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EDITORIAL

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Planning for Locally Embedded Economies in the Productive City

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Abstract

Various economic activities (urban agriculture, industries, services) are conceivable in the productive city. This thematic issue attempts to highlight especially urban production/manufacturing as tangible manifestations embedded in their local settings because they are conflict-ridden, emanate distinctive spatial characteristics, and require complex planning processes. Therefore, we called for empirical case studies of such locally embedded economies with the productive city. As the contributions in this thematic issue emphasize, these activities can relate to high-tech (e.g., platforms) but also to low-tech (garment) and high-touch industries (e.g., crafts, fashion). However, they all rely on the embeddedness of local economies in urban spaces as an enabling environment in the productive city. To fully realize these local embeddings, the productive city calls for alternative understandings of production, investment, and legal/planning frameworks entangled in zoning overlays or (informal) mixed-use developments, orchestrated by means of digital technologies in a sustainable way (by circular economies, through environmental benefits). Simultaneously, the current (largely anecdotal) corpus of conceptual and qualitative case studies leaves unresolved the question whether the proposed ideas, visions, and guidelines for locally productive urban quarters are in fact achievable or merely reflect the wishful thinking of political agendas. More studies and improved methodological approaches are needed to operationalize the local significance and multipliers in order to objectively and statistically capture the genuine impacts of these sectors.

Keywords

industrial and commercial planning; local economies; mixed-use development; productive city; urban and architectural design; urban crafts; urban production

1. Introduction

Current guidelines of urban development (e.g., EU Urban Agenda, The New Leipzig Charter) in Western economies (e.g., the US, EU, Australia) have shifted their focus from functionally separated areas within cities towards integrated, resilient, inclusive, livable, sustainable, and mixed-use urban quarters (Bundesministerium des Innern, 2020). These ideas are based on several contemporary spatial visions, imperatives, approaches, and models such as the compact city (Breheny, 1992), the city of short distances (Wegener, 1994), the 15-minute city (Moreno, 2016), and mixed-use development (Rowley, 1996) along with the rediscovery of local economies (Birkhölzer, 2000; Henn et al., 2020; Läpple & Walter, 2003) and urban manufacturing (Brandt et al., 2017; Grodach & Martin, 2025; Läpple, 2013)—both the guiding themes for this thematic issue—that feed into the image of a productive city (Gärtner & Meyer, 2023; Gärtner et al., 2021). The Sustainable Development Goals of the United Nations (UN SDG) are proclaiming these "locally embedded economies in the productive city" if we combine SDG 8 (Decent work and economic growth), SDG 9 (Industry, innovation and infrastructure), and SDG 12 (Responsible consumption and production) and place it in the urban or city frame of SDG 11 (Sustainable cities and communities; König et al., 2021; United Nations, 2015). The resurgence of the productive city and its local economies is driven not only by novel technologies that reintegrate and re-embed tangible production into inner-city areas, but also by democratic, multi-level governance principles, including place-based participation, co-creation, and local/near-shoring for the urban commons—thus preventing industrial displacement and commercial gentrification. A key element is an active property policy that secures current and future industrial and commercial services of general interest (*gewerbliche Daseinsvorsorge*; Avdikos & Pettas, 2021; Bundesministerium des Innern, 2020; Heider & Siedentop, 2024; Lingenhöle et al., 2025). In Section 2, we review the evolving rationales and understandings behind the productive city and locally embedded economies. Section 3 lays out the essence of contributions in this thematic issue and value-added for theory, methods, and empirics in pertinent discourses. Section 4 highlights limits, ambivalences, and ambiguities around productive cities, their embedded local economies, and underlying assumptions, before we briefly conclude.

2. Revisiting Debates Around the Productive City and Locally Embedded Economies

The concept of "productive cities" and "local economies" has a much longer history than contemporary debates might suggest. Productive cities have existed since ancient and medieval times, when craft-based guilds created tangible local economies, and later, during industrialization, factories shaped the image of the industrialized city (Gärtner & Meyer, 2023; Läpple, 2003). Throughout most of the 20th century, the term was rather used analytically as "productivity" from an economic perspective in the sense of efficiency, output, and value creation detached from empirical and concise context (Fogarty & Garofalo, 1988); in a more stylized way its spatial concentration in urban areas and cities was more prominently summarized as agglomeration economies based on localisation and urbanization than for the actual production of material goods (Novy, 2022; Suwala, 2023). The current meaning of the "productive city" and "local economies" evolved based on seminal contributions about both the economic and societal revival of "left-behind" or "deprived" inner-city areas (e.g., Jacobs, 1962; Tomaney & Pike, 2021; Witherspoon et al., 1976) and about the inner city as a "re-embedding context" in times of globalisation and blurring of boundaries. Rather than leading to a dissolution of spatial ties, these processes have resulted in an increased dependence on specific spatial—particularly urban—contexts, where untraded interdependencies emerge and innovation relies on tacit knowledge and cultural production in post-industrial cities (Gertler, 2003; Läpple, 2003; Storper, 1995).

Both discourses can be seen as a countermovement to the tendency towards an increasing spatial separation of functions and monotony in urban areas, as heralded by the Athens Charter (a document advocating rational principles of town planning from 1933).

This origin also explains why the concept of "local economies" attempted to avoid a separation into purely economic, social, and ecological viewpoints and was tied to concepts of social economy, solidarity economy, third sector, community economy, and ethnic economy. According to this understanding, the local economy refers to new forms of economic activity and local strategies of self-help that are closely tied to meeting the basic needs of people (Birkhölzer, 2000; Läpple, 2003). Later, the understanding took another turn, when Saskia Sassen criticized the focus of local economic policy on large companies in the advanced sectors of culture and services and the neglect of urban manufacturing industries (Sassen, 2006). In this context, the potential of the local economy through urban production was emphasised, including service–manufacturing linkages and networks that promote a new urban economy, stabilise social structures in cities, and strengthen local, circular, and resilient economies against the turbulences of global markets. This occurs through re-embedded businesses as well as through the generation of locally bound, unique, and tacit knowledge bases, innovation, and creativity within inter-urban competition (Läpple, 2013; Oinas, 1997; S. O. Park, 1996). These trends have recently been accelerated by the pandemic, the polarization of global trade, and the associated vulnerability of global production networks, but also by the maker movement that combines traditional crafts with modern electronics, programming, and digital fabrication (Kimura et al., 2020; Lane & Rappaport, 2020; Martin, 2021; Wolf-Powers et al., 2017).

By and large, the definition of a productive city based on locally embedded economies culminates into the following understanding: Locally embedded productive cities are comprised of small and medium-sized enterprises with tangible goods, non-disruptive craft business, low-emission high-touch artisanal production, and also high-tech customized start-ups or maker companies with prototypes or small production batches bound by service–manufacturing linkages and networks that reintegrate these activities with the help of advanced, smart and sustainable technologies into urban areas. This ensures local supply and transforms inner-city areas into attractive, multifunctional spaces for mixed use. To achieve this, a key component of urban planning must be the creation of innovation-friendly environments and opportunities for local and regional production (Gärtner & Meyer, 2023; Gärtner et al., 2021; Grodach & Martin, 2025; Henn & Behling, 2020; Henn et al., 2020; Läpple & Walter, 2003; Schwappach et al., 2023; Wolf-Powers et al., 2017). Hereby, the local scale is brought to the fore as local orientation, e.g., "neighbourhood economy with primarily local orientation" (Krummacher et al., 2003), local embeddedness, e.g., "locally embedded economy" (Läpple & Walter, 2003), or local roots, e.g., "locally rooted family firms" (Basco et al., 2021). Cities have used these imperatives to create guidelines on how to plan, design, administer, and operate cities with locally embedded economies, how to increase the presence of the productive economy in the city, how to reintegrate production into the urban fabric through digitalization, circular and innovative manufacturing technologies, and how to provide attractive and affordable locations for urban production (Ferm et al., 2021; Grodach & Martin, 2025; Meyer, 2023; Rappaport, 2016; Suwala et al., 2021). Examples include "Productive City" in Vienna (Stadt Wien, 2017), "Productive City" in Brussels (Borret, 2018), "Produktion in der Stadt" in Berlin (Erbstößer, 2016), "Quo Vadis Werkplatz?" in Zurich (INFRAS, 2017), "One New York: The Plan for a Strong and Just City" (OneNYC, 2015), or "Our Productive City" in Brisbane (Brisbane City Council, 2022), among many others.

3. Contributions to This Issue

Against this backdrop, the contributions in this thematic issue deal with pertinent building blocks around the constitution and characteristics of the productive city and its locally embedded economies as played out in in-depth encounters from a planning perspective, such as: governance issues within regulative frameworks when dealing with noise conflicts or while organizing urban manufacturing clusters (Daels & Grodach, 2025; Kim et al., 2025; Meyer et al., 2025); design issues when planning for the transformation or adaptation of formerly industrial sites or setting up novel urban commercial or industrial areas (Rappaport, 2025; Suwala et al., 2025); mixing issues as manifested in mixed-use development of commercial buildings or courtyards (Lingenhöle et al., 2025; Rappaport, 2025); collaboration issues when spatially organizing commons-based peer production or informal and community-based networks in the garment industry are at stake (Daels & Grodach, 2025; Kim et al., 2025; Liodaki et al., 2025); digitalization issues when orchestrating of digital platforms or peer production is necessary (Kim et al., 2025; Liodaki et al., 2025), or sustainability issues when platforms are used for circular economic measures or when the environmental benefits of urban manufacturing are brought to the fore (Angstmann et al., 2025; Kim et al., 2025). All contributions build on the embeddedness of local economies in urban spaces as an enabling environment in the productive city (see Table 1). In this embedded realm, they call for an alternative understanding of production (e.g., by including care work), investment (e.g., directed toward the commons), and legal structural frameworks, to be administered (e.g., noise conflicts; Meyer et al., 2025; Suwala et al., 2025) or organized through mixed-use development (e.g., commercial courtyards, Lingenhöle et al., 2025; Rappaport, 2025; Suwala et al., 2025) and orchestrated by means of digital technologies (e.g., platforms; Kim et al., 2025) or informality (e.g., community ties; Daels & Grodach, 2025), in a sustainable way (e.g., circular economy, environmental benefits; Angstmann et al., 2025; Kim et al., 2025; Liodaki et al., 2025).

Table 1. Main rationales, methods, fundamental results, and foci of the contributions to this thematic issue.

Authors	Main Rationale	Methods	Fundamental Results	Foci
Daels & Grodach	The study investigates how informal and community-based networks shape the spatial organization and economic dynamics of the garment industry in Buenos Aires.	Case study approach, integrating qualitative and spatial analysis (18 in-depth interviews, ethnographic site visits, spatial analysis using Google Earth).	Informal networks and flexible settlements provide the necessary embedded environment for blending work and housing next to enabling resilient, adaptive, small-scale manufacturing to garment producers after a relocation due to rising rental costs and stricter regulatory enforcement.	Governance, Collaboration
Kim et al.	The study lays out a typology of platform ecosystem orchestration strategies that best represent existing circular fashion platforms and explores how each type coordinates participant interactions to foster localized resource flows in urban contexts.	Exploratory approach for own dataset (34 platforms desktop research, expert recommendations, participation fairs, examination network members).	Four main types of platform ecosystem orchestration in circular fashion: (1) Market orchestration for textile reuse (local), (2) Supply chain orchestration for textile recycling (local), (3) Network orchestration (local), (4) Data analytics orchestration (non-local).	Governance, Collaboration, Digitalization
Liodaki et al.	The study explores the phenomenon of commons-based peer production (CBPP) from a geographical perspective and focuses on its spatiality, materiality, and implications for place-based development by addressing power relations and fostering just and sustainable futures.	Non-exhaustive literature review of the spatial dynamics, materiality, and socio-economic impacts of CBPP through post-colonial, uneven development, and feminist geographical theories.	CBPP calls for an alternative understanding of both production (where reproductive labor, such as care work and emotional support, power, and gender dynamics are included) and investment (as transvestment by redirecting resources from market cycles to commons cycles) from a place-based perspective to foster local resilience, sustainability, and community-led initiatives.	Collaboration, Digitalization, Sustainability

Table 1. (Cont.) Main rationales, methods, fundamental results, and foci of the contributions to this thematic issue.

