "limits of telecommuting" (Denham, 2021), such mobility largely remains within metropolitan orbits, fostering spatially extended suburbanisation and contributing to the emergence of an "extended donut" pattern around cities (Ramani et al., 2024; Vilhelmson et al., 2026).

Although activity spaces have become geographically extended, digitally mediated work and social relations have also reshaped daily and weekly life arrangements within them. Such dynamics support 15-minute-city-like patterns of space use (Moreno et al., 2021), emerging beyond rather than within major urban centres. The study further highlights diverse social strategies among remote-worker families. Face-to-face local ties typically develop through children's networks, parental interactions, or neighbour relations, mirroring patterns observed among other families leaving cities (Špačková & Ouředníček, 2012). Local digital platforms also facilitate local community involvement for some households, supporting everyday interaction, trust-building, and local anchoring.

The study demonstrates that remote work primarily functions as an enabler of leaving cities rather than as a force that fundamentally transforms families' residential mobility. By expanding the scope for aligning residential choices with values and preferences, remote work supports a better work–life balance. It further supports life course continuity, such as returning to inherited or childhood homes, and allows fluid transitions between primary and secondary residences. Although access to remote work remains occupationally stratified (Asmussen et al., 2024), the out-migration of remote-worker families may ease urban housing pressures for those unable to work remotely.

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Conflict of Interests

In this article, editorial decisions were undertaken by Ulf R. Hedetoft (University of Copenhagen).

Supplementary Material

Supplementary material for this article is available online in the format provided by the authors (unedited).

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ARTICLE

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Twin Transition Attitudes and Regional Left-Behindness: Unpacking the Drivers of Interregional Migration Intentions

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Abstract

This article investigates how individual attitudes toward the green and digital transitions, collectively referred to as the twin transition, and expressions of regional left-behindness shape EU interregional migration intentions across different life domains. The study disaggregates migration intentions by motive, work, education, quality of life, and retirement, to better understand the interplay between personal values and regional structural conditions. The findings reveal that while traditional socio-demographic characteristics remain strong predictors of work-related migration intentions, green and digital attitudes significantly influence relocation intentions for education and quality-of-life reasons. Notably, individuals with strong green values are more likely to express intentions to move for quality-of-life reasons. Rural areas, in this case, are aligned with ecological lifestyles, whereas digital attitudes correlate with urban settlement preferences and, for retirees, confidence in relocating to digitally connected rural regions. Expressions of regional left-behindness, such as economic decline, demographic ageing, and weak connectivity, act as structural push factors that differentially affect migration intentions. The analysis suggests that twin transition values function as behavioural primers which, combined with structural push or pull factors, guide individual intentions and reveal how unequal capacities to adapt to digital and green transitions shape migration intentions.

Keywords

digital transformation; green transition; left-behind areas; migration; twin transition

1. Introduction

The green and digital transformations, collectively known as the "twin transition," are rapidly reshaping Europe's economic and social landscapes in ways that are both transformative and uneven (International Labour Organization, 2018; World Economic Forum, 2025). While these shifts promise new opportunities in innovation, sustainability, and employment, they also present considerable challenges for regions already facing structural disadvantages, economic stagnation, and demographic decline (OECD, 2021). In this changing landscape, migration emerges as both a response to and a driver of regional inequalities. Even though it allows individuals to seek better opportunities, it could also accelerate the marginalisation of left-behind regions by depleting them of skilled labour.

Moreover, the twin transition shapes policy priorities and plays a growing role in defining regional attractiveness (Angelidou et al., 2022; Komninos et al., 2023). Twin transition policies aimed at decarbonisation and digital innovation offer new pathways for left-behind regions to reposition themselves as viable destinations for mobile populations, through investments in digital infrastructure, environmental quality, and smart services (García Fernández & Peek, 2023; Gómez-Carmona et al., 2023). Regions with strong embeddedness in the twin transition, characterised by access to natural amenities, low exposure to environmental stressors, and high digital connectivity, are increasingly attractive not only to remote workers but also to other mobile groups such as students, families, and retirees (OECD, 2023). This highlights the mix of economic, social, and environmental factors intersecting with life-course dynamics and driving migration decisions.

In this context, the study aims to address two interrelated questions at the intersection of migration and structural transformation in Europe. First, it explores how individual attitudes toward the green and digital transitions shape intentions to migrate across EU regions. As labour markets and regional futures are being reconfigured at an unprecedented pace, personal perceptions of opportunity, risk, and inclusion may play a pivotal role in shaping interregional migration choices. Second, it investigates how different dimensions of left-behindness, including economic stagnation, limited accessibility to services and amenities, and high levels of poverty, affect interregional migration intentions across a range of motives, such as work, education, quality-of-life, and retirement. Together, these questions aim to unpack the complex and uneven ways in which structural change interacts with personal agency and place-based disadvantage.

The remainder of this article is as follows. Section 2 develops the theoretical framework connecting our key terms: green and digital transition, left-behind areas, and migration, and how they link to each other. Section 3 presents the data and the methodological issues followed in the empirical analysis, whereas Section 4 illustrates the key findings. Finally, Sections 5 and 6 discuss our findings in relation to previous studies and highlight their policy relevance, as well as potential limitations and future research.

2. Background

2.1. Green and Digital Transitions and Changing Patterns of Migration

Migration is frequently conceptualised as an investment in utility maximisation, typically captured through income gains (Ivlevs, 2015). Economic drivers such as wage disparities, GDP per capita, price levels, and job

opportunities are central in this perspective (Albert & Monras, 2017; Borjas, 2001). Beyond these drivers, individual characteristics have long been central to theoretical accounts of migration, with factors such as gender, age, education, and family status identified as important determinants of mobility, alongside broader economic conditions (Boterman & Bridge, 2023; Faggian et al., 2007; Fratesi, 2014; Lu et al., 2025).

However, recent findings show that the influence of economic factors diminishes once certain thresholds are reached, pointing to the limits of purely economic explanations (Suppa et al., 2023). Attention has therefore shifted to non-economic factors. Local amenities, including education, healthcare, transport, and lifestyle options, are shown to strongly shape relocation choices (Faggian & Royuela, 2010; Florida, 2003; Glaeser et al., 2001). Environmental conditions, such as climate, air quality, or exposure to extreme weather events, also act as decisive push or pull factors (Beine & Parsons, 2015; Chi & Marcouiller, 2013). Moreover, subjective well-being (SWB) is increasingly recognised as a driver of migration, with individuals relocating in pursuit of life satisfaction as much as income, reflecting lifestyle preferences, quality-of-life expectations, or perceived social fairness (Ivlevs, 2015; Otrachshenko & Popova, 2012).

The expanded differential urbanisation model (Geyer & Kontuly, 1993) integrates these insights by distinguishing between productionist motives, driving less affluent groups toward large cities for economic opportunities, and environmentalist motives, leading more affluent groups toward smaller towns or rural areas in pursuit of higher living standards. While this framework captures key dynamics, contemporary challenges, such as rising housing costs in metropolitan centres, complicate these patterns, often displacing lower-income or younger groups (Rodríguez, 2024; Sarkar, 2018). Nonetheless, this dual lens remains useful for analysing how ongoing structural changes, including the twin transition, intersect with individual characteristics and contextual factors to reshape migration decisions.

The green transition is reconfiguring both economic structures and spatial dynamics across Europe. Policies such as the European Green Deal aim to decarbonise entire sectors, shift consumption and production systems, and reshape labour markets (European Commission, 2020). These transformations are likely to generate new migration flows, as opportunities in green innovation and clean industries attract skilled workers to dynamic regions. At the same time, the decline of carbon-intensive sectors risks displacing workers in "brown" industries, intensifying outward migration from structurally weaker areas (Shapiro & Metcalf, 2023). Whether the green transition results in net job creation or destruction remains contested (Botta, 2019), but its uneven impacts may deepen territorial divides and exacerbate regional inequalities unless mitigated by proactive policy frameworks (Rodríguez-Pose & Bartalucci, 2024).

In parallel, the digital transition is also reshaping the geography of work and migration. On one side, emerging technologies are reinforcing the concentration of highly skilled labour in innovation hubs, further strengthening already dynamic regions (Akerman et al., 2015; Kerr et al., 2016). On the other hand, digitalisation is loosening the traditional link between residence and workplace, enabling remote work, digital nomadism, and multilocal lifestyles (Foth et al., 2016; Hannonen et al., 2024). These developments function as both push and pull factors: While digital assets and vibrant ecosystems help regions retain and attract populations, lagging areas risk entrenchment in disadvantage through widening digital divides and reduced competitiveness (Lythreatis et al., 2022; Matli & Wamba, 2023). In this sense, the twin transition functions as a powerful filter, enabling some regions to thrive while exposing others to new forms of left-behindness.

2.2. Connecting Green and Digital Transitions to the Different Types of Left-Behindness

Although the twin transition is expected to amplify new and old forms of migration, access to the opportunities driving these shifts remains highly uneven across regions. In left-behind areas, migration is shaped not only by individual aspirations or policy incentives but also by deep-rooted structural constraints and regional conditions (Fiorentino et al., 2024; Velthuis et al., 2025), extending beyond economic stagnation to social, political, environmental, and cultural dimensions, forming a complex web of factors (Pike et al., 2024). Such multi-level left-behindness significantly influences intention to relocate, positioning it as a critical intermediary between the twin transition and patterns of migration.

The term "left-behind" reflects a lack of capacity to adapt to and benefit from major transition processes, such as economic restructuring or shifts in dominant growth models (MacKinnon et al., 2022; Velthuis et al., 2023). Left-behind regions often struggle to remain competitive, with local characteristics, such as industrial path-dependence, infrastructure, and institutional capacity, playing a critical role in shaping their ability to retain and attract residents (Velthuis et al., 2023). Patterns of depopulation in such areas are frequently rooted in historical processes such as deindustrialisation, suburbanisation, and demographic ageing, which continue to exert long-term effects on local development trajectories (Franklin, 2021). Empirical evidence suggests that different dimensions of left-behindness have distinct effects on population decline and migration intentions, highlighting the need to understand migration as a place-contingent response to multi-scalar disadvantage (Karp et al., 2022).

Connecting the two concepts is critical. First, the green transition is expected to generate indirect spatial effects by increasing factor mobility and redistributing economic and social assets (Rodríguez-Pose & Bartalucci, 2024). This runs the risk of concentrating innovation, employment, and technological investment in already prosperous regions equipped with the skills, infrastructure, and institutional readiness to absorb green growth, while leaving left-behind regions struggling to capitalise on these opportunities. The resulting outmigration of skilled workers, driven by mismatches in local labour markets and the absence of green-sector opportunities, can further reinforce regional disparities and amplify political discontent in areas already feeling excluded from transition-related benefits (Fratesi & Rodríguez-Pose, 2016). At the same time, the environmental benefits of certain declining or rural regions, such as proximity to nature, lower pollution, along with lower cost of living, may also attract eco-migrants or retirees seeking sustainable lifestyles, showing that left-behindness can create selective forms of attractiveness alongside exclusion (Curry et al., 2001; Steinführer et al., 2024).