Authors	Main Rationale	Methods	Fundamental Results	Foci
Meyer et al.	The study explores the integration of urban manufacturing into German urban land-use planning, focusing on mixed-use strategies, legal approaches, and the role of court decisions in resolving noise-related conflicts.	Structured document and qualitative content analysis of nine preparatory land-use plans (2007–2018) and 87 binding land-use plans (2011–2021) from 23 large German cities and 15 court decisions (2016–2021).	Land-use plans and binding land-use plans inadequately protect urban manufacturing from residential pressure and noise conflicts; court decisions expose planning gaps and call for stronger legal frameworks and solutions (zoning transitions, green buffers, and noise protection) to prevent industrial gentrification and support SMEs.	Governance, Mixture
Angstmann et al.	The study unearths key arguments for the environmental benefits of urban manufacturing and focuses on its contributions to carbon, resource, and space efficiency to promote sustainable urban economies.	Systematic literature review based on 163 relevant articles from the Web of Science and Scopus databases (1993 and 2024) by MAXQDA software for coding and categorizing findings.	Urban manufacturing can enhance carbon, resource, and space efficiency through proximity (agglomeration), circular practices (less emissions), and innovative land use (vertical production), though benefits vary by technology, context, and implementation challenges.	Sustainability
Lingenhöle et al.	The study proposes a "New Berlin Mix" in the city's commercial courtyards based on diversity of use, integration of the productive economy, and vibrant urban spaces from a functional mixed-use development perspective.	Mixed-methods analysis (desktop research, on-site inspections, quantitative inventory, GIS geoferencing, qualitative ex-post interviews) of 35 commercial courtyards in Berlin.	The original Berlin Mix is dying out in the inner city, but a modified version exists, with Autonomous Courtyards on the outskirts often showing higher diversity of use and productive economy integration, challenging traditional understanding of mixed-use concepts in inner urban areas.	Mixture

Table 1. (Cont.) Main rationales, methods, fundamental results, and foci of the contributions to this thematic issue.

Authors	Main Rationale	Methods	Fundamental Results	Foci
Rappaport	The study portrays successful examples from various cities that demonstrate the potential of mixed-use developments for urban manufacturing and calls for an adaptation of building and zoning codes to integrate light manufacturing with residential and commercial uses, revitalizing urban spaces.	Case studies (author's former research through exhibitions, books, essays, and fieldwork) of mixed-use projects in Europe and the US were examined to identify successful models and strategies for integrating light manufacturing into urban areas.	Modern light manufacturing can be integrated into cities through novel technologies, visible production, mixed-use zoning overlays, and hybrid building types, strengthening local economies while fostering community engagement and equitable neighborhood–industry connections.	Design, Mixture
Suwala et al.	The study focuses on planning and designing publicly owned commercial courtyards from an integrative mixed-use development perspective in Berlin.	Mixed-use imperatives and experimental design of three planned commercial courtyards in Berlin using a multi-methods approach combining locational analyses next to urban, architectural utilization concepts, and expert interviews.	Various types of hybrid commercial courtyards will be proposed: (1) innovation-oriented; (2) mixed-use craft, cultural-creative, and manufacturing-based; and (3) socially anchored commercial courtyards with childcare facilities. For successful implementation, balancing societal demands with logistical and economic considerations within long-term planning horizons and collaboration between public authorities, stakeholders, and urban planners is necessary.	Design, Mixture, Governance

4. Limits, Ambivalences, and Ambiguities

Although the contributions to this thematic issue illuminate diverse pathways for strengthening locally embedded economies in the productive city, current debates and literature often add to an (anecdotal) corpus of conceptual and qualitative case studies and leave unresolved the question of whether the proposed ideas, visions, and guidelines for compact, sustainable, mixed-use, and locally anchored urban quarters are in fact achievable or rather reflect wishful thinking driven by political agendas. More studies and improved methodological approaches are needed to operationalize local significance and multipliers to objectively and statistically capture the genuine impacts of these sectors and alternative encounters (see for exceptions: Brixy et al., 2024; Meyer & Schonlau, 2024; J.-I. Park, 2023; Piegeler & Spars, 2019). Planners and decision-makers should be aware that urban production is a highly heterogeneous construct, drawing on a wide variety of economic activities (Meyer & Schonlau, 2024). Even if one sixth of all companies and employment, for example, in Germany are attributable to city-affine sectors as an approximation for urban production/manufacturing (Piegeler & Spars, 2019), studies also confirm that statistically urban production significantly lost ground in urban context in all types of urban areas (Brixy et al., 2024; Centre for London, 2022) also as a result of planning frameworks and agency that favored service activities and led to industrial displacement and commercial gentrification over several decades in most cities of Western economies (Novy, 2022). In addition, there is rising criticism towards concepts underlying the productive city, such as the compact, 15-minute, or city of short distances, pointing to exclusiveness, fragmentation, and squandered opportunities (Casarin et al., 2023; Glaeser, 2021).

5. Conclusion and Outlook

In this context, the thematic issue seeks to make three key contributions. First, highlight that the productive city and its locally embedded economies shall be built on a contemporary and alternative understanding of production and investment, taking not only the novel silent technologies but also (reproductive) labor and/or the commons into account. Second, legal and planning frameworks should adopt a more courageous stance toward mix-making, mixed-use development, zoning overlays, and innovative planning approaches. Third, more studies are needed to statistically capture the genuine local impacts of these alternative and heterogeneous encounters, to gain credibility and legitimation for both science and society, and to move beyond an anecdotal corpus and a rather wishful thinking of political agendas.

LLMs Disclosure

To ensure responsible AI use and maintain publication integrity, we disclose using DeepL (version 25.8.2) and ChatGPT (version 5.1). Both tools were used to translate selected parts of the article, which were then manually verified by researchers; these tools also enhanced our manuscript's grammar and style in those parts.

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Informal and Community-Based Agglomeration: Development and Change in the Garment Industry of Buenos Aires

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Abstract

This article explores the interplay between formal and informal economic activities in the garment industry of Buenos Aires. Focusing on the emergent cluster in Villa Celina, it examines how immigrant-led social and economic networks intersect with policy shifts and economic pressures to shape production geographies. The case underscores the importance of informal and community-based practices in enabling clustering in low-tech, high-touch manufacturing. The findings enrich agglomeration theory by showing how industrial clusters in contexts of informality and limited state support rely not only on conventional drivers but especially on informal governance and adaptive place-based community networks. These embedded and often invisible dynamics sustain production and enable spatial concentration under constraint. Informal economies generate their own trust-based external economies, including shared resources and logistical systems, both of which support ongoing activity and attract formal firms seeking to tap into these networks. The study concludes with implications for rethinking zoning and regulatory frameworks to better accommodate inclusive and diverse forms of urban manufacturing.

Keywords

agglomeration; Buenos Aires; garment industry; immigrants; industrial districts; informal economy; labor; land use; manufacturing

1. Introduction

In the context of renewed interest in urban manufacturing, cities are rediscovering the value of local production. However, urban and industrial planning policies continue to bias advanced manufacturing and

Industry 4.0 agendas. While these matter, policy often neglects two interrelated factors: (a) the existence of low-tech, high-touch forms of manufacturing that play a vital role in urban economies by providing essential and local services (Grodach & Martin, 2021) and (b) the roles of informal and unregulated practices in shaping the spatial organization of productive networks, which are often pronounced in these industries.

The study of interfirm and spatial linkages between formal and informal activity gains relevance in the context of the growing attention to local production, as these linkages support the adaptability, inclusivity, and resilience of urban manufacturing systems. This focus may offer insights for creating economies that are not only technologically advanced, but also more equitable and localized (Gibson-Graham et al., 2013). Informal and low-tech manufacturing not only enriches economic diversity, but also provides critical employment opportunities for urban workforces, particularly for marginalized and immigrant populations. This dynamic, however, is not without challenges. While these sectors create avenues for economic participation and offer a pathway for some workers to ascend within the production chain, they are often characterized by exploitative labor conditions, such as low wages, lack of social protections, and precarious employment. This duality underscores the complexity of informal manufacturing, where opportunities for empowerment coexist with the perpetuation of systemic inequalities. Addressing these issues requires balancing the support for economic mobility and entrepreneurship with efforts to combat exploitative practices and promote fair labor standards.

Aligning with scholarship that highlights how agglomeration drivers and outcomes can vary widely across sectors (Diodato et al., 2018; Faggio et al., 2017; Grodach & Guerra-Tão, 2024), this study examines the spatial interactions and networks of the garment industry in Buenos Aires, which combines traditional factory setups with a substantial informal outworker sector. The case is a compelling example of localized industry agglomeration comprised by a spectrum of formal, informal, and quasi-formal enterprises (Gomez et al., 2020; Guha-Khasnobis et al., 2006). This article traces the movement and development of garment production to the Villa Celina area. What began as a consolidated hub in the Flores neighborhood—originally established by Korean immigrant seamsters—expanded to Villa Celina, which has increasingly become a focal point for informal workshops in response to stricter regulatory control. We demonstrate that the garment sector in Buenos Aires is shaped by a complex interplay between formal and informal activities, influenced by policy shifts, economic pressures, and longstanding community dynamics.

By analyzing the dynamic interplay of formal and informal activity in shaping the garment manufacturing cluster alongside the impacts of planning regulations and property costs, this study reveals how these factors collectively reshape the economic geography of the metropolitan area. It highlights how the planning system interacts with informality through policy leniency to anchor production in key areas. These dynamics drive the relocation and consolidation of garment production, underscoring the intricate relationship between planning frameworks and the evolving landscape of formal and informal economic activities.

2. The Urban Garment Industry: Agglomeration Dynamics Between the Formal and the Informal

Garment manufacturing is highly flexible. Tasks including designing, pattern making, fabric selection, cutting, assembling, finishing, and adding details such as buttons and zippers, may be locally concentrated yet geographically dispersed into specialized segments. This flexibility helps the industry integrate into and

adapt to urban spaces with minimal industrial footprint. The garment industry is typically characterized by small firms (Scott, 1984), minimal adoption of advanced technologies (Gago, 2017; Montero, 2012), and a largely low-paid immigrant workforce (Arcos, 2013; Cregan & Kulik, 2022; Goldberg, 2014; Ludmer et al., 2023; Magliano et al., 2017; J. Montero, 2011; Sutherland, 2016). These features are found in diverse cities including Los Angeles (Bonacich & Appelbaum, 2000), London (Evans & Smith, 2006), Manchester (Warren, 2005), Prato (Ceccagno, 2012), Paris (Iskander, 2007), Amsterdam (Rath, 2003), Milan (Pisati et al., 2020), Johannesburg (Kesper, 2014; Rogerson, 2018), Melbourne (Burchielli et al., 2009; Cregan & Kulik, 2022; Delaney et al., 2018), Cali (Moreno-Monroy & Cruz, 2016), São Paulo (Buechler, 2013; Ikemura Amaral, 2022; Lesser, 2013), and Buenos Aires (Gago, 2017; Ludmer et al., 2023; J. Montero, 2012).

A defining characteristic of the industry is its reliance on subcontracted informal labor (Brien, 2013; Sassen, 2013) organized in small workshops or homes where workers assemble garments for larger companies (Cregan & Kulik, 2022; J. Montero, 2011). This structure allows firms to bypass regulations on worker protections and shift risks to subcontractors (Greig, 1992). Outworkers are individuals who carry out their work from home or in locations that are not typically considered formal business premises. These outworkers either receive materials delivered to them or collect them, then complete assembly tasks at home (Burchielli et al., 2009; Delaney et al., 2018). They return the finished products to the subcontractor, which often works under a larger firm. Outworkers are typically paid by piece-rate, have little control over profit margins, and bear all production costs, including overhead and running expenses (Burchielli et al., 2009; Chen, 2014; Delaney et al., 2018). Their isolation and lack of visibility may enable their exploitation in systems where they are essentially dependent workers or disguised wage earners (Burchielli et al., 2009; Delaney et al., 2018; Kellett & Tipple, 2000). Home-based outwork is viable due to the affordability and simplicity of sewing machines (Peck, 1990). Low entry costs make the industry volatile, with frequent new entrants competing with established small firms (Ludmer et al., 2023). Garment production remains labor-intensive, relying on manual skills and personal relationships with local suppliers (Cox, 1995).

While these features align with the conventional understanding of agglomeration economies, informal and unregulated activities are rarely theorized as critical to shaping agglomeration patterns. Classic agglomeration theory identifies advantages such as access to skilled labor, a cost-effective supply of specialized inputs, and localized knowledge spillovers (Duranton & Puga, 2004; Rosenthal & Strange, 2004). Other contributions have built on this work by addressing how "untraded interdependencies" (Storper, 1997) or the non-market-based relationships that influence economic activity and place-based social conventions (Blundel & Smith, 2013)—sustain agglomeration.

However, even this work tends to center on formal sectors and relatively stable institutional environments (Visser, 2009). As a result, the literature often under-theorizes how agglomeration operates in informal and institutionally fragile settings, where producers navigate weak regulatory support and infrastructural gaps by mobilizing kinship ties, trust-based exchanges, and adaptive spatial practices (S. Montero & Chapple, 2018).

Existing literature presents divergent views on the localized agglomeration effects of informality. Some scholars emphasize its positive contributions to employment, flexibility, and economic diversity (Duranton, 2008; Meagher, 2006, 2010, 2013; Moreno-Monroy, 2012; Mukim, 2014), while others point to its negative externalities, including congestion and the displacement of formal enterprises (Harris, 2014; Moreno-Monroy, 2012; Overman & Venables, 2005).

Recent econometric studies have sought to quantify agglomeration economies in both formal and informal sectors, but they typically treat these sectors as distinct and largely segregated systems. Tanaka and Hashiguchi (2020), using establishment-level data from Cambodia, find that informal firms significantly benefit from employment density, with productivity gains amplified by spatial network effects, whereas formal firms show little responsiveness to local agglomeration. Similarly, García (2019), analysing Colombian cities, demonstrates that employment density has a significantly positive effect on productivity and wages in the informal sector, while the formal sector exhibits much weaker agglomeration returns. By contrast, Matano et al. (2020) find that while urbanization and localization economies increase wage premiums for formal workers, only informal workers embedded within formal sectors experience similar gains. As Tran et al. (2024) emphasize, this variability underscores the need to move towards understanding the relationships—such as subcontracting and social networks—that shape how informal and formal enterprises interact within industry agglomerations.

Other studies have examined the spatial co-location or segregation of formal and informal enterprises, using spatial autocorrelation models (Moreno-Monroy, 2012; Moreno-Monroy & Cruz, 2016). These analyses provide valuable insights into proximity patterns but still conceptualize formality and informality as parallel and non-interacting categories, emphasizing statistical correlations over dynamic social and economic interactions. These studies rarely consider how informal firms and labour pools may act as pull factors attracting formal businesses, nor how informal institutions—including trust-based networks, kinship ties, and community governance—support the formation and persistence of hybrid production systems within agglomerations.

To address these gaps, we investigate the complex spatial and economic relationships between formal and informal businesses within Buenos Aires' garment industry. We examine the significant role of informal production practices and their strong reliance on a network of relationships and interactions to create pathways for survival, economic opportunities (Afroza et al., 2016; Alam & Houston, 2020; Fransen et al., 2023; Simone, 2004, 2008, 2013; Thieme et al., 2021; Waliuzzaman, 2020; Waliuzzaman & Alam, 2022), and innovation (Fransen et al., 2023; Nederhand et al., 2023; Phelps & Aritenang, 2023). A key dimension of these networks is their deep entanglement with immigrant communities, whose cultural and ethnic ties shape their operation (Caggiano, 2014; Gago, 2017; Kim, 2014; Parra Garcia, 2019). These interactions reflect a sort of social architecture (McFarlane, 2011; Simone, 2004) built on trust, reciprocity, and community arrangements (Caggiano, 2014; Fransen et al., 2023; Gago, 2017) rather than formal institutions or regulations. Such arrangements highlight how migrant communities mobilize shared cultural identities and practices to develop adaptive strategies and sustain economic activity in the face of urban and regulatory challenges, further underscoring the critical role of ethnicity and cultural cohesion in shaping informal economic geographies. Additionally, we analyze how urban policies influence this agglomeration by facilitating, restricting, or interacting with informal networks (Cleaver, 2002; Das & Poole, 2004; Roy, 2009), thereby shaping the spatial organization and trajectory of the garment industry across the city.

3. Methods

This article adopts a case study approach, focusing on the garment industry in Buenos Aires, where estimates suggest that between 60% and 70% of clothing is produced within informal productive units (Bertranou & Casanova, 2016; Campos, 2008; Lieutier et al., 2018). As such, Buenos Aires provides a rich context to explore

the socio-spatial dynamics between formal and informal enterprises and those in-between (Figure 1). We aim to study how these enterprises occupy shared spaces (Ludmer et al., 2023), the complex interactions between formal and informal production and commercialization circuits (Gago, 2017; Ludmer et al., 2020), and the ways in which regulatory differences across jurisdictions affect the spatial organization of production networks in the garment industry. Buenos Aires' garment production sector has undergone notable spatial transformations over the past few decades, shaped by a blend of regulatory shifts, economic pressures, and the evolving roles of immigrant communities. We trace the movement and development of garment production across the city's neighborhoods, from Flores—a long-standing hub established through the contributions of Korean and Bolivian immigrant labor—to the emerging center of Villa Celina, where recent waves of informal workshops have settled (Figure 1).

Central to this interaction is the role of the urban planning system, which, while designed to regulate land use and economic activity, may inadvertently accommodate or exacerbate informality. We analyze the impacts of enforcement changes and urban policies, to understand how the planning system interacts with the evolving landscape of formal and informal economic activities.

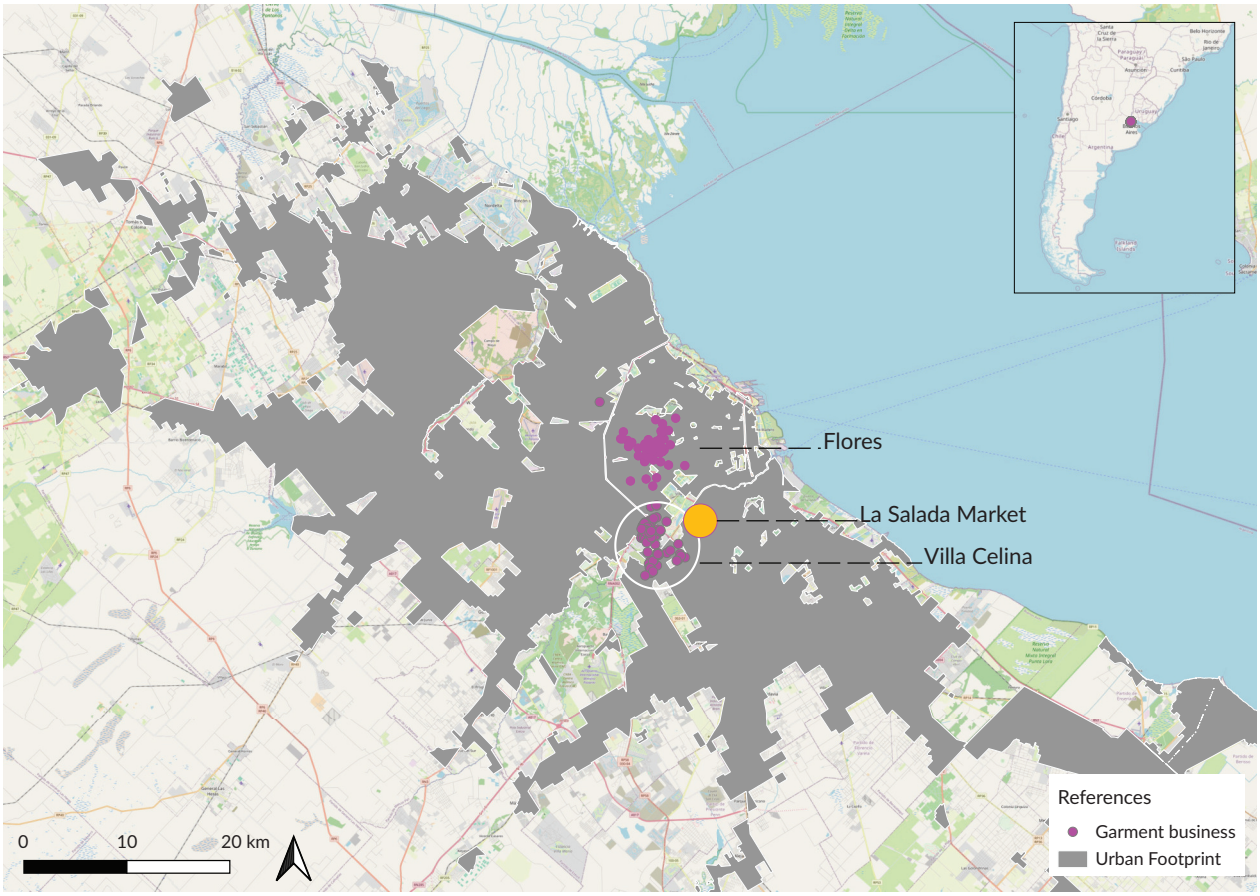

Figure 1. Spatial distribution of garment production units within the urban footprint of the metropolitan area of Buenos Aires. Source: Author's elaboration based on Google search, desktop mapping, and field observations conducted in 2024. Basemap: OpenStreetMap.

The research is based on fieldwork conducted between March and July 2024, integrating in-depth interviews and ethnographic site visits to explore the spatial dynamics of formal and informal manufacturing

in Buenos Aires. This approach enables a nuanced understanding of the lived experiences, social and community networks, and informal institutions that shape the spatial patterns of the garment industry.