Similarly, the digital transition is double-edged. While the digitalisation of services, including e-health and e-governance, has the potential to enhance access and improve quality of life in remote or underserved areas (Salemink et al., 2017), the benefits are not always accessible. Rural communities often lack the necessary digital infrastructure, skills, or trust to fully engage with dematerialised services (Löfving et al., 2022). This limits their capacity to leverage digital technologies for development, thereby reinforcing left-behindness and migration outflows. However, demographic decline and low density in such areas can also open "opportunity spaces" for digitally empowered newcomers, including remote workers, returnees, and lifestyle migrants. These groups can act as agents of revitalisation by supporting local services, reusing housing stock, and contributing new forms of social capital (Tietjen & Jørgensen, 2016). These positive effects are not automatic and depend on local receptiveness, which can provide conditions for new inflows reshaping local trajectories.

3. Data and Methodology

Our study combines a novel dataset created in the context of a recent Horizon Europe project (MOBI-TWIN) focusing on examining changing patterns of interregional migration triggered by the twin transition, considering life satisfaction and individual characteristics, as well as a set of secondary data sources to introduce the regional dimension and the focus on left-behind areas (Väisänen et al., 2024; Velthuis et al., 2023). A schematic representation of the connection between these elements is given in Figure 1.

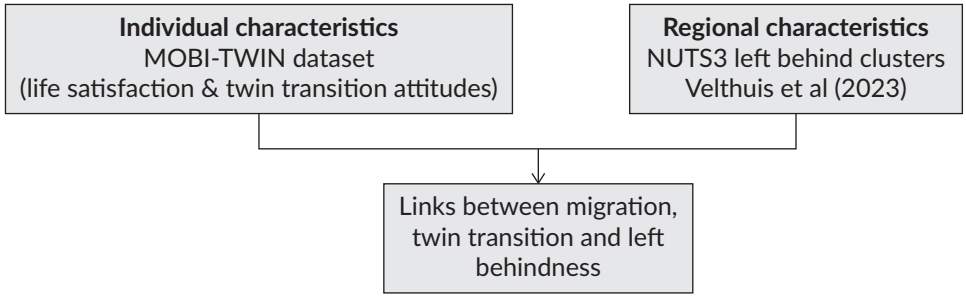

Figure 1. Combined data sources for investigating the links between interregional migration intentions, twin transition, and left-behindness.

The MOBI-TWIN dataset was developed using a quantitative research design, incorporating survey methods and stakeholder engagement (Väisänen et al., 2024), to examine interregional migration intentions at the NUTS3 level. The survey assessed citizens' intentions in relation to various life events, forms of migration, regional attractiveness factors, and determinants of (im)mobility. It predominantly comprised closed-ended questions, offering response options including multiple-choice items and Likert scale questions. Data collection was conducted online between November and December 2023, yielding an initial 11,622 responses. The process was facilitated through the SurveyMonkey platform, employing a non-random quota sampling approach to ensure the fulfilment of predetermined quotas at both EU and country levels. Data were collected through two channels, Dynata and the Prolific platform, with measures in place to ensure no duplication in the final sample. Dynata targeted specific demographic quotas within each country, while the Prolific platform was leveraged to access a broader participant pool and expedite data collection. Quotas were established for age, gender, and education, with adjustments made to ensure demographic balance across countries. After data cleaning and geocoding survey responses with the open-source geocoder Photon (Komoot, 2024), which assigned NUTS3 regional codes to respondents, the final dataset used in this study comprises 6,861 fully completed and valid responses reflecting individuals reporting high or very high migration intentions and covering 12 EU member states (Austria, Belgium, Germany, Denmark, Greece, Spain, Finland, France, Ireland, Italy, Netherlands, Portugal). Due to limited data availability for the left-behind clusters, the analysis was restricted to these 12 countries. Post-stratification weighting has been applied to improve the reliability of statistical inferences drawn from a quota sample by aligning the sample distribution with known population characteristics.

Next, the left-behind regional clusters developed by Velthuis et al. (2023) were employed to categorise NUTS3 EU regions based on the degree and nature of left-behindness. This methodology incorporates a comprehensive set of variables to capture various dimensions of left-behindness, encompassing economic, demographic, social, and accessibility factors. By assessing regions across these dimensions, Velthuis et al.

(2023) developed a composite index at the NUTS3 level to classify them. This enabled us to identify distinct groups of regions based on shared left-behindness characteristics, providing deeper insights into the spatial distribution and heterogeneity of regional disparities within the EU.

The key dependent variable in our analysis (MIGR_INT) captures migration intentions among respondents who reported a high or very high likelihood of moving to another EU region. First, respondents indicated the probability of changing their place of residence on a five-point scale (where 1 = *very low* and 5 = *very high*). From the full sample of 6,861 individuals reporting high or very high migration intentions, we identify the main relocation motive and estimate separate models for each motive-specific group. In these models, the dependent variable is coded as a binary indicator where 1 represents individuals whose primary motive corresponds to the one examined in that model, and 0 otherwise. For example, in the model examining work-related migration intentions, the dependent variable equals 1 for the 1,267 respondents who selected work as their main reason, and 0 for the remaining respondents in the high-intention sample. This approach enables comparison of how socio-demographic characteristics, subjective factors, twin-transition attitudes, and regional conditions differentiate types of high migration intentions, rather than predicting whether individuals intend to migrate at all.

As the objective is not to estimate the probability of migration itself but to examine how individual and regional characteristics differentiate between motives among high-intention respondents, a multilevel linear regression model (MLM) provides an appropriate and transparent analytical framework. The MLM specification accommodates the hierarchical structure of the data, individuals nested within regions, allowing control for unobserved regional heterogeneity while estimating individual-level effects.

For the empirical analysis, we estimate the following specification using an MLM linear regression model:

$$\begin{aligned}\text{MIGR\_ INT}_{ij} = a + b_1\text{DEM}_i + b_2\text{LIFESAT}_i + b_3\text{PREV\_ EXP}_i + b_4\text{PREFS}_i + b_5\text{TIMING}_i \\ + b_6\text{TT\_ ATTITUDE}_i + b_7\text{LEFTBEHIND}_j + \varepsilon_{i,j}\end{aligned}$$

Where i represents each individual ($i = 1,\ldots,N$); j denotes the NUTS3 region of residence for each individual; DEM_i accounts for various demographic attributes, namely age, gender, educational attainment, and whether the individual has children; LIFESAT_i represents the level of life satisfaction for individual i; PREV_ EXP_i indicates whether the individual has experienced short- or long-term migration within the past five years; PREFS_i captures individual preferences regarding the timing of movement and the type of area they wish to relocate to; TIMING_i refers to their intention to move in the short- or long-run; and TT_ ATTITUDE_i reflects each individual's attitudes toward aspects related to the twin transition, both green and digital. To incorporate an MLM perspective in our analysis, we include LEFTBEHIND_{ij}, which characterises the predominant type of left-behindness in the NUTS3 region j where individual i resides. The model also includes an error term ε and a constant α. We estimated our MLM model using an ordinal least squares (OLS) regression.

Table 1 summarises the rationale for selecting the independent variables used in the empirical analysis. Detailed descriptions and data sources for each variable are provided in Table A1 in the Supplementary File. Starting with individual demographic characteristics, first, we aim to control for the effect of gender. The gender dimension has been very often highlighted as a significant factor for triggering migration variations (Faggian et al., 2007). Specifically, gender disparities within the labour market, characterised by

wage gaps, occupational segregation, and uneven access to economic opportunities, can directly shape an individual's migration choices. Women often face limitations in economic empowerment, which may prompt them to seek better prospects in other regions. In some cases, women's migration between regions is driven by the pursuit of employment opportunities that align with their skills and aspirations. However, women can also face unique challenges, such as the need to balance career aspirations with caregiving responsibilities, which can affect their willingness and ability to migrate (Palchykov et al., 2013). Second, age is a critical factor affecting migration outcomes, often indicating a U-shaped relationship with increased migration typically higher in younger and older ages and lower in middle age (Lu et al., 2025). Third, educational level is included in our model as a significant aspect of migration. Evidence suggests that a higher educational level is linked with increased probability of migration (Fratesi, 2014). This can be supported by neoclassical theory, which posits that tertiary education typically provides individuals with specialized knowledge, critical thinking abilities, and advanced skills valued in the job market, opening doors to higher-paying jobs, career advancement opportunities, and greater social mobility; consequently, highly skilled individuals who invest more in education also seek higher returns through their wages, thereby increasing the likelihood of migrating to places with higher average salaries (Faggian et al., 2019). Finally, family status in relation to having children or not offers an additional individual characteristic included in our analysis, as parenthood increases the importance of quality-of-life factors when considering migration decisions (Boterman & Bridge, 2023).

Table 1. Summary of the determinants of migration intentions used for the empirical analysis.

Variable name	Expected impact	References
Individual characteristics		
Gender (FEMALE)	Gender differences may influence migration intentions; women may exhibit distinct migration patterns driven by labour-market disparities, caregiving roles, and opportunity structures. Direction may vary depending on context.	Faggian et al. (2007); Palchykov et al. (2013).
Age (AGE/AGE^2)	Non-linear (U-shaped) effect: Higher likelihood of migration at younger and older ages, lower in middle age.	Lu et al., (2025).
Educational level (EDU_TER)	Positive effect: Higher education increases migration probability due to higher expected returns, skill-matching opportunities, and mobility-enabling resources.	Faggian et al. (2019); Fratesi (2014).
Family status (CHILDREN)	Having children may reduce migration intentions due to increased place-dependence, though quality-of-life considerations may also drive selective relocation.	Boterman and Bridge (2023).
Subjective factors		
Life satisfaction (LIFESAT)	Lower life satisfaction increases likelihood of considering migration, acting as a push factor.	Stawarz et al. (2022).
Previous experience (PREV_EXP)	Positive effect: Prior migration experience lowers barriers and increases probability of future mobility.	Gubert and Senne (2016); Williams et al. (2018).
Preferences (PREFS_X)	Preferences for specific destination types (urban/rural) influence long-term migration intentions; alignment between preferences and perceived regional attributes increases likelihood of relocation.	Berry and Glaeser (2005); Venables (2006).
Time horizon (TIMING_X)	Migration likelihood varies across temporal horizons; intentions generally strengthen over longer planning periods.	

Table 1. (Cont.) Summary of the determinants of migration intentions used for the empirical analysis.

Variable name	Expected impact	References
Twin transition attitudes		
Digital attitudes (DIGITAL_ATT)	Mixed but systematic effect: Positive attitudes towards digitalisation may increase migration intentions toward digitally advanced regions, while individuals perceiving digital divides or lagging digital environments may be more likely to leave less competitive regions. Digitalisation also enables remote work and multilocal lifestyles, loosening the constraint of physical proximity to workplaces.	Akerman et al. (2015); Foth et al. (2016); Hannonen et al. (2024); Kerr et al. (2016); Lythreatis et al. (2022); Matli and Wamba (2023).
Green attitudes (GREEN_ATT)	Positive effect: Stronger pro-environmental attitudes increase the likelihood of migrating to greener, more sustainable regions, particularly those progressing faster in the green transition. Conversely, lack of green infrastructure may push individuals away from lagging regions.	Connor et al. (2024).
Regional characteristics		
Regional left-behindness (LEFT_BEHIND_X)	Higher levels of left-behindness in origin regions expected to increase migration intentions (push effect); effects vary across types of left-behindness.	Connor et al. (2024); Fiorentino et al. (2024); Velthuis et al. (2023).

Beyond individual characteristics, we include a range of other factors such as life satisfaction, prior migration experience, preferences regarding the type of destination (urban or rural), and intentions to move in the short or long term. Literature identifies life satisfaction as a potential driver of migration decisions, suggesting that lower levels may prompt individuals to relocate in search of better living conditions (Stawarz et al., 2022; Waibel, 2019). Previous experience seems to be a critical factor for increasing the opportunity to migrate (Gubert & Senne, 2016; Williams et al., 2018), whilst individual preferences for different residential settings, such as urban or rural areas, may act as triggers for long-term movements (Berry & Glaeser, 2005; Venables, 2006).

Finally, our model incorporates a range of regional characteristics indicating the type of left-behindness prevalent in each region, as measured by Velthuis et al. (2023). While studies have begun to explore how different forms of left-behindness influence migration decisions (Connor et al., 2024; Fiorentino et al., 2024), this dimension remains underexamined in the literature. Incorporating these variables, our model seeks to address this gap and contribute to a deeper understanding of the central research question of this article.

Table 2 presents the main descriptive statistics of the independent variables, whilst Figure 2 presents the matrix of raw correlation coefficients among all variables included in the empirical model. The figure illustrates the extent to which multicollinearity may be a concern and demonstrates the relative independence of the explanatory factors. The correlations across most variables are low, indicating that the included predictors capture distinct dimensions of individual characteristics, attitudes, and regional contexts. Regarding regional context, we operationalise left-behindness using the categorical LEFT_BEHIND indicator and select LEFT_BEHIND_3, representing regions with relative economic and demographic stability, as the reference category.

Table 2. Descriptive statistics of the independent variables (6,861 observations).

Variable	Min	Median	Mean	Max	*SD*
FEMALE	0.00	1.00	0.51	1.00	0.50
AGE	18.00	34.00	37.27	81.00	13.84
AGE^2	324.00	1,156.00	1,580.00	6,561.00	1,204.20
EDU_TER	0.00	0.00	0.28	1.00	0.45
CHILDREN	0.00	0.00	0.24	1.00	0.42
LIFESAT	1.00	7.00	6.61	10.00	1.90
PREV_EXP	0.00	0.00	0.29	1.00	0.45
PREFS_U	0.00	0.00	0.45	1.00	0.50
PREFS_R	0.00	0.00	0.27	1.00	0.45
INT_MOVE_LONG	0.00	0.00	0.38	1.00	0.48
INT_MOVE_SHORT	0.00	0.00	0.08	1.00	0.27
DIGITAL_ATT	1.00	3.50	3.48	5.00	0.84
GREEN_ATT	1.00	4.09	4.04	5.00	0.66
LEFT_BEHIND_1	0.00	0.00	0.05	1.00	0.23
LEFT_BEHIND_2	0.00	0.00	0.19	1.00	0.39
LEFT_BEHIND_3	0.00	0.00	0.20	1.00	0.40
LEFT_BEHIND_4	0.00	0.00	0.30	1.00	0.46
LEFT_BEHIND_5	0.00	0.00	0.11	1.00	0.31
LEFT_BEHIND_6	0.00	0.00	0.15	1.00	0.36

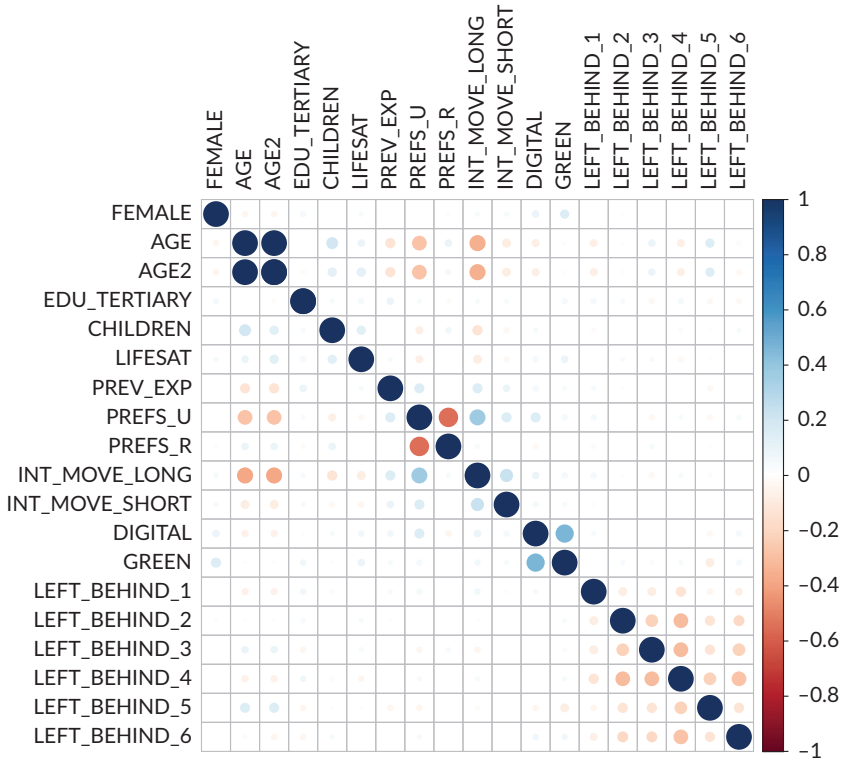

Figure 2. Correlation matrix of independent variables.

4. Results

Our models reveal how different factors influence interregional migration intentions across four distinct motives, namely work, study, quality of life, and retirement (Table 3). Starting with work-related migration intentions, findings indicate that these are shaped more by individual socio-demographic characteristics and regional disadvantage rather than attitudes toward the twin transition. Specifically, younger and high-skilled individuals are significantly more likely to express an intention to move for employment-related reasons. Past migration experience is also positively associated with this motive. Satisfaction with life emerges as a key predictor, as individuals reporting low scores are considerably more inclined to express intention to move in pursuit of work opportunities. Gender differences are also evident, with women less likely than men to migrate for employment, possibly reflecting unequal caregiving responsibilities or structural labour market barriers. In geographical terms, intended destinations are predominantly urban areas, while rural regions are less frequently considered, underscoring persistent urban–rural disparities in perceived employment opportunities. Respondents intending to migrate for work are also more likely to report a desire to move within shorter time horizons, suggesting greater urgency. Interestingly, attitudes toward green and digital transitions do not significantly influence work-related interregional migration intentions. Despite their centrality in current policy discourse, they appear to play a limited role in shaping relevant decisions, at least at the attitudinal level. However, regional context matters. Using the above-described regional clusters (numbering follows Velthuis et al., 2023, for consistency), individuals located in areas characterised by economic stagnation and disconnection (Cluster 6) show a higher propensity to migrate for work, indicating that perceived "left-behindness" acts as a strong push factor. On the contrary, those in regions associated with long-term economic prosperity (Cluster 1) or high-growth trajectories (Cluster 2) exhibit a higher degree of immobility.

Second, results suggest that education-related migration intentions are strongly shaped by age and regional context. As expected, younger individuals, particularly students, show the highest likelihood of intending to migrate. These intentions are typically directed toward urban areas, where higher education institutions are concentrated, reinforcing the established urban-centric geography of educational opportunity. Twin transition factors reveal interesting contrasts. While digital transition attitudes do not significantly influence the intention to migrate to another region for study, stronger green transition attitudes are associated with higher migration intentions. Regional characteristics also play a crucial role. Individuals residing in economically prosperous areas (Cluster 1) exhibit a higher likelihood of study-related migration intentions. In contrast, those from regions facing economic decline and de-industrialisation (Cluster 4) demonstrate a negative correlation with education-related migration intentions.

Third, migration intentions motivated by quality-of-life considerations tend to be more prevalent among older individuals and families, reflecting life-course stages where environmental, lifestyle, and well-being factors become more central. Respondents who report low satisfaction with their current living conditions are significantly more likely to express a desire to relocate for quality-of-life reasons, highlighting a strong push factor. Unlike work- or study-related migration, quality-of-life migration is predominantly directed toward rural areas, with urban destinations less commonly cited. This pattern reflects stated destination orientations rather than realised migration flows and suggests a growing preference for quieter, less congested environments that may offer cleaner air, access to nature, and improved conditions for family life or retirement. Importantly, this type of migration is typically framed as a long-term intention, reflecting

gradual decision-making processes often tied to major life changes or future planning. Attitudes toward the twin transition are differentially associated with this motive. Stronger green transition attitudes correlate positively, suggesting that individuals who value environmental sustainability seek regions that align with their lifestyle and ecological preferences. In contrast, stronger digital transition attitudes are linked to a lower probability of intentions to move for quality-of-life reasons, indicating a preference among digitally oriented individuals to remain in areas with robust technological infrastructure, which are often, though not exclusively, urban. Regarding regional characteristics, residents of economically prosperous (Cluster 1) and high-growth regions (Cluster 2) exhibit higher migration intentions, reflecting a capacity to convert resources into lifestyle changes. Meanwhile, those living in regions facing demographic decline and ageing (Cluster 5) are more likely to remain immobile, indicating a possible strong attachment to their place.

Finally, retirement-related interregional migration intentions are observed, as expected, among older individuals whose children are over 18, indicating a life stage with reduced caregiving responsibilities and greater residential flexibility. These intentions are oriented towards rural areas, with urban destinations less frequently mentioned, reflecting preferences for quieter, more natural environments that may offer a slower pace of life and lower cost of living. Unlike other forms, in the case of retirement-related interregional movements previous migration experience is negatively associated with retirement-related movement, suggesting that those who have relocated earlier in life may prefer to settle down rather than move again in later years. Twin transition attitudes present a notable contrast with other migration intention motives. Higher digital transition attitudes are positively associated with retirement-related migration intentions, which reflect a growing segment of digitally literate retirees who feel empowered by connectivity and digital services to relocate to less urbanised areas without sacrificing access to information or essential services. In terms of regional dynamics, residents of high-growth regions (Cluster 2) are less likely to express intentions to move for retirement, likely due to the continued availability of services, infrastructure, and supportive environments that meet their needs. In contrast, individuals in regions experiencing demographic decline and ageing (Cluster 5) are more likely to express retirement-related migration intentions.