The data collection involved 18 in-depth interviews with garment producers, workers, business owners, and community leaders. The interviews provided rich details on how informal networks and community arrangements support or hinder business operations, and how participants navigate formal and informal regulatory landscapes. To ensure participant anonymity, fictional names have been assigned and are consistently used throughout the article. Additionally, ethnographic site visits were conducted to examine the physical and social environments of garment hubs, providing insights into the often-overlooked but tangible operational dynamics of these spaces. These visits documented how businesses adapt their spaces for production, implement informal logistics systems, repurpose urban infrastructure for unofficial activities, and rely on community-based communication methods to coordinate and sustain their operations. These observations were systematically recorded through notes, photographs, and sketches, providing context-specific insights into the spatial layouts and interactions between formal and informal enterprises. The analysis utilized thematic coding of interview transcripts and field notes, identifying key themes such as business development, locational decisions, zoning impacts, enforcement practices, real estate pressures, and community networks.

To complement these qualitative methods, the study incorporated spatial analysis using Google Earth Street View images to examine changes in the physical landscape over time. Comparisons of Street View imagery from 2015, 2019, and 2024 were conducted to identify visible transformations in garment production areas. The integration of these temporal snapshots enriched the qualitative findings, offering a dynamic view of the evolving urban fabric over the studied period. By integrating qualitative insights with spatial dynamics, the study reveals how informal governance structures influence business relocations, foster resilience, and support the garment industry's growth amidst formal regulatory challenges and real estate pressures.

4. The Spatial Dynamics of Buenos Aires' Garment Production Sector

This case provides insight into the dynamic interplay between community-based informal production networks and urban policies in reshaping the garment industry geography in Buenos Aires. Throughout the early 2000s, Flores solidified as the hub of garment production in Buenos Aires largely due to the integration of the Bolivian community into the local workforce (Gago, 2017; Parra Garcia, 2019). Initially employed as tailors in Korean-owned workshops, Bolivian workers gradually gained technical skills and knowledge in production processes, which enabled many to transition from tailoring to establishing their own manufacturing workshops (Kim, 2014; Parra Garcia, 2019). However, tragic workshop fires in 2006 and 2015 raised safety concerns and intensified labor and workplace safety inspections and stricter compliance checks for zoning and land use. These measures were often accompanied by evictions and closures of non-compliant workshops. These events initiated a notable migration of informal workshops from Flores to Villa Celina, where Bolivian entrepreneurs set up independent operations, transforming Villa Celina into a new garment production hub. Formal businesses followed the informal workshops, drawn by the labor networks and production chains that had consolidated in Villa Celina. This case highlights how community networks and social ties not only facilitated the relocation of informal businesses but also fostered the emergence of Bolivian seamsters as central figures in Buenos Aires' garment sector.

In the following sections, we delve deeper into these spatial shifts, to examine how policy responses, and community-driven networks collectively shape the landscape of garment production in Buenos Aires.

4.1. From Flores to Villa Celina: Industry Structure and Relocation of Buenos Aires' Garment Sector

The textile hub in Flores initially emerged from the concentration of Korean seamsters working in residential areas, which evolved into a wholesale and later retail commercial area (Kim, 2014, 2022). As a seamster interviewee explains:

> The Korean owned his house, and the garage was the buttoning station. The house in the back had two workshops where we did the sewing; but everything was owned by the same person. There were around 16 of us in the house, and the wife of one of the workers who also sewed, was the one who cooked for all of us. (Victor, Bolivian seamster, May 2024)

As the garment hub in Buenos Aires expanded, Korean manufacturers began focusing on higher-value tasks such as pattern making, fabric cutting, and commercialization. To manage the more labor-intensive aspects of production, they subcontracted sewing and related tasks to Bolivian seamsters like Victor. These seamsters often lived and worked in precarious conditions, including sublets or squatted housing in informal settlements located near the hub. This proximity fostered a spatial and economic interdependence between the formal operations of Korean manufacturers and the informal labor of Bolivian workers within the local garment industry (Kim, 2014, 2022; Sassone & Mera, 2007).

Pablo, a Korean garment manufacturer, illustrates this division of labor:

> I have my factory, where I've got my cutting table, storage for fabrics, and everything else. Here, I have the store and stock for sales. Generally, about 90% of the production is outsourced. Very few people handle both things. The factory does the patterns, the fabric layout, and the cutting, while everything else—sewing, embroidery, sublimation, finishing—is outsourced. (Pablo, Korean manufacturer, May 2024)

This transition highlights the interconnectedness of formal and informal sectors, where informal settlements and housing arrangements are not merely byproducts of the garment industry but integral to its broader ecosystem. The physical proximity of informal settlements to production hubs facilitates this relationship, allowing formal enterprises to leverage the flexibility and cost advantages provided by informal labor networks, which, in turn, sustain the industry's competitiveness.

The concentration of sewing workshops in Flores attracted a network of complementary activities, including fabric and trimming warehouses, commercial stores, and, more recently, unlicensed shopping galleries (Kim, 2022). This commercial expansion coincided with a sharp rise in the average sale price per square meter of commercial spaces. According to the land use survey report of the City of Buenos Aires (Gobierno de la Ciudad Autónoma de Buenos Aires, 2022), prices increased by 172.6% between 2008 and 2017, from USD 1,561.2 to USD 4,256.6 per square meter, effectively more than doubling the value of similar neighboring areas. This trend underscores the growing demand and premium associated with this commercial hub.

However, a series of fatal fires in informal sewing workshops in Flores, which gained media visibility in 2006 and 2015, triggered a crackdown on clandestine workshops. This in turn prompted many workshops to relocate to Villa Celina, a neighboring jurisdiction with fewer regulatory constraints (Ludmer et al., 2023). The relocation of workshops has significantly reshaped the garment production geography. As a Bolivian workshop owner explained:

> They cleaned up everything here [in Flores]. At first, it was the seamsters who used to come and pick up work here in Flores, but then [Villa] Celina suddenly took off, and now you have everything there: fabrics, threads, machinery. In Flores it has become very difficult because of the high rental costs. And then there's the issue of permits. Before, workshops operated in houses, but now if you do not have a permit, they might shut you down. (Alberto, Bolivian workshop owner, April 2024)

The rapid proliferation of informal garment workshops in Villa Celina highlights the adaptability and ingenuity of informal economies (Afroza et al., 2016; Roy, 2009; Simone, 2008; Thieme et al., 2021). These workshops, which are embedded within informal settlements (Gago, 2017; Parra Garcia, 2016), have created localized networks of production, distribution, and consumption. As a municipal officer vividly described, "We are flooded with workshops, completely invaded. You can tell by the number of fabric stores….Whenever you see a Kangoo van, you'll see five Kangoos [vans] parked, and that means they're here to buy fabric" (Pedro, Villa Celina municipal officer, May 2024).

While Villa Celina's rise as a textile hub is linked to regulatory pressures in Flores, it is also intrinsically linked to the emergence and consolidation of the largest and most emblematic market in Latin America: La Salada (Benencia & Canevaro, 2017; Gago, 2012; Girón, 2011). La Salada started in the 1990s as a grassroots effort by Bolivian seamsters and merchants who sought to establish a space for selling their goods, often produced in unregistered workshops (Benencia & Canevaro, 2017). Currently, the market occupies an area of 20 hectares, attracts around 50,000 visitors per day, supplies approximately 200 smaller markets across the country, and directly or indirectly generates employment for around 6,000 families (Gago, 2012; Massidda et al., 2010).

The market was established on abandoned land near the Riachuelo River, an area at the margins of the river and the society (Biehl, 2022) that allowed for informal activities to flourish due to weak state enforcement and affordable land costs. It operates as a massive event three days a week, with vendors selling a wide range of products, including clothing, footwear, and accessories—many of which are either locally produced or informally imported from countries like Chile, Brazil, and Paraguay (Parra Garcia, 2016). The goods sold at La Salada are often significantly cheaper than those in formal retail stores, making it a popular destination for lower-income shoppers and small retailers seeking affordable merchandise:

> If you come here on a Saturday, you'll see buses coming from out of town, long-distance buses bringing people to buy clothes. Earlier today, I was at La Salada, and what is striking is that despite the economic crisis impacting consumption, La Salada is booming. You would not believe how many people were there today shopping, and how the place has grown. (Isaias, textile seller at Villa Celina, May 2024)

The market's activities are intrinsically linked to the wider garment production networks in Buenos Aires. These networks span informal workshops operated by seamsters to exclusive designer labels (Lieutier, 2010), creating a complex ecosystem of interdependence. This dynamic aligns with Sassen's (1993)

argument that informalization is deeply connected to larger processes of economic restructuring and polarization. On one hand, the growth of low-income populations fuels demand for affordable goods and services provided by informal markets like La Salada. On the other hand, the rise of affluent urban groups generates demand for customized, high-quality niche products, fostering a unique synergy between informal economies and advanced urban markets.

Leo, a textile seller with vast experience in the garment industry, elaborated on this relationship, revealing the fluid boundaries (Gomez et al., 2020) between formal and informal production circuits:

> Sometimes workshops keep some garments to sell on the informal market, or they steal the design. The counterfeit goods from La Salada Market come from this. For example, around 2004–2005, Kosiuko [clothing national brand] was at its peak, and everything in La Salada was Kosiuko. But it was the same garments being sold in both places because the same workshops were supplying both the formal and informal markets. Even the labels were original. (Leo, textile seller, May 2024)

Informal workshops supply both markets simultaneously, blurring distinctions between counterfeit and original goods (Gago, 2012). This practice highlights how informal economies not only parallel formal markets but are often intertwined with them, leveraging shared production networks and resources.

La Salada has grown significantly since its inception, becoming a key node in the informal economy of Buenos Aires. It is deeply integrated into the lives of residents in the neighboring settlements, where the informal economy shapes both work and living arrangements. As a municipal officer from Villa Celina explained:

> I can assure you that in the Hernández neighborhood, just across the river from the market, 70% of the people work at La Salada. They sew, sell, drive remises, push carts, or transform a room in their house into a storage space. (Sara, Villa Celina municipal officer, May 2024)

This proximity fosters a symbiotic relationship between the market and the relocated workshops in the surrounding communities, providing livelihoods while shaping the local economy. A Bolivian pattern maker reflected: "The truth is that most of us are here because of La Salada. If that market ever disappears, I do not know if there will be as much work around here" (Hugo, Bolivian pattern maker at Villa Celina, May 2024).

4.2. Social Fabric and Community Networks in Villa Celina's Garment Sector

Villa Celina's and La Salada's growth can be linked to the economic adaptability of its manufacturers, who often work with limited resources but rely on strong social networks (Alam & Houston, 2020; Fransen et al., 2023; Simone, 2004; Waliuzzaman, 2020). As a Bolivian manufacturer and market vendor recalled:

> When we started to produce to sell in La Salada, we didn't even have a cutting table; we would layer the fabric on the floor and cut it with scissors. At first, there was always someone from the villa (slum) who came to our house with a machine to cut the pieces for us. (Aurelia, Bolivian manufacturer and market vendor, May 2024)

The reliance on collaborative labor and tools (Gibson-Graham et al., 2013) underscores how these networks are deeply rooted in the social fabric that enables small-scale manufacturers to participate in and contribute to the thriving informal market. These networks not only facilitate production but also ensure the logistics of informal trade, covering transportation, security, and sales. As a Bolivian pattern maker from Villa Celina described:

> The merchandise is taken to La Salada by car or remis. There are several *remiseros* who are familiar with the work and know how to avoid the checkpoints because, if they stop you, you need to slip them some cash to let you pass. Also, you have to watch out for people who might steal your merchandise or the money you earned at the market. (Hugo, Bolivian pattern maker at Villa Celina, May 2024)

The concentration of Bolivian immigrants not only sustains economic networks but also fosters a sense of community identity and cohesion (Pizarro, 2009; Sassone, 2009). This connection is evident in the concentration of Bolivian eateries, local festivities, and religious events that shape daily life in Celina, contributing to both social integration and the informal economy's resilience. The sector leverages a communitarian capital (Gago, 2017) that is both reinforced and celebrated through events like the Virgin of Copacabana festival and the Ekeko festival, which draw participants from across the region and stimulate the local economy.

These festivals are both culturally and economically significant (Seeliger & Turok, 2014; Simone & Pieterse, 2018). The Virgin of Copacabana festival, for instance, involves over 75 dance groups parading in traditional attire through the streets, bringing together thousands of community members. This event not only displays traditional Bolivian music and dance but also boosts local commerce, as vendors set up stalls selling traditional foods and other goods: "This generates a huge economy, all organized and capitalized by the community" (Pedro, Villa Celina municipal officer, May 2024).

Religious and social events in Villa Celina act also as informal marketplaces where workshop owners connect with seamsters in communal settings. These gatherings facilitate traditional labor practices, familial employment, and community-based supply chains, all of which are vital to the garment production and distribution network. By fostering these interactions, such festivities fulfill a broader social function, legitimizing the material, labor, and exchange relationships that underpin this migrant community (Caggiano, 2014; Grimson, 1999; Parra Garcia, 2019; Sassone, 2009, 2016). As a Bolivian sewist recalled:

> My uncles would go to Bolivia every time they could. Whether it was for Carnival or other festivities in my uncle's hometown, they always went. Every time they went to Bolivia, they would bring new people, two or three at a time. They would offer transportation costs, food, and dwelling. Some stayed for only a short while and then left, but there was always someone who wanted to learn and later start their own workshop. (Eugenia, a Bolivian sewist, April 2024)

Eugenia's account aligns with the concept of chain migration within Villa Celina's informal garment industry, where migration facilitators (Hans, 2023) hold hierarchical positions over newcomers. These individuals assume travel costs, provide housing, training, work, and access to networks (Meeus et al., 2020; Wessendorf, 2022) while maintaining control and deriving benefits through dependency, loyalty, or reduced compensation. This mirrors the classic padrone system (Nelli, 1964; Pedone, 2005), blending opportunity

with exploitation (Kohlbacher, 2020; Wessendorf, 2022). The hierarchy is deeply rooted in the community's cultural and social fabric, legitimized through shared traditions and trust-based relationships, fostering economic integration while entrenching inequalities within the network (Parra Garcia, 2019).

This concentration of power is exemplified by the dual role community radio stations play as economic and social gatekeepers. Often controlled by consolidated workshop owners, these radio stations influence labor markets, advertise services, and reinforce communal bonds. The overlapping roles of media operators and business owners consolidate economic and social power in the hands of a few, shaping both the workforce and the cultural fabric of Celina.

Figure 2 illustrates two key phenomena: the rapid consolidation of the area within just five years and the pivotal role of the community radio station at its core. The station's central positioning underscores its function as a socioeconomic and cultural anchor, fostering local networks and community cohesion. Additionally, the architectural style in the area exhibits a strong influence of Freddy Mamani, the renowned Bolivian architect known for his neo-Andean aesthetic, which blends Indigenous heritage with contemporary urban development (Thorne, 2019). This architectural presence not only signals economic growth but also represents a deliberate assertion of cultural identity in the built environment.

Figure 2. Rapid urban consolidation and the role of communitarian radio at Villa Celina (corner of Olavarría St. and Roosevelt St.): (a) 2014; and (b) 2019. Source: Google Street View images: (a) https://maps.app.goo.gl/BbhUYGyuqPqXV2iP8; (b) https://maps.app.goo.gl/wyVLAXsFtg6VbDHg9.

The cultural and identity representations of a society of origin are pivotal in fostering and maintaining interpersonal connections and trust-based networks. This dynamic is particularly evident in Villa Celina, where business iconography and naming practices reflect the importance of trust-based relationships, especially in sectors complementing or intersecting with the informal garment industry. Services such as remis agencies, financial institutions, medical centers, legal firms, and community organizations frequently adopt communitarian names that reinforce cultural ties and foster trust within the community (Figure 3).

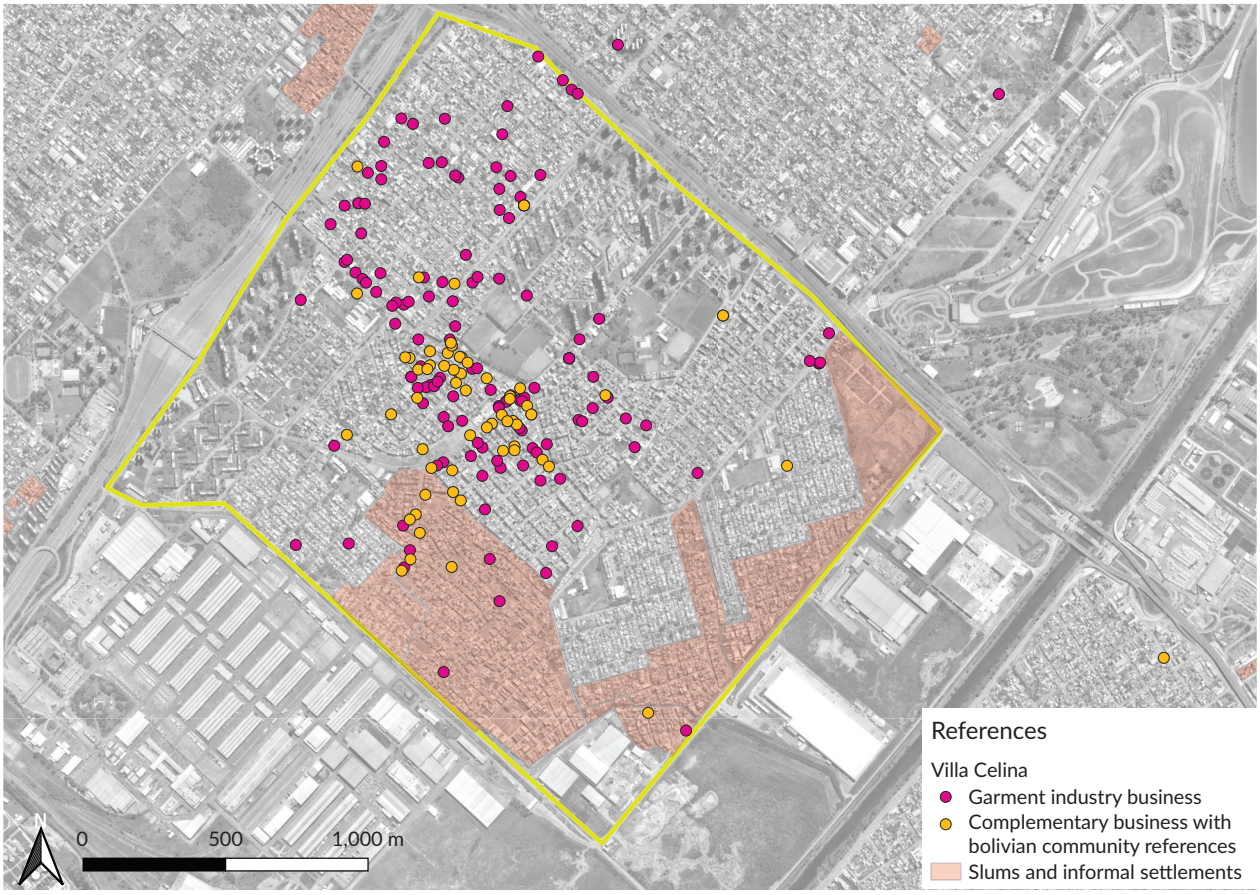

Figure 3. The ecosystem of garment and community-based businesses in Villa Celina (2024). Source: Author's elaboration based on Google search, desktop mapping, and field observations conducted in 2024. Basemap: Google Earth Satellite imagery.

These trust-based services play a crucial supporting role in the informal garment industry by providing essential logistics, financial aid, health services, and legal assistance. Together, they form an interconnected ecosystem of frugal practices (Fransen et al., 2023) that sustains the industry's operations and reflects how cultural identity and trust extend beyond production.

At the same time, this condition closes off opportunities for outsiders (Waliuzzaman & Alam, 2022). As an Argentine woman living in Villa Celina who entered the garment production business to earn extra income for her daughter's 15th birthday explains:

> After a while, we could not keep up; it's very demanding work, and the Bolivian community didn't help us at all. We wanted them to do the sewing as they did for their clients in the city: We would cut,

> prepare everything in bags for them, and they would take care of the sewing. But they did not want to sew for us. It is like they only help each other. (Mariana, Argentinean garment manufacturer, May 2024)

4.3. Economic Expansion of Villa Celina Through Informality

The expansion of garment workshops in Villa Celina has significantly boosted local employment, driven economic activity, and stimulated commerce there. Describing the scale of operations, a municipal officer remarked:

> If you come here in the afternoon, you will see trailers unloading fabrics and armored trucks with police escorts, private security, and everything. They block off the street, and you must wait until they're done working. Everything is done in cash, and they have permanent police surveillance. (Pedro, Villa Celina municipal officer, May 2024)

Much of the money generated locally is reinvested in the community. As one Villa Celina trader emphasized: "The money made here stays here and starts being spent here. You see more businesses, more restaurants, more hardware stores, more eateries, more kiosks, more butcher shops—you start to notice it" (Alvaro, Villa Celina trader, April 2024). This dynamic illustrates how informal economies not only meet local production demands but also fuel broader commercial ecosystems, transforming Villa Celina into a bustling center of economic activity.

A key driver of this transformation is the blending of home and workspaces, which exemplifies the resourcefulness of small-scale manufacturers. "We bought the machine in installments, and my house turned into a workshop," shared Mariana, a clothing manufacturer; "the dining room became a working table; we set up a board we bought from a neighbor, and there my son and daughter helped me spread out the fabric" (Mariana, Argentinean garment manufacturer, May 2024). This integration of domestic and productive activities not only sustains livelihoods but also involves family members, reinforcing communal ties and shared labor within households.

Further reinforcing this integration is the construction of new buildings designed to accommodate both families' living quarters and workshop facilities: "All these new buildings are both homes and workshops…you can already see that the new buildings are all narrow and deep so a cutting table can fit inside" (Pedro, Villa Celina municipal officer, May 2024). These dual-purpose structures demonstrate how informal production becomes woven into the physical and social fabric of the community, fostering a unique interplay between residential and economic spaces (Motta, 2014; Wainer, 2022; Ward & Smith, 2015; see Figure 4).