Table 3. Factors influencing permanent migration based on the four estimated models.

Dependent variable: Intention to migrate (REASON)	(1) Reason: Work		(2) Reason: Study		(3) Reason: Quality of life		(4) Reason: Retirement	
Individual characteristics								
FEMALE	−0.028	***	0.001		0.005		−0.007	
	(0.007)		(0.004)		(0.009)		(0.006)	
AGE	−0.005	***	−0.015	***	0.004	***	0.009	***
	(0.002)		(0.001)		(0.002)		(0.001)	
AGE^2	0.000		0.001	***	0.001	***	0.001	***
	(0.001)		(0.001)		(0.001)		(0.001)	
EDU_TERTIARY	0.056	***	−0.011	**	−0.010		0.001	
	(0.008)		(0.005)		(0.010)		(0.006)	
CHILDREN	0.002		0.002		0.042	***	−0.029	***
	(0.009)		(0.005)		(0.011)		(0.007)	

Table 3. (Cont.) Factors influencing permanent migration based on the four estimated models.

Dependent variable: Intention to migrate (REASON)	(1) Reason: Work		(2) Reason: Study		(3) Reason: Quality of life		(4) Reason: Retirement	
Subjective factors								
LIFESAT	−0.004	**	−0.001		−0.004	*	0.001	
	(0.002)		(0.001)		(0.002)		(0.002)	
PREV_EXP	0.040	***	−0.001		−0.004		−0.021	***
	(0.009)		(0.005)		(0.011)		(0.007)	
PREFS_U	0.158	***	0.027	***	0.199	***	0.103	***
	(0.010)		(0.005)		(0.012)		(0.008)	
PREFS_R	0.061	***	0.002		0.261	***	0.140	***
	(0.009)		(0.005)		(0.011)		(0.007)	
TIMING_LONG	0.029	***	0.010	*	0.088	***	−0.011	
	(0.010)		(0.005)		(0.012)		(0.008)	
TIMING_SHORT	0.044	***	0.008		−0.004		−0.012	
	(0.016)		(0.008)		(0.019)		(0.012)	
Twin transition attitudes								
DIGITAL_ATT	0.002		−0.004		−0.019	***	0.017	***
	(0.005)		(0.003)		(0.006)		(0.004)	
GREEN_ATT	−0.003		0.008	**	0.056	***	0.001	
	(0.006)		(0.003)		(0.007)		(0.005)	
Regional characteristics								
LEFT_BEHIND_1 Long-term economic prosperity	−0.041	***	0.024	***	0.052	***	−0.005	
	(0.014)		(0.008)		(0.017)		(0.011)	
LEFT_BEHIND_2 High growth	−0.023	**	0.002		0.043	***	−0.019	**
	(0.011)		(0.006)		(0.013)		(0.009)	
LEFT_BEHIND_4 Economic decline & deindustrialisation	−0.010		−0.011	*	−0.003		−0.010	
	(0.011)		(0.006)		(0.013)		(0.008)	
LEFT_BEHIND_5 Demographic decline and ageing	−0.003		0.003		−0.062	***	0.020	**
	(0.013)		(0.007)		(0.016)		(0.010)	
LEFT_BEHIND_6 Disconnected, high poverty	0.029	**	0.002		−0.015		−0.017	
	(0.014)		(0.008)		(0.017)		(0.011)	
Constant	0.250	***	0.350	***	−0.194	***	−0.331	***
	(0.042)		(0.023)		(0.051)		(0.033)	
Observations	6,861		6,861		6,861		6,861	
Adjusted-R^2	0.1373		0.0898		0.1360		0.1034	
AIC	5,596.22		−2,693.29		8,464.47		2,258.52	
BIC	5,732.89		−2,556.62		8,601.14		2,395.19	
Weights	YES		YES		YES		YES	
p-value	0.000		0.000		0.000		0.000	

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; standard errors in parentheses.

5. Discussion

This study explores the possible role of the twin transition in spatial inequalities by examining how individual attitudes toward green and digital transformations, along with expressions of regional left-behindness, shape interregional migration intentions. Although the green and digital transitions are central to EU policy frameworks, such as the European Green Deal and the Digital Compass (García Fernández & Peek, 2023; Gómez-Carmona et al., 2023; Muench et al., 2022), there remains a significant gap in understanding how they shape individual decisions regarding relocation. Our results suggest that the influence of digital and green attitudes on individual migration intentions varies significantly depending on the reason behind the relocation intention, such as work, study, quality of life, or retirement.

When considering work-related migration intentions, the impact of green and digital attitudes is limited. Instead, traditional socio-demographic characteristics such as age, educational level, and prior migration experience remain the most robust predictors of work migration intentions, as suggested by previous research (Fratesi, 2014; Lu et al., 2025; Williams et al., 2018). While the twin transition may be structurally reshaping labour markets, individual-level intentions around work-related migration are not (yet) strongly influenced by personal attitudes toward it. Student long-term migration intentions present a different picture, as green attitudes indicate a positive link with the intention to relocate for educational purposes, consistent with findings that environmentally oriented values can shape educational choices (Golbazi et al., 2020).

When examining migration intentions related to quality of life, twin transition values carry greater explanatory weight. Individuals with strong green attitudes are more likely to express intentions to relocate for quality-of-life reasons. Rural areas may be perceived as offering environmentally attractive conditions and opportunities for sustainable living, but our results do not test an interaction between these factors. This finding resonates with emerging research on "green lifestyle migration" (Forde, 2020). Conversely, individuals with high digital attitudes tend to remain in their areas, mostly urban, where digital infrastructures and services are more robust. Finally, retirement migration intentions are positively and significantly linked to digital attitudes as well as rural areas. This relates to previous studies indicating that digital literacy, reflected in confidence navigating online services and maintaining remote connections, enables older individuals to consider rural living without fear of isolation (Ji, 2024; Nguyen et al., 2022).

Our findings also suggest that expressions of left-behindness, rooted in economic decline, deindustrialisation, demographic decline and ageing, lack of connectedness, and high poverty (Pike et al., 2024; Velthuis et al., 2023), function as structural push factors for migration intentions. Individuals residing in economically lagging regions are more likely to express intentions to migrate for work, reflecting the constraints and limited opportunities in economic and demographic "deserts" (Rodríguez-Pose, 2018). In contrast, those in economically dynamic regions are more inclined to stay, benefiting from place-based advantages such as service provision, cultural amenities, and employment access (Florida, 2003; Glaeser et al., 2001). Yet, these expressions of left-behindness affect different types of migration intentions unequally. While high economic stagnation, expressed through high poverty and lack of connectedness, prompts work-related migration intentions, it appears to suppress student migration, particularly in deindustrialising or declining areas. Migration intentions triggered by quality-of-life aspirations, in turn, are more prevalent among those living in prosperous regions who possess the resources and digital capacities to

act on lifestyle preferences. On the contrary, individuals in ageing and demographically shrinking regions tend to report lower migration intentions, pointing to deep-rooted place attachment, economic precarity, or limited digital access as potential constraints.

Taken together, these findings have important implications for regions experiencing stagnation, depopulation, or broader forms of left-behindness. The differentiated effects of green and digital attitudes on migration intentions suggest that the twin transition can either exacerbate or mitigate existing territorial divides, depending on how regions position themselves. Left-behind regions are unlikely to retain or attract populations solely by competing with dynamic regions on labour-market performance alone. Instead, targeted and place-specific strategies are required. Strengthening digital infrastructures can reduce perceived isolation, create remote-work opportunities, and expand e-services, enabling both working-age individuals and retirees to envision viable futures locally. Investing in environmental assets, sustainable mobility, and high-quality public places can appeal to individuals with strong green preferences, particularly those motivated by quality-of-life considerations. Such improvements can support a healthier and more livable environment, which, along with affordable housing policies, can encourage residents to stay and potential newcomers to settle. Place-specific strategies that incorporate the twin transition in ways that respond to local needs and leverage existing assets and social capital in left-behind regions hold the potential to, at least partially, counterbalance the economic and social imbalances in these regions, supporting quality of life and well-being. Notably, this approach can uphold the "freedom to stay" (Letta, 2024), enabling people to live and sustain a decent, high-quality livelihood in their communities.

6. Conclusions

This study contributes to a deeper understanding of how individual attitudes toward the green and digital transitions, alongside structural dimensions of regional left-behindness, shape interregional migration intentions across a range of motives. While socio-demographic factors remain central to explaining intentions to move for work or study, attitudes toward environmental and technological change increasingly influence quality-of-life- and retirement-related migration intentions, especially among individuals seeking alignment between personal values and living environments. The differentiated role of twin transition attitudes, more influential in lifestyle-oriented moves than economically driven ones, suggests that migration decisions are not solely practical but also deeply embedded in subjective values, aspirations, and perceived quality of life. At the same time, the study highlights the persistent influence of left-behindness in conditioning the intention to move. Economic stagnation, demographic decline, and disconnection from core services and infrastructures act as powerful push factors for some forms of migration, especially work-related.

However, several limitations should be acknowledged. First, the reliance on self-reported intentions rather than actual migration behaviour introduces uncertainty regarding the translation of stated preferences into action. Second, the attitudinal measures of green and digital transitions, while informative, may not fully capture the complexity or salience of these transitions in individual decision-making. Third, longitudinal data would be needed to trace how attitudes and conditions evolve alongside actual migration patterns. Finally, an additional limitation is that cross-country differences are not examined in detail, although national institutional settings, welfare regimes, and labour-market structures may influence both the formation of left-behind clusters and the mechanisms linking attitudes to mobility intentions.

Future research should build on these findings by addressing both methodological and conceptual gaps. Migration reflects not only individual aspirations but also structural asymmetries between regions with differing capacities to adapt to transitions. Understanding how these asymmetries shape the geography of opportunity will be crucial for anticipating future inequality trends. Moreover, new forms of mobility beyond permanent migration, such as circular, temporary, or hybrid movements, are likely to play an increasingly important role in regional attractiveness and should be systematically examined. Finally, extending the analysis beyond Europe could offer comparative insights into how different institutional settings influence the co-evolution of migration and the twin transition on a global scale.

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Conflict of Interests

The authors declare no conflict of interests.

LLMs Disclosure

ChatGPT was used solely for language polishing. All generated outputs were critically reviewed, revised, and approved by the authors.

Supplementary Material

Supplementary material for this article is available online in the format provided by the authors (unedited).