Site visits revealed the adaptability of these dwellings to support local economic activities (Figures 4 and 5). For example, homes near La Salada Market have been repurposed into storage units or *bauleras*, serving as merchandise deposits for market vendors. This adaptation mitigates the lack of on-site storage at the market, which operates only three days a week, and reduces risks associated with police checkpoints where goods and earnings may be confiscated. Other households have started selling fabric by the kilo, catering to small-scale garment makers who cannot purchase or store entire fabric rolls. Additionally, some dwellings have been transformed into eateries, serving neighborhood workers and visiting customers, further embedding these settlements into the garment sector's broader ecosystem.

Figure 4. Integration of residential and workshop spaces in Villa Celina (2024).

Figure 5. Economic innovation and spatial adaptations in Villa Celina and La Salada Market (fieldwork register, April 2024): (a) dwelling in Villa Celina adapted for fabric sales by the kilo; (b) carts parked at La Salada Market entrance during operating hours; and (c) dwelling near La Salada Market converted into storage units (*bauleras*) for garments.

Interviews and fieldwork observations show that most workshops operate within informal settlements (see Figure 3), where inadequate infrastructure and precarious living conditions pose significant challenges. These makeshift buildings often lack essential services such as electricity, water, and gas. Structural limitations further complicate workshop operations, with narrow streets hindering the movement of large quantities of fabric and materials. In response, an informal system of hand-pulled carts has emerged to navigate these congested areas, exemplifying the remarkable "frugal practices" (Fransen et al., 2023) of residents and workers.

As shown, informal settlements like those in Villa Celina are not merely spaces of hardship (Simone, 2008); they also provide an environment where informal production can thrive beyond the constraints of regulatory oversight (Bayat, 1997; Benjamin, 2000; Chakravorty et al., 2005; Simone, 2008). Urban geography scholars

have highlighted the ingenuity and resourcefulness (Dale et al., 2010; Simone & Pieterse, 2018) inherent in such spaces, advocating for a shift away from focusing solely on the physical limitations of informality to a more nuanced understanding of the adaptive strategies these communities employ (J. Robinson, 2006; Roy, 2005; Simone, 2008; Watson, 2009). These insights underscore the importance of recognizing informal settlements as dynamic, productive hubs integral to urban economies rather than solely as spaces of deprivation.

In recent years, Villa Celina has also become a magnet for textile warehouses and sales centers, supplying a manufacturing hub that has seen rapid consolidation. A municipal officer explained: "Around 10 years ago, what we call the Jewish merchants arrived, and they boosted the work of the previous Bolivian communities by establishing fabric warehouses" (Pedro, Villa Celina municipal officer, May 2024). This influx of merchants has significantly transformed the area, with a dynamic mix of formal and informal textile activities now firmly rooted in the local economy.

Larger warehouses, often developed by established merchants, "stand out as more modern and well-constructed" (Pedro, Villa Celina municipal officer, May 2024). In contrast, many other smaller workshops operate discreetly, hidden in makeshift buildings that blend into the surrounding neighborhood. These dual layers of visible and invisible production activities reflect the diverse and complex nature of Villa Celina's textile ecosystem and the formal–informal continuum (Gomez et al., 2020) that shapes it.

A striking example of this dynamic is the expansion and relocation of a textile-importing company. Initially, the company operated exclusively in Flores, where it ran two large stores. However, as garment production shifted to Villa Celina, the company strategically expanded its presence, opening three new stores within a 150-meter radius in Villa Celina over the past five years. This move allowed the company to align with the geographic shift in garment production, capitalize on the growing demand, and integrate more effectively into the area's localized supply networks. The decision to relocate was driven by a combination of logistic, economic, and regulatory factors. A textile business manager explained:

> There was a time when Bolivians came all the way here to Flores to pick up the fabric cuts and take them back for sewing, but over time it became complicated, especially because of parking issues. They spent so much time driving around looking for a spot. Plus, the cost of rent in Celina is much lower. For example, what costs me 100 pesos in Flores costs me 10 pesos in Celina. I ended up renting a closed poultry shop in Celina; the owner would never have imagined it would end up being rented for 500,000 pesos. (Mercedes, textile business manager, May 2024)

The reduced cost of rent and proximity to workshops have made the area increasingly attractive; however, rising property prices and informal rental arrangements have introduced new challenges:

> Nowadays, property prices in Villa Celina have gone up quite a bit, but they're still much more affordable than in Flores. However, sometimes it is difficult to find a landlord willing or able to enter into a formal rental agreement. A lot of the land does not have proper papers, so it's hard to set up anything formal. (Mercedes, textile business manager, May 2024)

This lack of formal tenure complicates transactions for incoming businesses, but it also helps explain why small-scale, low-tech producers have been able to remain in the area despite rising land values. In this sense,

widespread informal land occupation offers a form of spatial stability that protects these producers from displacement pressures (B. E. Robinson & Diop, 2022). In the process, Villa Celina has become an essential node in Buenos Aires' textile supply chain. As formal enterprises follow the movement of informal activities, capitalizing on established networks and localized demand patterns by leveraging the dense networks of suppliers, labor, and customers developed organically in Villa Celina, they contribute to the transformation of the area into a more consolidated and mixed production zone. As a textile seller observed:

> Over the last five years, an interesting textile hub has developed in Celina. One of the first to settle there was a massive national company that produces everything in its factory in San Martín. Now, there must be at least 20 textile businesses in the area. (Leo, textile seller, May 2024)

The arrival of formal businesses, alongside the thriving informal sector, underscores the consolidation of Villa Celina as a key node in Buenos Aires' garment industry (see Figure 6).

Figure 6. Villa Celina: People queuing outside a textile warehouse to purchase fabric (fieldwork register, April 2024). The queue in front of this textile warehouse reflects strong local demand and indicates the proximity of workshops operating within walking distance. The warehouse's stock, geared toward direct sale to individuals and micro-producers, signals a consolidated production hub supported by a dense network of small-scale garment makers.

5. Discussion: Insights From Informal Garment Clusters for Inclusive and Adaptive Urban Planning

The garment production sector in Buenos Aires exemplifies the complex layering of localized activities across a spectrum from formal to informal, deeply rooted in community networks, and adapting to shifts in policy and economic pressures. By foregrounding the dynamics of informal clusters, this study enriches traditional agglomeration theories, which often prioritize functional market-driven interactions. The case of Villa Celina reflects a particular configuration of agglomeration dynamics shaped by the interplay of formal

and informal economic activity. While proximity to labour, suppliers, and opportunities for knowledge spillovers continues to play a role, these benefits are mediated through dense social networks, informal economic practices, and adaptive land-use strategies. In this context, informality functions as an enabling infrastructure, offering both flexibility and protection to small manufacturers navigating displacement, labour market volatility, and institutional neglect.

This study demonstrates that informal networks, cultural cohesion, and trust-based arrangements play a significant role in sustaining economic clustering—especially in contexts where small-scale, labor-intensive industries operate in the interstices of formal and informal systems, under conditions of institutional fragmentation. Informal economies generate their own forms of external economies—including shared resources, logistical systems, workforce training, and informal financial support—that substitute for formal infrastructure, governance, and regulatory frameworks. These embedded mechanisms not only sustain production but also act as a pull factor for formal businesses seeking to access these local networks. This contributes to a more nuanced understanding of agglomeration, by complicating the assumption that clustering is primarily driven by formal sector dynamics and instead highlighting the intertwined formal–informal relationships and hybrid governance arrangements that underpin spatial concentration in contexts of institutional fragmentation.

Informal garment production in Buenos Aires relocated from the historically concentrated area of Flores to Villa Celina largely due to the movement of informal enterprises. This shift is driven by rising rental costs, increased regulatory enforcement, and, in some cases, forced evictions, all of which pushed home-based seamsters and workshop operators to seek alternative, proximate locations. In Villa Celina, ethnic networks and community ties significantly influence relocation decisions, fostering an emerging cluster that offers more affordable and less regulated spaces. These community-based networks and informal institutions function as economic infrastructure, supporting resource circulation within the local economy and creating a safety net that allows businesses to adapt flexibly to market shifts. The vitality of Villa Celina's garment sector relies on the strong cultural and social fabric of the predominantly Bolivian immigrant community. Communal events, local media, and social practices reinforce social ties, creating community capital that supports trust-based business relations. These relations in turn enable garment workers and enterprises to operate outside the formal regulatory framework while maintaining economic viability, and help individuals deal with unexpected events by providing a degree of stability amid unpredictable urban environments where resources are scarce.

The evolution of garment production hubs, such as the shift from Flores to Villa Celina, further underscores the temporal and spatial fluidity of clusters. The interplay of displacement, real estate pressures, regulatory leniency, and community arrangements reveals the complex forces shaping the geography of garment production in Buenos Aires. These dynamics reinforce the view that, in contexts like Buenos Aires, industrial clustering reflects not only firm-level agglomeration logics but also the influence of external pressures and locally embedded adaptive strategies (Gibson et al., in press).

The displacement of informal workshops from Flores, particularly following tragic fires and stricter regulatory enforcement, disrupted an established production cluster. In the process, Villa Celina emerged as a reactive form of agglomeration, offering displaced workshops a low-rent, low-regulation environment that allowed them to reestablish operations in a locally embedded context. The informal tenure system and

de facto land occupations in Villa Celina shield these low-tech, high-touch businesses from market pressures and speculative development, providing a relatively stable base for production.

A critical factor in this dynamic is the role of community-based governance structures, which function both as a protective buffer and an enabler of economic activity. These structures reinforce informal tenure systems, offering businesses a degree of security while maintaining adaptability. Similar to industrial zones in other high-growth, service-oriented metropolitan areas (Chapple, 2014; Grodach & Martin, 2025; Grodach et al., 2023; Martin & Grodach, 2023), Villa Celina's informal clusters demonstrate how de facto occupations create semi-stable spaces where businesses can establish, grow, and reproduce.

On the other hand, the relative absence of land use and business regulations in informal business clusters allows greater flexibility in non-traditional modes of operation. In contrast, formally zoned areas often impose strict land-use classifications and operational restrictions, limiting the types of activities that can take place in specific locations (Grodach & Martin, 2025). For instance, zoning laws might separate manufacturing from retail, restrict mixed-use spaces, or introduce long permit application processes that slow adaptation. By operating in loosely regulated environments, businesses in informal economies can experiment more freely with production processes, supply chains, and business models. They can rapidly adjust to shifts in demand, introduce small-batch or customized production, and adopt flexible work arrangements that might be constrained by compliance requirements in formal zones. This flexibility makes informal settlements fertile ground for economic experimentation and adaptive growth, as businesses can pivot quickly without the delays associated with regulatory approvals. However, this does not mean informal businesses operate in a vacuum. Rather than relying on state-imposed regulations, these businesses often function within alternative governance structures, such as social norms, community agreements, and informal enforcement mechanisms. These structures can provide predictability and stability while allowing greater room for adaptability than rigid formal regulations. At the same time, the lack of oversight can also lead to labor exploitation and unsafe working conditions, highlighting the precarious nature of unregulated production.

Ultimately, these spaces seem to offer a balance of benefits, combining some of the protective features associated with industrial zoning—such as shielding businesses from speculative pressures—with the flexibility to operate outside rigid regulatory frameworks. This raises critical questions for urban planning: Can lessons from these spaces inspire more adaptive and inclusive planning tools? How might planning systems blend protective zoning features with flexible regulations to support innovation while maintaining stability? Could hybrid zones be designed to shield cost-sensitive businesses from market pressures while fostering environments where enterprises can experiment and thrive? These questions challenge planners and policymakers to reimagine zoning as a tool for balancing economic resilience, equity, and inclusivity, learning from the ingenuity and adaptability inherent in informal urban economies.