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ARTICLE

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Immigrants' Cross-Border Interaction and the Pandemic: Estonians Living in Finland

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Abstract

Although major Covid-19 restrictions have ended, their impact on how immigrant communities navigate physical and digital mobility continues to demand attention. This article examines shifts in cross-border offline and online interactions before and after the pandemic's most disruptive phase, focusing on Estonians in Finland, the country's second-largest immigrant group. Survey data from 2,398 respondents shows how the pandemic reconfigured cross-border activity spaces: Physical travel to Estonia sharply declined while digital contact via phone and social media intensified. The pandemic altered immigrants' spatial agency and expanded digital spaces of interaction. Digital communication and interaction did not replace embodied mobility nor generate hybrid transnational identities; instead, it reinforced emotional and cultural attachments to Estonia. After restrictions eased, in-person visits not only resumed but exceeded pre-pandemic levels. This case highlights how digital tools reconfigure cross-border activity spaces and belonging in highly specific ways, shaped by ethnic, spatial, and socio-technical factors. Ensuring equitable digital inclusion policies remains essential for sustaining immigrants' well-being and spatial agency.

Keywords

activity space; Covid-19 pandemic; cross-border; Estonian; Finland; social media

1. Introduction

The Covid-19 pandemic marked a profound rupture in everyday spatial practices across Europe, disrupting one of the EU's core principles: freedom of movement. Mobility restrictions and border closures, implemented for public health, temporarily suspended cross-border movement for all, regardless of

institutional rights or mobility entitlements (Flood et al., 2024). These measures disproportionately affected immigrant communities, many of whom rely on regular cross-border interaction to sustain family ties, cultural continuity, and economic livelihoods. Border closures not only interrupted mobility flows but also exposed vulnerabilities in EU integration and heightened societal tensions, including increased hostility toward immigrants and declining support for supranational governance (Herbig et al., 2025).

In this context, the pandemic offers a unique lens for examining how cross-border activity spaces, understood as the spatial and temporal domains in which daily practices unfold across national borders, shifted as interaction moved from physical to digital environments. Institutionally, cross-border activity space is shaped by the spatial and governance dynamics of border regions, where national borders act as both obstacles and resources, structure interaction and integration, and create spatial configurations where flows of people, goods, and capital intersect with localized places (Song et al., 2024). Due to mobility constraints during the pandemic, digital practices such as social media use, messaging, and video calls became essential for maintaining cross-border ties, yet they could not fully replace the value of in-person presence. Still, these technologies expanded spatial possibilities by allowing immigrants to sustain connections to their country of origin despite physical immobility. As this article demonstrates, the interplay between physical and digital mobilities has significant implications for how spatial inequalities are reproduced or reshaped across social and ethnic groups in different countries, regions, and cities.

This article investigates these dynamics by focusing on Estonian immigrants in Finland, the country's second-largest immigrant group and the largest group of foreign nationals in the early 2020s. We examine how their cross-border interaction practices evolved before, during, and after the height of the pandemic. The findings show how the digital transition restructured immigrant cross-border activity spaces across time and space, revealing both the possibilities and the limits of digital substitution during mobility crises.

During the pandemic, digital communication tools, especially smartphones, messaging apps, and social media platforms, became central for immigrants navigating separation from loved ones. These technologies enabled frequent, real-time interaction and emotional proximity at a time when physical visits were severely curtailed (Hillyer, 2021; Reisdorf & Rhinesmith, 2020). In the EU, the use of internet-based telephone and video calls surged from 52% in 2019 to 63% in 2020 and later to 73% by 2025 (Eurostat, 2025), reflecting the broader entrenchment of digital communication in everyday life. In high-connectivity settings such as Finland and Estonia, where digital divides are minimal, this shift reinforced the role of digital infrastructures in enabling social continuity across borders, strengthening immigrants' digital inclusion, and expanding their spatial agency, allowing them to maintain cross-border ties even when physically immobilized.

National responses to the pandemic diverged widely due to differences in institutional capacity and risk tolerance (Docquier et al., 2022; Martin & Bergmann, 2021). Even within the EU, fragmented containment and border policies (Guild, 2020) created uneven impacts on immigrants depending on their national, legal, and spatial circumstances. For many, especially migrants from neighbouring countries or border regions, restrictions disrupted not only international travel but also the daily and seasonal mobilities that structured their lives.

In the early 2020s, due to pandemic-related restrictions, many immigrants experienced prolonged periods of separation from their home countries, sometimes extending to three years, significantly straining familial,

social, and economic relationships (Fredheim & Varpina, 2023; Mencutek, 2022; Triandafyllidou, 2022). Shifting international travel rules and occasional suspensions of domestic mobility (Martin & Bergmann, 2021; Mencutek, 2022) added emotional and logistical uncertainty. Within the EU, inconsistent measures from full closures to differentiated testing and quarantine regimes further complicated mobility, especially for prospective returnees and borderland residents (Guild, 2020; Ruotsala, 2021).

During the pandemic, physical mobility was curtailed unevenly across time and space, but when digital communication infrastructure was available, digital interaction channels remained open. Digital interaction technologies gained new prominence in countries and regions in which digital divides were minimal. Digital connectivity emerged as an essential and immediate substitute for face-to-face interactions, enabling immigrants to exercise a form of digital spatial agency by sustaining relationships and participating in cross-border social life despite enforced immobility. Studies regarding the early stages of the pandemic, such as those in the United States and the EU, revealed that digitally mediated communication intensified in response to lockdowns. With more time and fewer in-person options, individuals reached out more frequently through new and existing digital means, reconnecting with both strong and weak social ties (Eurostat, 2025; Nguyen et al., 2020). Social media platforms were also repurposed to sustain emotional proximity amid physical separation, further demonstrating how digital infrastructures can reshape cross-border activity spaces when physical mobility is limited.

This study addresses the following research questions: What were the patterns of physical and digital cross-border communication and interaction (cross-border activity spaces) among Estonians living in Finland before, during, and after the height of the pandemic? How did digital communication and interaction practices between Estonians in Finland and their contacts in Estonia evolve during the pandemic? Do immigrants' intensified cross-border digital communication and interaction with their home country replace the need for physical on-site interaction, as evidenced by the study population?

The analysis is grounded in a longitudinal dataset of survey responses from 2,398 Estonians residing in Finland, almost 6% of the country's adult Estonian population. Data collected in 2019 (pre-pandemic) and again in 2022 (post-peak pandemic) enable a comparative examination of how cross-border engagement evolved over time. The study focuses on three dimensions of communication and interaction: in-person visits to Estonia, telephonic and social media contact, and broader digital media use, including whether digital interaction could replace or complement physical mobility. The article additionally situates these shifts within longer-term migration and short-term mobility trajectories between Estonia and Finland before and after the pandemic. This dual approach linking empirical patterns with lived experience provides a nuanced understanding of how immigrant communities recalibrate their cross-border lives and activity spaces during systemic crises.

By framing these developments within the broader concept of cross-border activity spaces, the article contributes to ongoing debates about how digital transitions reshape spatial opportunity structures for different ethnic and social groups. It underlines the need to consider how digital infrastructures mediate mobility, belonging, and (in)equality under disruptive conditions such as the Covid-19 pandemic (Nguyen et al., 2020; Simola et al., 2023) and the escalated war in Ukraine (Jauhiainen, 2026). Ultimately, it highlights the fluid interplay between digital and physical mobilities and the resilience of immigrant communities navigating unprecedented constraints.

The findings show that Estonian immigrants in Finland experienced prolonged separation from their country of origin during the pandemic, with many unable to travel for extended periods. This created emotional strain and practical difficulties, particularly around caregiving, major life events, cross-border work, and education. At the same time, digital tools enabled forms of virtual co-presence that temporarily expanded migrants' spatial agency by allowing them to sustain relationships and obligations across borders despite immobility. These digitally mediated practices reshaped cross-border activity spaces, yet their effects were uneven: While they offered flexibility and resilience, they also exposed inequalities in access and underlined the continuing importance of physical co-presence for maintaining belonging.

Digital communication and interaction strengthened immigrants' ties to their country of origin rather than producing hybrid transnational identities. Yet it only partially substituted for in-person visits. Once mobility restrictions were lifted, Estonians resumed travel from Finland to Estonia, and did so more frequently and for longer periods than before the pandemic. Digital and physical mobilities remain interdependent, and digital inclusion is crucial for enabling flexible cross-border interaction and activity spaces, as well as preventing social exclusion. Addressing digital divides is therefore essential for contemporary migration policy and the development of cross-border infrastructures in post-pandemic Europe and beyond that.

2. Immigrants' Physical and Digital Cross-Border Interaction

Over two decades ago, scholars already recognized that digital interaction, alongside physical face-to-face contact, plays a crucial role in shaping immigrants' belonging and identity (Cassarino, 2004). Today, migration unfolds within a broader condition of digital spatiality, in which digital infrastructures and practices fundamentally reconfigure how migrants experience, navigate, and produce space. Digital spatiality encompasses the relational spaces created through online communication, platforms, and information flows that are spaces that operate alongside, and increasingly intertwined with, physical geographies. For migrants, these digitally mediated spaces and cross-border activity spaces are not peripheral but integral to their everyday lifeworlds (Cagney et al., 2020).

Immigrants navigate overlapping local, national, cross-border, and transnational social fields as complex spheres of influence that shape their lived experiences across borders (Levitt & Jaworsky, 2007). These spheres often operate in concert but may also come into tension, influencing migrants' adaptation and integration trajectories in multifaceted ways. In this context, digital inclusion became very relevant: ensuring that all individuals, including immigrants, have meaningful access (minimal digital divide) to and use (enhanced digital literacy) of information and communication technologies, affordable internet, devices, digital skills, and accessible content (National Digital Inclusion Alliance, 2017).

Central to contemporary international migration are digitally mediated communication and interactions facilitating migrants' ties between the host and home countries. In 2025, an estimated two-thirds of global population used the internet (68%) and the share of social media users (65%) was near to it. Digital divides are significantly narrowing: In 2010 it was estimated that 30% of the world's population used the internet and now it is expected that by 2030, up to 90% of the world population will have access to the internet and use it (International Telecommunication Union, 2025). Such advancement of digital accessibility has major impacts on migration and immigrants' lives. Increasingly ubiquitous digital access and interaction reshape immigrants' activity spaces (Cagney et al., 2020), enabling cross-border activity spaces in which individuals

carry out daily life in their host-country neighborhoods while remaining intensively connected to their country of origin and its social networks.