The case of Villa Celina's garment cluster highlights the dynamic interaction between informal and formal economies and contributes to ongoing conversations in urban studies and economic geography. It engages with debates that question the formal–informal divide in planning frameworks, while also enriching discussions on industrial agglomeration by foregrounding the multiple social, spatial, and institutional forces that shape clustering in contexts of informality. As Simone (2004) has shown in other contexts, informality can function not as a regulatory gap but as a form of urban governance—one that enables resource sharing, adaptability, and localized coordination. Similarly, the practices observed in Celina align

with Gibson-Graham's et al. (2013, 2016) call to recognize economic diversity and the generative capacity of non-mainstream economies. By foregrounding the social, spatial, and institutional dimensions that underpin clustering in contexts of informality, this case offers insights into how planning can become more inclusive and context-sensitive.

Beyond the significance of informal activity to localized agglomeration economies, the key planning insight is the importance of more nuanced approaches to zoning and land use. Rigid zoning frameworks often fail to accommodate low-tech, high-touch production sectors—particularly those embedded in dense social networks and characterized by adaptive business models. Planners should consider hybrid zoning approaches that combine regulatory protections—such as shielding businesses from displacement and speculation—with greater flexibility in production, retail, and distribution activities.

Another important insight is that community-based governance structures can complement formal planning systems. Informal networks provide economic stability through trust-based relationships, informal tenure arrangements, and alternative credit mechanisms—functions that formal institutions often struggle to replicate. This does not imply a call for deregulation, but rather the need for more contextually grounded regulatory approaches that respond to the realities of diverse urban economies.

By reframing urban planning as both a facilitator of economic diversity and a safeguard for social equity, planners can develop frameworks that protect vulnerable production systems from speculative pressures while supporting the flexibility needed to sustain dynamic, network-driven economies.

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Conflict of Interests

The authors declare no conflict of interests.

Data Availability

The data supporting this study are based on confidential interviews and are not publicly available to protect the privacy and anonymity of participants. Access to anonymized excerpts may be considered on a case-by-case basis, subject to ethical approval and participant consent.

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ARTICLE

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Orchestrating Circular Fashion in the Productive City: A Digital Platform Ecosystem Framework

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Abstract

The resurgence of urban manufacturing presents new opportunities for innovative governance and planning strategies, especially in fostering circular economy practices and localized resource flows. A key challenge, however, is how ecosystems of heterogeneous actors, including manufacturers, designers, waste managers, and residents, can effectively collaborate to advance circular production and consumption at the local level. Addressing this challenge requires a renewed approach to thinking about intermediation and ecosystem management in urban planning practice. This article proposes that new technology in the form of digital platforms offers a critical governance tool to facilitate and coordinate such complex ecosystems. Drawing on industrial management literature, particularly the concept of platform ecosystem orchestration, we develop a typology of orchestration strategies used by circular fashion platforms and analyze how each type coordinates participant interactions to support localized resource flows. Our focus is on the fashion and textile sectors, which present significant opportunities to keep clothes and textiles circulating at their highest value within the city's economy. Our analysis of circular fashion platforms identifies four main types of platform orchestration: marketplaces for residual textile exchange, supply chains for textile recycling, cross-sector networking, and supply chain data analytics. We examine the orchestration dimensions of platform orchestration, the varying degrees of localized interactions they generate, and opportunities to further enhance socio-spatial outcomes through platform orchestration. Overall, this exploratory study aims to foster future dialogues on the potential of digital platforms as governance tools for building sustainable and inclusive productive cities.

Keywords

circular economy; circular fashion; circular manufacturing; digital platform; ecosystem orchestration; productive city; urban manufacturing

1. Introduction

The pressing need to rethink the flow of resources in urban economies along more circular and regenerative lines has supported a renewed interest in the local manufacturing potential of cities (Acerbi & Taisch, 2020; Tsui et al., 2021). Following over half a century of hailing the birth of the post-industrial city, a more locally tailored manufacturing renaissance, spurred by technological advances and supported by mixed-use zoning, is now considered integral to urban planning and development that meet pressing sustainability and inclusion agendas (Ferm, 2023).

On an industrial management level, the implementation of the circular economy by manufacturing companies has taken shape in a variety of micro- and meso-level strategies (Lieder & Rashid, 2016). The former includes cleaner production, circular design practices, waste management, material and energy efficiency, and servitization; while the latter can be implemented through industrial symbiosis and closed-loop supply chains (Acerbi & Taisch, 2020). These strategies constitute what Acerbi and Taisch (2020, p. 11) term "circular manufacturing," defined as manufacturing strategies that aim to reduce resource consumption, extend resource lifecycle, and close resource loops. While the circular economy is an industrial system that operates at levels of micro (e.g., products, companies, and consumers), meso (eco-industrial parks), and macro (city, region, nation, and beyond; Kirchherr et al., 2017, p. 224), what we see is that circular manufacturing efforts tend to focus on company-level implementation, highlighting a greater potential for adoption at the meso or macro level (Acerbi & Taisch, 2020).

Yet a number of challenges remain when it comes to promoting circular manufacturing practices at the macro level, particularly in cities. For example, on a spatial level, research has evidenced growing "intra-industrial gentrification" that is driven by the limited supply of urban land and heightened demand for space, and results in emerging forms of competition and displacement that call into question the potential of cities to accommodate such a manufacturing renaissance altogether (Ferm, 2023, p. 266). This also presents specific challenges for locating "circular hubs" in urban settings (Tsui et al., 2024, p. 325), including access to resources, transportation networks, and labor availability.

In addressing these challenges and devising coordinated measures to support and strengthen local ecosystems towards sustainable and circular manufacturing, technologies are often considered central to efforts boosting the adoption of circular practices (Acerbi & Taisch, 2020). In particular, digital platforms and their ecosystem orchestration strategies are discussed in industrial management literature as fulfilling a crucial coordination and collective action role (Ritala, 2024; Sahamies & Welinder, 2025). Digital platforms offer a governance approach that facilitates information exchange, incentivizes participation, and ensures the efficient functioning of circular resource flows and network effects to create value (Blackburn et al., 2022; Ritala, 2024). Specifically, technologies can support information sharing and communication, which are often identified as barriers to the implementation of circular practices and the furthering of industrial symbiosis (Acerbi & Taisch, 2020; Halstenberg et al., 2017).

Although technologies such as digital platforms can help the adoption of circular practices and shape supportive ecosystems, their implications for urban planning and circular manufacturing governance remain underexplored. Building on Suwala et al. (2022), there is room to examine the role of space in industrial management. We propose that digital platforms can serve as a crucial governance tool for urban planning

practitioners, enabling them to orchestrate ecosystems of local producers and industry actors more effectively. By leveraging digital platforms, planners can facilitate collaboration among manufacturers, suppliers, and waste managers, ensuring that materials and products retain their highest value within the local economy.

The fashion and textile industry sectors offer a compelling case for studying how digital platform orchestration could facilitate local ecosystem development and localize resource flows in urban settings. Fashion production and consumption generate significant social and environmental impacts, including high waste levels, resource depletion, and carbon emissions (Kozlowski et al., 2012; Niinimäki et al., 2020). In response to these challenges, a growing movement is emerging to implement circular principles, reshore production, and develop short, local supply chains in fashion (Buchel et al., 2022). This study examines digital platforms designed to facilitate such a transition away from the dominant linear paradigm in the textile and fashion sectors. We ask: What typology of platform ecosystem orchestration best represents existing circular fashion platforms, and how does each type coordinate participant interactions to foster localized resource flows? With the start of this exploratory study, we aim to initiate both scholarly and practice-oriented dialogues on ways to integrate platform orchestration into urban planning for more productive cities and circular manufacturing practices.

2. Literature Review

2.1. From Urban Manufacturing to Circular Urban Manufacturing

Urban planning scholars have called for renewed attention to production within urban contexts, especially as manufacturing activities have been reshaped by technological advances. Industry 4.0 technologies, including cyber-physical systems, the Internet of Things, and smart factories powered by automation, 3D printing, and big data analytics, are driving the digitalization of manufacturing and blurring the line between production and knowledge-intensive services (Busch et al., 2021). At the same time, labor-intensive forms of "high-touch, low-tech" manufacturing, particularly in cultural sectors, still benefit from proximity to urban networks (Grodach & Martin, 2021; Lavanga, 2020). This resurgence of urban manufacturing supports diverse job opportunities and strengthens local economic resilience by reducing reliance on vulnerable global supply chains (Ferm, 2023). Aligned with the maker movement, it fosters flexible, market-responsive production that often integrates symbolic and aesthetic value, reinforcing the growth of cultural and creative industries (Grodach et al., 2017; Wolf-Powers et al., 2017). Urban manufacturing also supports knowledge-intensive and research and development (R&D) activities that thrive on spatial proximity to production (van Winden et al., 2010), while new spaces such as makerspaces and Fablabs promote inclusive, community-driven practices around making and consuming (Brandellero & Niutta, 2023).

In recent years, urban manufacturing has also been recognized as a promising strategy to support the circular economy transition agenda in cities, or circular cities (Lavanga & Drosner, 2020; Williams, 2019). In circular cities, localized resource and material flows are theorized to play a key role in preventing cities from remaining hotbeds of waste, virgin material consumption, and greenhouse gas emissions. For this, the implementation of circular manufacturing practices as highlighted by Acerbi and Taisch (2020) is crucial, including cleaner production, circular design practices, waste management, material and energy efficiency, servitization, and closed-loop supply chains. Tsui et al. (2021) identify that circular manufacturing in the urban setting can contribute to sourcing local waste or secondary raw materials for production and to

establishing localized supply chains for a local consumer base. In this way, circular urban manufacturing may not only minimize global supply chain risks but also reduce greenhouse gas emissions by shortening supply chains and time to product delivery (Tsui et al., 2021). Circular urban manufacturing is also posited to promote a culture of repair and upcycling, in which makerspaces play a role in enhancing urban citizens' participation in community activities in reuse, repair, and sharing (Coskun et al., 2022).

Supportive intermediaries play a crucial role in advancing circular manufacturing and localizing resource and material flows in cities (Tsui et al., 2021). While not grounded explicitly in the circular economy context, urban and regional scholars have examined how intermediaries more broadly help urban manufacturers connect with local stakeholders and navigate complex ecosystems. Clark (2014) identifies three types of regional intermediaries: supply chain, labor market, and innovation intermediaries. Supply chain intermediaries build networks among producers, designers, and innovators to embed manufacturing capacities locally. Labor market intermediaries coordinate among businesses, educational institutions, and governments to promote skill development through training and certification programs. Innovation intermediaries link firms with research centers, offering access to expertise and equipment to support collaborative R&D. Similarly, Wolf-Powers et al. (2017) highlight the role of maker-enabling entrepreneurs who provide services such as prototyping tools, affordable workspaces, business assistance, financing, and networking, often tailored to the specific challenges faced by urban manufacturers. Expanding these ideas, Lowe and Vinodrai (2020) introduce the concept of place-connecting intermediation, which links urban-based designers and makers with non-urban manufacturers. The Carolina Textile District, for instance, acts as a broker, trainer, and consultant to create localized, equitable, and sustainable value chains.