In immigration contexts, Levitt and Glick Schiller's (2004) seminal distinction between "ways of being" and "ways of belonging" captures the dual nature of migrants' connections to both host and home countries. Ways of being refer to tangible cross-border practices such as maintaining social and political ties across borders, sending remittances, or managing property. Ways of belonging denote emotional, symbolic, and cultural attachments grounded in memory, language, and collective identity enactments of identification with and attachment to multiple countries, diasporas and/or transnational communities (Skovgaard-Smith, 2023). Belonging is experienced personally yet shaped by socio-spatial forms of inclusion and exclusion (Marlowe et al., 2017). These dimensions often intersect, producing hybrid attachments and reshaping notions of home, adaptation, and integration abroad.

Within this framework, the EU provides a particularly enabling environment for the formation of cross-border activity spaces. Free movement legislation supports high levels of intra-European mobility for work, study, and family life, while policies such as the abolition of roaming charges strengthen digital connectivity and lower the barriers to ongoing cross-border engagement. These infrastructural conditions underpin forms of "liquid migration" (Engbersen, 2018), in which physical and digital mobilities operate as interconnected, continuous processes embedded in migrants' everyday routines.

In the EU, immigrants have possibilities to share their meaningful daily lives between several locations, for example, between the country of origin and the current country of residence, and sometimes even other countries. Some scholars have started to use the concept of transnational lifestyle regarding those people who share their lives between two or more countries within and beyond the physical and cultural boundaries of the nation-state (Levitt & Glick Schiller, 2004). Migrants are embedded in geographically dispersed networks, engaging in these ties at varying intensities throughout the life course.

In this EU context, immigrants can distribute their meaningful daily lives across multiple locations, for example, between the country of origin and the country of residence, and sometimes beyond both. Scholars use the concept of transnational lifestyle to describe such patterns, in which individuals live across physical and cultural boundaries while remaining embedded in geographically dispersed networks that vary in intensity over the life course (Levitt & Glick Schiller, 2004). However, in this article, a conceptual distinction is drawn between cross-border and transnational lifestyles within immigrants' activity spaces.

"Cross-border lifestyles" refer to the ongoing interactions that individuals maintain between their country of current residence (host country) abroad and another country—usually that of origin—referred to as the home country. These practices include physical travel, digital communication, media consumption, and social connections. Individuals engaged in cross-border lifestyles socially and culturally integrate into their host country to a varying extent, yet they sustain active and frequent ties to their country of origin. They maintain strong relationships with family and friends remaining there, participate in cultural traditions of their country of origin, and consume home-country media, thus being present in the cross-border activity space. Importantly, while abroad, such individuals do not necessarily relinquish their original cultural identity or aim for assimilation into the host society. In this context, lifestyles and identification refer to national culture both as an abstract, imagined concept and as something material and internalized through everyday

life. This shapes a sense of distinction between the immigrants' country of origin and their current country of residence.

By contrast, "transnational lifestyles" in this context refer to a deeper and more complex form of cultural hybridity. Transnational individuals navigate and embody multiple cultural frameworks simultaneously, without fully identifying with either the country of origin or the current country of residence. Some research defines transnationalism as maintaining ties between two or more countries, but this study understands transnationalism as deeper cultural blending and hybridization, where individuals no longer identify with any single national culture. Instead of holding distinct affiliations to their home and host countries, transnational immigrants navigate fluid identities. They feel at home in their uniquely blended cultural environment, regardless of their individual physical location, yet they do not fully belong to the cultural frameworks of either the home or host nation, while remaining connected to both but living in a different transnational activity space (Tedeschi et al., 2022).

Early scholarship on immigrants' cross-border interaction and transnationalism, especially from the 1990s and early 2000s, emerged in a context where sustained daily interaction across borders was limited by distance, cost, and technological constraints. Until the 2010s, digital communication was neither advanced nor widely accessible enough to support continuous, interactive engagement between migrants and their countries of origin (Bacigalupe & Cámara, 2012). Expensive and cumbersome international phone calls produced a punctuated sociality that both alleviated and intensified the emotional strain of long-distance separation (Skovgaard-Smith, 2023; Vertovec, 2004). As a result, early academic discussions of digitally mediated cross-border interaction now appear dated in light of technological transformations of the 2020s, including those visible during the pandemic.

The widespread adoption of smartphones and ubiquitous internet access has fundamentally reshaped migration experiences. Digital tools have become essential for maintaining both emotional and informational ties across borders, ranging from passive media consumption to active participation and interaction through blogging, vlogging, and other forms of user-generated content (Telve et al., 2023). Migrants now use digital platforms throughout the entire migration cycle from pre-migration information searching to post-migration settlement and potential return (Recchi & Favell, 2019). Real-time access to information, support networks, and emotional sustenance enables migrants to inhabit multiple locales simultaneously, transforming the spatiality of migration. Digital interaction thus enhances both virtual and physical forms of mobility, allowing migrants to sustain meaningful ties with their country of origin while engaging in everyday life in the host society.

Strong cross-border ties, however, can have mixed implications for integration. They may dilute local engagement and slow aspects of social integration in the host country (Verdery et al., 2018), support circular migration, or facilitate selective, domain-specific integration (de Haas & Fokkema, 2011). For returnees, digital connections may continue to anchor them to their former country of residence. Digital engagement also shapes belonging through media consumption: Simultaneous access to home- and host-country news and cultural content contrasts with earlier eras in which information was limited or filtered through diasporic intermediaries. This dual media engagement allows migrants to remain socially, culturally, and politically informed in both contexts, supporting civic participation in two settings or, in some cases, sustaining primary orientation toward the country of origin despite residence abroad.

In recent years, social media has become central to migrants' cross-border communication and interaction. Messaging applications enable intimate, real-time interaction, while broader platforms support public sharing of life events and expressions of diasporic identity. Group chats and digital communities reduce the burden of maintaining one-to-one ties and facilitate participation in geographically dispersed networks. Among regular and irregular migrants, platforms such as WhatsApp, Facebook, X (formerly Twitter), Instagram, Snapchat, TikTok, and YouTube serve different communicative needs across age, ethnic, and socioeconomic groups (Hillyer, 2021; Merisalo & Jauhiainen, 2021). Video calls via WhatsApp, FaceTime, or Messenger simulate physical co-presence, allowing migrants to participate in everyday family rituals, such as meals, celebrations, and caregiving, across distance (Demirsu, 2021; Toumi, 2023). Sharing short videos further fosters affective intimacy and a sense of shared daily life (Kedra, 2020). Although not all migrants produce content actively, the range of engagement from passive observers to transnational influencers illustrates the evolving nature of migrant subjectivities in the digital age.

The Covid-19 pandemic heightened the importance of digital inclusion policies as remote work, learning, and social interaction became essential, exposing and often widening digital inequalities (Reisdorf & Rhinesmith, 2020). Remote work expanded rapidly, including across national borders, and online economic and professional activities increasingly replaced offline practices. This super-digitalization weakened the traditional, place-bound link between residence and work, even across national borders, though the possibilities for remote work and digital entrepreneurship were unevenly experienced among immigrants (Andrejuk, 2022).

3. Estonians in Finland During the Covid-19 Pandemic: Diverging Mobilities and Policy Responses

Estonia and Finland, neighboring EU member states, are geographically separated by a two-hour ferry crossing across the Gulf of Finland. Despite their cultural and geographical proximity and advanced digital infrastructure, high smartphone penetration, and robust internet connectivity, the Covid-19 pandemic revealed significant divergences in their mobility regimes and policy responses. These differences had profound implications for Estonians' mobility and settlement patterns in Finland, regarding their country of origin and their lifestyles in between these two countries (Järv et al., 2021).

In the early 2020s, Estonians constituted the second-largest foreign-background population and the largest foreign citizen group in Finland, numbering approximately 50,000. The vast majority (80%) of them were adults, with a slight male majority (53%; see Statistics Finland, 2025). Since Estonia's independence in 1991, Finland has served as a prominent destination for Estonian labor migrants and later family reunifiers, especially during the early 2010s migration peak (Jakobson et al., 2012; Telve, 2019).

This migration is multifaceted. While some Estonians relocate permanently, others engage in lifestyle migration seeking improved living standards and earnings in Finland while maintaining strong ties to Estonia, to which they eventually return (Jauhiainen & Smolander, 2025). Prior to the pandemic, frequent cross-border travel was a central feature of this mobility system. In the mid-2010s, 29.1% of all Estonians visited Finland annually, and made an average of 4.1 trips each year (Silm et al., 2021), and in 2018 alone, Estonians made over 244,000 overnight trips to Finland (Visit Finland & Business Finland, 2019). Over the years, migration inflows from Estonia to Finland remained modest but steady, ranging annually from 500 to

6,000, in recent years between 1,400 and 2,400, while return migration to Estonia rarely exceeded 2,000, being in recent years between 1,200 and 1,900 (Statistics Estonia, 2025a; Statistics Finland, 2025).

The outbreak of Covid-19 in early 2020 radically disrupted these patterns. Despite geographical proximity and initially synchronized responses, Estonia sealed its borders on March 17, followed by Finland on March 19. Both nations initially adopted quarantine rules and travel restrictions, but policy trajectories soon diverged: Subsequent practices generated considerable uncertainty for cross-border practices of Estonians (Guild, 2020; STT, 2021).

Notably, ferry travel, which was the primary mode of transport, was intermittently suspended or severely limited, hindering mobility and fracturing cross-border routines. The air travel was also at times suspended. In summer 2020, low infection rates allowed the temporary reopening of borders, but Finland reinstated border controls in January 2021 in response to external spikes in Covid-19 cases, prompting diplomatic friction with Estonia over the impact on commuting Estonians or Estonian residents in Finland aiming to spend holidays in the country of origin. The rollout of the EU Digital COVID Certificate in June 2021 eventually eased mobility barriers, and all travel restrictions were lifted by late June 2022 (Finnish Institute for Health and Welfare, 2022; Kriis.ee, 2022). However, pandemic-era travel volumes remained well below pre-pandemic levels: Overnight visits to Finland by Estonians dropped to just 83,500 in 2021 (a third of 2019 levels) and recovered to only 140,000 in 2022, just 57% of their pre-pandemic frequency and up to 168,300 in 2024, still below the pre-pandemic time (Statistics Estonia, 2025b).

Pandemic-related restrictions also suppressed long-term migration. In 2020, only 1,596 Estonian citizens migrated to Finland, which was an all-time low since Estonia's EU accession in 2005, while 1,269 returned to Estonia. Although migration temporarily rebounded in 2021 (2,349 out-migrating and 1,052 returning), 2022 saw a decrease in out-migration to Finland (1,794) while return remained almost the same (1,185), trends continuing to 2023, 1,400 and 1,012, respectively (Statistics Finland, 2025). In parallel, smaller yet steady flows involved Estonians born in Finland to migrate to Estonia, reflecting second-generation mobility patterns (Jauhiainen & Smolander, 2025).

Importantly, policy responses diverged not only in timing but in stringency. Estonia implemented fewer restrictions on gatherings and social interactions compared to Finland. This divergence shaped the epidemiological landscape: By March 2023, Estonia had recorded over 600,000 confirmed cases (46.2% of the population), while Finland registered 1.4 million (25.5%; see Johns Hopkins, 2023). However, these figures may mask real infection rates, as public compliance with case reporting declined as the pandemic evolved.

4. Data and Methods

This study draws on data from two semi-structured surveys conducted among Estonian citizens officially residing in Finland, collected in 2019 and 2022. To align with the study's objectives, only respondents meeting the following criteria were included in the analysis: adult Estonian citizens who migrated to Finland after 1998, as they could do so without a visa, who reported Estonian as their mother tongue, and who provided valid responses on gender and age. The respondents were randomly selected from all Estonians in Finland who met this criterion. They were contacted by phone and informed about the study's aims and procedures, and could withdraw at any time. Those who participated did so anonymously, and by responding

during the call or filling the sheet on-line they gave consent to take part in the research. The broader project had ethical approval from the relevant university.

The final sample totaled 2,398 respondents, all aged 18 or older. They comprised about 5.8% of the total adult Estonian population in Finland. In 2019, 1,607 participants completed the survey; in 2022, 791 did so. The 2022 dataset had a balanced gender distribution (55% female), but the 2019 dataset had a slight overrepresentation of women (65%). Respondents in 2022 were also slightly older on average. To ensure comparability, the data weighting was implemented so that the 2019 data matched the age and gender structure of the 2022 sample to allow direct comparison.

In addition to analyzing the full sample, three overlapping subgroups were identified to highlight distinct characteristics and lived situations within the broader Estonian immigrant community in Finland. However, the same person can belong to one, two, or three subgroups, i.e., the subgroups are neither exhaustive nor mutually exclusive.

The first group consisted of employed and self-employed respondents, spanning various life stages. They formed the majority (83%, n = 1,987) of respondents. Their employment rate increased from 81% in 2019 to 87% in 2022. Notably, 27% of those over 65 remained economically active despite they had reached the official age of retirement.

The second group contained older adults and retirees: respondents aged 60 or older. They comprised 14% of the sample (n = 347): 13% in 2019 and 17% in 2022. Fully retired, non-working individuals accounted for only 28% of them (n = 96), indicating continued labor market participation among older Estonians in Finland, as mentioned above. Furthermore, many retired non-working Estonians return from Finland to Estonia (Jauhiainen & Smolander, 2025).

The third group of respondents had underage children in Finland. In Finland, school attendance is compulsory until one is 18 years old. This group formed a substantial portion (43%, n = 1,035): 45% in 2019 and 40% in 2022. Among these, a clear majority (73%) had children enrolled in Finnish schools, and that increased from 69% in 2019 to 79% in 2022, reflecting the challenge to travel back and forth to Estonia during the pandemic.

Comparative temporal analysis was conducted between responses collected prior to the onset of the Covid-19 pandemic (in 2019) and after the pandemic's peak period (in 2022). This longitudinal comparison allowed for the identification of temporal shifts in attitudes or behaviors among Estonians living in Finland during the pandemic context. The analytical approach employed in this study involved several complementary methods. First, a direct frequency distribution of responses was calculated for Estonian respondents residing in Finland to provide an overview of response patterns. Second, responses were disaggregated into three principal subgroups of respondents, as mentioned above, to inspect group-specific trends and variations, and they were each analyzed independently to detect intra-group patterns. Third, cross-tabulation techniques were applied to examine associations between categorical variables, and p-values were computed to identify statistically significant relationships.

5. Results

5.1. Digital Interaction Devices Among Estonian Respondents in Finland

Among the studied Estonians living in Finland, neither first-level (access to digital interaction tools) nor second-level (use) digital divides were present. Digital interaction was affordable and easily accessible: Finnish telecom contracts often include low-cost or equal-rate calls to Estonia and robust, unlimited internet access, enabling frequent and meaningful cross-border communication. The combination of advanced digital infrastructure, affordable pricing, and high digital literacy created favorable conditions for sustained cross-border connectivity and the formation of local, cross-border, and transnational social spheres (Cassarino, 2004; Levitt & Jaworsky, 2007; Tedeschi et al., 2022).

Digital proficiency was widespread. All respondents had access to digital communication tools, and 98% owned a smartphone (Table 1). The small share of basic-phone users (2%) reflected personal preference rather than economic constraint. They spanned different age groups, were mostly employed, and were not concentrated in low-income households. A substantial majority of Estonian immigrants in Finland reported strong digital access: 90% had fixed internet and 89% used WiFi. Device ownership was also high—76% had a laptop, 45% a tablet, and 33% a desktop computer—with no significant variation across the three sub-groups studied. This digital access enabled dynamic connections within Finland, to Estonia, and globally.

Most respondents were active on at least one social media platform. In 2022, the most commonly used were Facebook Messenger (86%), Facebook (85%), WhatsApp (84%), and YouTube (78%). While YouTube was mostly used for passive content consumption, the other platforms supported active, multidimensional interaction. Usage was high across demographic groups, though slightly lower among retirees and those over 60.

Facebook Messenger and WhatsApp dominated messaging, reflecting familiarity with Estonian (Messenger) and Finnish (WhatsApp) digital communication and interaction norms. Other platforms saw more limited use: Snapchat (16%), Twitter (5%), and Instagram (40%), with Instagram particularly popular among women and respondents under 35. TikTok was used by 18%, especially by parents of school-aged children (27%) and far less by retirees (7%). Only 8% used Telegram, indicating limited engagement with Russian-speaking digital networks. Prior research shows that Russian-speaking Estonian citizens in Finland rely far more on Telegram, which is linked to their cross-border interaction with Russian-speaking communities, including those in Estonia (Vorobeva & Jauhiainen, 2023).

The widespread use of both Messenger and WhatsApp reflects respondents' strategic choice of platforms depending on social context and location: Messenger was mainly used to connect with Estonians in Estonia or in Finland, while WhatsApp was preferred for communication with Finns. This cross-platform engagement allowed migrants to draw on digital practices from both countries and navigate national differences in social media use. Together, these tools supported varied forms of communication and interaction from casual short-video exchange to more in-depth audio-visual content sharing, which helped sustain shared, digitally mediated social spaces between Finland and Estonia (Demirsu, 2021; Hillyer, 2021).

5.2. Media Consumption Among Estonian Respondents in Finland

Estonians are active digital media users, aligning with broader trends toward digital-first news consumption. Nearly all respondents in Finland regularly followed both Finnish and Estonian media, indicating sustained engagement with societal developments in both countries. This dual media orientation reflects immersion in two national social spheres and signals cross-border or transnational forms of belonging rather than exclusive attachment to either the country of origin or the country of residence (Levitt & Jaworsky, 2007).

No statistically significant shifts were observed in respondents' media engagement during the pandemic (Table 1). Their overall following of media declined only slightly during the pandemic: Finnish media from 95% in 2019 to 92% in 2022; Estonian media from 96% to 94%, respectively. Frequent media consumption was also stable. In 2019, 75% of respondents followed Estonian media at least daily; this figure was 1% unit less in 2022. Estonian respondents followed Finnish media almost with equal frequency and at the same daily rate in both years (72%). Retirees and individuals over 60 were the most consistent consumers of both media spheres during pre-pandemic and post-height pandemic periods (Table 1).

Table 1. Estonians living in Finland: Following of Estonian and Finnish media (%).

		Estonian media					Finnish media					
		more	daily	weekly	monthly	no	more	daily	weekly	monthly	no	n
All		**34**	**40**	**13**	**9**	**4**	**33**	**39**	**14**	**9**	**6**	**2403**
	2019	34	41	13	9	4	33	39	14	9	5	1612
p: E = 0.072, F = 0.168	2022	35	39	12	8	6	31	39	13	9	8	791
Employed		**33**	**40**	**13**	**9**	**5**	**32**	**39**	**14**	**9**	**6**	**1981**
	2019	32	41	14	9	4	32	39	14	9	6	1293
p: E = 0.170, F = 0.264	2022	34	39	13	8	6	32	39	13	8	8	688
Child at school in Finland		**31**	**40**	**15**	**11**	**3**	**34**	**37**	**16**	**8**	**4**	**750**
	2019	30	40	16	12	3	33	38	18	7	4	501
p: E = 0.462, F = 0.081	2022	33	41	14	8	4	37	35	12	10	6	249
Retired and over 60		**38**	**44**	**8**	**6**	**4**	**40**	**43**	**8**	**7**	**3**	**348**
	2019	39	43	9	6	3	45	41	7	6	1	213
p: E = 0.450, F = 0.079	2022	37	45	5	7	5	33	44	11	7	4	135

5.3. Physical Cross-Border Practices With Estonia Among Estonian Respondents in Finland

Physical visits to Estonia are a key cross-border engagement for Estonians residing in Finland. Travel between the two countries is relatively easy and affordable: The Helsinki–Tallinn ferry route offers approximately 10 daily departures in each direction, with a two-hour crossing time and typical one-way fares ranging from EUR 15 to EUR 30. Unsurprisingly, Estonian residents in or near Helsinki, the closest Finnish city to Tallinn, the capital of Estonia, visit Estonia more frequently than those living farther away, reflecting geographical proximity's role in enabling cross-border practices and the maintenance of physical cross-border activity space.

Visits to Estonia are typically bottom-up initiatives, illustrating migrants' agency in maintaining ties to the country of origin. Nearly all respondents reported having cross-border social spheres, combining local ties in Finland with enduring connections in Estonia. In 2019, prior to the pandemic, almost all respondents (96%) had visited Estonia within the previous year. By 2022, this figure had declined to 90%, but was still very high despite the pandemic restrictions had made the travel more troublesome (Table 2).

Earlier estimates suggest that in the mid-2010s about 20,000 people lived intensively and equally between Finland and Estonia, reflecting relatively rare cross-border or blended transnational lifestyles and activity spaces (Silm et al., 2021). Such patterns were uncommon among our respondents. Before the pandemic, 34% traveled to Estonia at least monthly: evidence of sustained cross-border "ways of being" (Levitt & Glick Schiller, 2004) through regular embodied interaction with the country of origin. During the pandemic, this share dropped sharply to 20%, indicating a significant contraction in highly frequent cross-border mobility and the partial substitution of physical visits with other practices (Table 2).

The pandemic disrupted and hindered mobility routines and these results were statistically significant (Table 2). Of all respondents, the majority (59%) experienced a decrease in travel frequency to Estonia, 34% maintained their prior patterns, while almost none (2%) reported an increase during the pandemic. These findings confirm the profound impact of pandemic-related mobility restrictions and complexities on maintaining the physical cross-border activities among Estonians in Finland during the pandemic.

Table 2. Estonians living in Finland: Visit frequency to Estonia in previous year (%).

		weekly or almost	monthly or almost	4–7 times	1–3 times	no visits	*n*
All		**7**	**22**	**28**	**37**	**6**	**2395**
	2019	8	26	30	33	10	1604
2019 vs. 2022: $p < 0.001$	2022	5	15	24	47	10	791
Employed		**7**	**22**	**28**	**37**	**7**	**1997**
	2019	8	25	30	32	5	1289
2019 vs. 2022: $p < 0.001$	2022	5	15	25	46	9	688
Child at school in Finland		**5**	**20**	**28**	**40**	**6**	**751**
	2019	6	24	34	29	7	502
2019 vs. 2022: $p < 0.018$	2022	4	17	25	48	6	249
Retired and over 60		**7**	**27**	**28**	**30**	**8**	**346**
	2019	8	30	30	26	7	211
2019 vs. 2022: $p < 0.119$	2022	7	26	26	32	8	135

Strict travel restrictions in early 2020 intensified respondents' need and/or desire to reconnect physically with Estonia, and this was realized once travel resumed in 2021. After the peak pandemic period, a larger share of respondents (34%) reported longer stays in Estonia compared to before the pandemic (25%), a statistically significant increase (Table 3). Many extended their annual visits from 2–3 weeks to 4–8 weeks, dedicating a substantial portion or even all of their holidays to Estonia, marking a clear departure from pre-pandemic patterns. Employed individuals and those living with children in Finland were especially likely to report longer post-pandemic visits. This shift reflects a strong need to re-establish in-person contact and compensate for prolonged absence, despite the availability of digital interaction (Simola et al., 2023).

Table 3. Estonians living in Finland: Visit length to Estonia in previous year (%).

		over 6 months	3–6 months	1–2 months	2–3 weeks	up to one week	no visits	*n*
All		**3**	**9**	**28**	**34**	**25**	**2**	**2290**
	2019	3	9	25	36	24	2	1579
2019 vs. 2022: $p < 0.001$	2022	2	9	34	30	25	1	711
Employed		**3**	**8**	**28**	**35**	**25**	**2**	**1894**
	2019	3	9	24	37	25	3	1271
2019 vs. 2022: $p < 0.001$	2022	2	8	35	30	25	1	623
Child at school in Finland		**0**	**2**	**23**	**42**	**31**	**2**	**722**
	2019	0	2	19	46	30	3	493
2019 vs. 2022: $p < 0.001$	2022	0	3	33	34	31	0	229
Retired and over 60		**3**	**16**	**33**	**26**	**20**	**3**	**328**
	2019	3	15	28	30	20	4	207
2019 vs. 2022: $p < 0.008$	2022	3	19	41	18	19	0	121

5.4. Changes in Interaction Among Estonian Respondents in Finland

Limits on public and private gatherings and mandatory social distancing, combined with cross-border travel bans, curtailed Estonians' direct face-to-face social interaction in Finland for extended periods during the pandemic (Järv et al., 2021). Their local social spheres and networks were disrupted, geographical extension of physical activity space was reduced even if digital tools provided partial alternatives.

In 2022, 45% of respondents reported a decline in their leisure-time communication within Finland, compared to pre-pandemic period, while only 1% noted an increase, and 54% reported no change. This reduction in local communication indicates how pandemic-related measures weakened everyday social connectivity and interaction. Some respondents maintained contact with both Finns and Estonians, while others favored one of these groups.

A key compensatory practice to the lack of face-to-face encounters was the increased use of phone calls as an interaction practise. In 2022, 88% of respondents made phone calls at least daily—up from 78% in 2019. This pattern held across all subgroups: Employed respondents increased their daily phone calls from 80% to 89%, households with children from 82% to 92%, and retirees/over-60s from 71% to 80%. Concurrently, infrequent calling dropped from 6% to 2%.

Digital communication and interaction via social media rose as well. In 2019, almost all respondents used at least one platform (95%) and in 2022 even more did so (99%). Social media was thus present in everyone's lives. The most frequently used platforms—Facebook, Messenger, and WhatsApp—enabled instant messaging, video calling, and multimedia sharing, often in combined modes. Frequent use of Facebook (including Messenger) rose from 63% in 2019 to 73% in 2022, with notable increases among households with school-aged children (68% to 84%) and retirees/over-60s (55% to 65%). WhatsApp usage also increased significantly suggesting increased digital communication and interaction with Finns. Instagram's daily/near-daily use rose from 14% to 21%, driven more by generational uptake than by the pandemic context itself.

With in-person travel restricted, digital interaction became essential for maintaining cross-border activity spaces. Finland and Estonia's highly developed digital infrastructures removed structural barriers to such contact. Nearly all respondents (99%) stayed in touch with Estonia by phone during the pandemic: 14% increased call frequency, while only 5% reduced it. Among those who cut back on physical visits, 17% increased phone contact, underlining its role as a substitute for face-to-face interaction.

Social media communication and interaction with Estonia also remained high. While 88% maintained pre-pandemic levels, 13% increased their use and only 6% decreased it. Among those who traveled less, 17% intensified social media engagement to compensate for reduced in-person contact. Digital interaction thus became a central component of respondents' cross-border social practices during the pandemic.

Digitally accessible Estonian media offered broad information during the pandemic, but direct contact with family and friends remained essential for personalized and context-specific updates. Most respondents maintained regular communication with their social networks in Estonia, hihglighting the strength and continuity of their cross-border ties. Interaction frequencies remained largely stable: About three-quarters were in contact with relatives or friends at least weekly (75% in 2019; 78% in 2022), showing the persistence of strong cross-border social networks and activity spaces.

There was no major increase in hyper-frequent communication and interaction, as the share interacting several times a day showed no significant change. Daily or near-daily contact remained most common among retirees and those over 60, rising slightly to 44%. Respondents with school-aged children, being typically less frequent communicators, also increased their engagement by four percentage points to 32% in 2022. The share contacting Estonia a few times a week grew modestly by 3% units to 40%, while monthly or less frequent interaction declined by 3% units to 21% (Table 4).

Overall, personal cross-border relationships proved highly important and resilient. Despite mobility restrictions, respondents maintained and in some cases modestly deepened their ties through consistent

Table 4. Estonians living in Finland: Interaction with friends and family in Estonia (%).

		several times a day	almost daily	a few times	monthly or almost	Not at all	*n*
All		**12**	**26**	**38**	**23**	**1**	**2403**
	2019	12	26	37	24	1	1612
	2022	11	26	40	21	1	791
Employed		**12**	**25**	**39**	**22**	**1**	**1981**
	2019	13	25	38	23	1	1293
	2022	12	26	40	22	1	688
Child at school in Finland		**7**	**22**	**42**	**28**	**2**	**751**
	2019	6	22	41	30	2	502
	2022	8	24	43	23	1	249
Retired and over 60		**9**	**33**	**36**	**20**	**2**	**348**
	2019	8	33	33	23	3	213
	2022	11	33	40	15	2	135

digital communication and interaction. Only 1% in both years reported no contact with individuals in Estonia. These respondents had already oriented away from Estonian culture and identity, did not follow Estonian media, and showed broader signs of assimilation to Finland, with the pandemic having no discernible effect on their behavior.

6. Conclusion

Increased digitalization enables the emergence of cross-border activity spaces in which immigrants conduct daily life in their host-country neighborhoods while remaining intensively digitally and socially connected to their country of origin (Cagney et al., 2020). When digital divides are minimal, these activity spaces are integral to migrants' everyday lifeworlds, combining relational spaces created through online communication, platforms, and information flows with physical geographies that are increasingly intertwined. This impacts also the formation of institutional cross-border activity spaces (see Song et al., 2024).

In an increasingly interconnected and mobile yet crisis-prone world, as demonstrated by the Covid-19 pandemic and the escalation of war in Ukraine, understanding how migrants navigate the interplay between digital and physical cross-border interaction between the country of origin and that of current residence is essential for grasping contemporary lives across borders (Andrejuk, 2022; Herbig et al., 2025; Jauhiainen, 2026). This article contributes conceptual and empirical insight by examining how Estonian immigrants in Finland adapted their cross-border practices during and after the pandemic, preserving, modifying, and reconfiguring ties across space, time, and media.

The analysis demonstrates how digital transitions reshape cross-border activity spaces for ethnic groups whose everyday lives span multiple spatial and technological domains. The pandemic operated as a critical juncture that disrupted physical mobility and intensified reliance on digital communication and interaction, revealing both the resilience of migrant ties and the differentiated ways digital and physical mobilities structure their spatial agency, access to opportunity, and experiences of belonging. These findings indicate the theoretical importance of cross-border activity spaces and highlight digital inclusion as a key condition for equitable participation in social life across national borders.

The findings show that digital communication and interaction played a crucial role during the pandemic in sustaining Estonians' emotional, cultural, and informational ties across borders, thereby maintaining their cross-border activity spaces. Overall, digital communication functions as a complement not a substitute to physical cross-border engagement, highlighting the enduring importance of embodied social relations and place-based ties. Once travel restrictions eased, many Estonians increased both the frequency and duration of their visits. Notably, retirees and others over 60 differed somewhat from employed respondents and those with underage children: After the height of the pandemic they made longer and more frequent trips to Estonia, as they were less constrained by work obligations. Furthermore, older generations were the most consistent consumers of both Finnish and Estonian media.

Digital transitions alter but do not erase the centrality of physical co-presence in migrants' cross-border activity spaces. Instead, migrants recalibrate these practices dynamically as constraints and opportunities shift, creating new configurations of cross-border engagement. Among Estonians in Finland, digital interaction primarily reinforced national identity and origin-oriented belonging rather than fostering hybrid

transnational identities or deeper embeddedness in Finland. In this sense, digital tools functioned more as connective infrastructures strengthening homeland affiliations. This highlights how evolving digital geographies may unevenly reproduce or challenge existing patterns of spatial inclusion and exclusion in host contexts.

With respect to spatial inequality, the study illustrates that access to affordable, familiar, and linguistically accessible digital infrastructures enabled continued cross-border engagement for Estonians in Finland. For migrants in more precarious legal, economic, or technological positions, the shift from physical to digital space may reproduce or intensify exclusion from essential social, economic, and familial networks. However, a limitation of this study is the lack of in-depth analysis of the content of Estonian immigrants' digital practices, and the long-term effects of the pandemic remain uncertain given that survey data covers only 2019–2022.

These findings call for more nuanced, comparative research into how digital transitions differentially shape the cross-border activity spaces of diverse ethnic groups across urban and regional settings. Migration and integration policies must treat digital inclusion not merely as a technological matter but as a core dimension of spatial justice and immigrant well-being. Digital inclusion is nowadays a fundamental part of social inclusion.

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Conflict of Interests

The author declares no conflict of interest.

Data Availability

The data is not available for public use.

LLMs Disclosure

ChatGPT-4o has been utilized for language checking.

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