These studies collectively emphasize the importance of institutional intermediary actors in supporting manufacturing within place-based contexts, which is also crucial in supporting local circular manufacturing practices. Tsui et al. (2021) acknowledge that circular urban manufacturing faces challenges not only because of a lack of affordable industrial land and limited prioritization from investors, but also because of insufficient availability and accessibility of quality waste and secondary materials from local sources, as well as production networks to process these materials. In other words, despite the importance of circular manufacturing in supporting the transition towards circular cities, the challenge emphasized by Clark (2014, p. 437) still stands, which is that it is about "how to re-connect and re-create supply networks after decades of seemingly de-territorialized production systems." We propose that digital platforms represent a novel form of intermediation capable of addressing these challenges and advancing circular urban manufacturing. Bringing digital platforms into focus also expands the discussion of urban planning and intermediation in the context of circular transitions. Specifically, urban planners could use platform-based tools to intermediate, or orchestrate, circular manufacturing activities and ecosystems, drawing on insights from platform ecosystem orchestration developed in industrial management studies. To explore the core components of such digital platforms, we now turn to the concept of platform ecosystem orchestration.

2.2. Platform Ecosystem Orchestration for the Circular Economy

The transition to a circular economy in cities requires an ecosystem perspective, which brings to the forefront the importance of loosely coupled interdependencies among actors, technologies, and institutions, coordinated through shared goals, values, and affiliation (Aarikka-Stenroos et al., 2021; Jacobides et al., 2018). However, ecosystems do not emerge in a vacuum; they often require an orchestrator to establish the

conditions under which collaboration can take place. Increasingly, digital platforms have gained attention as tools for such orchestration, enabling connections among diverse actors and supporting the transition toward a circular economy. In particular, in business-to-business applications, platforms move away from having hierarchical control toward enabling participant engagement and managing relationships, which requires balancing control with the encouragement of contributions (Grabher & van Tuijl, 2020). In this role, platforms help establish what Ritala (2024, p. 169) describes as platform ecosystems or "communities and groups of actors in different markets orchestrated via a digital platform" and that are an effective organizing form in addressing complex societal and ecological challenges.

In relation to circular economy, scholars have studied digital platforms through various lenses, such as circular business models for start-ups (Henry et al., 2020), business-to-business applications that facilitate industrial symbiosis and material exchange (Krom et al., 2022; Ritala & Jovanovic, 2024), and even as tools that enable non-commercial exchange of goods among local residents in everyday life (Korsunova et al., 2025). In particular, industrial management research has explored the specific mechanisms through which digital platforms orchestrate ecosystems to promote circular resource flows and waste recovery (Blackburn et al., 2022; Ciulli et al., 2020; Sahamies & Welinder, 2025). In this framework, digital platforms contribute by shaping three key organizing dimensions to address grand challenges effectively (Ritala, 2024).

The first organizing dimension is coordinating structures. As Ritala (2024) explains, the first organizing dimension of platform ecosystem orchestration involves establishing coordinating structures. These structures provide shared principles, rules, and technologies that define the platform's participatory architecture. This architecture facilitates the matching and brokering of inputs, such as resources and activities contributed by participants. Through the platform's coordinating structures, orchestrators must ensure that participants' contributions align with the platform's overall value proposition.

In the context of digital platforms in a circular economy, as Blackburn et al. (2022) argue, these platforms promote circular value creation by structuring interactions among actors, their resources, and their activities. Circular value creation is defined as "an effort to simultaneously address economic and circularity objectives for a firm" (Blackburn et al., 2022, p. 254). Platform ecosystem orchestrators develop a user-friendly platform architecture capable of automating the exchange of circular resources such as residual materials, waste, or unused assets (Blackburn et al., 2022; Ciulli et al., 2020; Sahamies & Welinder, 2025). This structure enables transactions for resources that have limited or no supply and demand in traditional linear markets, fostering new value flows through platform participation. To further realize circular value creation, orchestrators also establish platform-specific rules and identities that encourage participants to engage in making connections with other platform participants (Blackburn et al., 2022).

Collective action, the second key aspect of platform ecosystem orchestration, involves fostering collective action to support circular value creation (Ritala, 2024). Orchestrators establish platform-specific rules and shared identities that encourage participants to connect, align around common goals, and engage in joint activities (Blackburn et al., 2022; Ritala, 2024). To enable network effects, orchestrators attract new participants by presenting compelling business cases (e.g., improved resource efficiency) and lowering entry barriers through marketing, training, and support initiatives (Blackburn et al., 2022). Growing participation in the platform increases the availability and diversity of circular resources, enhancing value for all users (Cennamo, 2021; Ritala, 2024). With more users joining, the utility of the platform for each participant

increases, as both supply and demand for circular resources grow, reinforcing the platform's capacity to generate circular value (Ciulli et al., 2020; Sahamies & Welinder, 2025), thus driving a virtuous cycle of network effects (Rochet & Tirole, 2003).

Generativity, the third organizing dimension of platform ecosystem orchestration, refers to the platform's potential to inspire creativity and new contributions of participants, without direct intervention (Ritala, 2024). By encouraging participants to experiment, collaborate, and share knowledge, orchestrators are able to build a repository of shared solutions and experimental practices. In the context of digital platforms in a circular economy, generating actionable insights on resource traceability or environmental performance metrics can empower participants to assess and enhance their circularity efforts independently (Blackburn et al., 2022; Ciulli et al., 2020; Sahamies & Welinder, 2025). This accumulated data in the platform ecosystem fosters a self-sustaining cycle of learning, experimentation, and improvement, further advancing the platform's circular value creation.

As advanced in industrial management literature, digital platform ecosystem orchestration focuses on establishing the platform coordinating structures, collective action and network effects, and generativity potential for continuous experimentation and innovation among platform participants. However, for these organizing dimensions to have relevance to urban planning practices, there is room to further explore the potential for digital platforms to serve as effective orchestrators of localized circular practices, thereby supporting diverse actors, including urban manufacturers, and promoting the transition toward circular cities. As Barns (2019) observes, digital platforms shape the socio-spatial experiences of everyday life through intentional design strategies that foster highly interactive and participatory ecosystems. At the same time, Ricart et al. (2020) caution that digital platforms in cities must adopt governance approaches that engage diverse stakeholders and present an inclusive value proposition to minimize resistance. This inclusivity, which emphasizes joint creation and continual updating of value, is essential for platforms to generate positive impacts in urban settings (Carrasco-Farré et al., 2022). In planning circular activities within the textile and fashion sectors, it is particularly important to consider the socio-spatial relationships that platforms could help foster.

2.3. Circular Urban Manufacturing for the Fashion Industry

Today's fashion industry provides valuable insights into sustainability challenges, largely driven by the fast fashion paradigm, which has normalized a linear take-make-waste model that encourages both overproduction and overconsumption of textiles and garments (Bhardwaj & Fairhurst, 2010; de Koning et al., 2024). As supply chains have globalized and grown more complex to minimize production costs, the ecological and social burdens of fashion supply chain activities disproportionately affect countries in the Global South, where production has been outsourced (Niinimäki et al., 2020; Pugh et al., 2024). Meanwhile, cities in the Global North, once vibrant centers of garment production in the 19th century, have experienced deindustrialization and become hubs of fashion consumption (Wubs et al., 2020), lacking the infrastructure and skills needed to reuse, repair, or recycle clothing (Vladimirova et al., 2024).

Against this backdrop, current discourse on circular fashion seeks to replace the linear industrial model with a circular one, where "clothes, textiles, and fibers are kept at their highest value during use and re-enter the economy afterwards, never ending up as waste" (Ellen MacArthur Foundation, 2017, p. 22). Aligned with this

effort, there is a growing push to shorten fashion supply chains and localize resource flows, emphasizing the need for supportive intermediation to connect makers and producers operating near cities and regions (Kim, 2024). Intermediaries in the fashion and textile industry have a key role in strengthening the connections among different actors in the value chain (Lavanga, 2018), and their role in accelerating the sustainability transition is increasing. Studies by Norris (2019) and Real et al. (2020) highlight cases in Bristol, UK, and the Nouvelle-Aquitaine region in France, where local makers, designers, fiber producers, and educators collaborate in shared workspaces to create localized textile flows. Scholars such as Smith et al. (2017) discuss the role of local production and makerspaces in experimenting and developing new design strategies on material recovery, repair, and reuse. Similarly, industrial districts or eco-industrial parks promote recycling innovation by connecting collectors, suppliers, and recyclers (Bressanelli et al., 2022; Huang et al., 2021).

Despite these growing efforts, short, localized supply chains and resource flows in fashion remain as niches (Buchel et al., 2022). Echoing the broader challenges faced by circular urban manufacturers (Tsui et al., 2021), establishments in fashion production, upcycling, and recycling need accessible urban space to facilitate sourcing, production, storage, and other logistics matters (Kim, 2024; Williams, 2020). Studies also point to the absence of a systematized information network for tracking secondary textile materials by location, quantity, and composition (Han et al., 2017; Singh et al., 2019). Furthermore, effective circular supply chains in fashion depend on trust-building, shared commitments, and cross-sector collaboration, including between seemingly unrelated fields such as fashion design and secondhand sorting (Karell & Niinimäki, 2019; Kazancoglu et al., 2020).

In the following analysis, we examine digital platforms that support circular fashion practices in production and identify a typology of platform ecosystem orchestration that best represents these platforms. We then explore how each type coordinates participant interactions through the dimensions of platform ecosystem orchestration, as summarized in Table 1. Additionally, we assess whether these orchestration strategies integrate socio-spatial considerations to facilitate localized resource flows and networking among local producers and related actors. By analyzing how orchestration is implemented across existing platforms along these organizing dimensions, we suggest that urban planning practitioners can gain insights into the types of digital tools and mechanisms they could employ when planning circular fashion initiatives in urban contexts.

Table 1. Analytical framework on platform ecosystem orchestration mechanisms with socio-spatial considerations.

Platform dimension	Orchestration mechanisms
Coordinating structure	Design a platform with participatory architecture and features that enable platform users to contribute and interact
	Facilitate and, where possible, automate matching and brokering of inputs such as resources, skills, and activities
Circular value creation	Articulate the platform's value proposition around circular economy objectives
Collective action	Frame a shared objective or goal around circular value creation that motivates participant contribution
	Enable network effects by attracting new participants and incentivizing engagement
Generativity potential	Foster continuous experimentation and knowledge sharing among platform participants
	Provide environmental performance metrics, resource traceability tools, and a repository of circular practices

Table 1. (Cont.) Analytical framework on platform ecosystem orchestration mechanisms with socio-spatial considerations.

Platform dimension	Orchestration mechanisms
Socio-spatial consideration	Design a platform participatory architecture that specifies the geographic distribution of participants
	Enable matching and brokering of inputs within geographic boundaries
	Promote value creation with positive socio-spatial impact
	Support tailored skill development and capacity-building initiatives

Note: This table is adapted and extended from Ritala (2024).

3. Method

To develop a typology of platform ecosystem orchestration that best represents circular fashion platforms, we first compiled a list of existing platforms operating with the goal of advancing circular and sustainable practices in the fashion and textile sectors. Our initial dataset was built upon a list developed during a platform benchmarking exercise conducted by platform experts in the EU-funded project FABRIX, in which the authors participate. This list was assembled through desktop research conducted between July and August 2024 and supplemented by recommendations from experts and practitioners in the field. To expand our dataset, we incorporated additional platforms identified through participation in a circular textile fair in the Netherlands (September 2024) and an examination of ECOSYSTEX network members, a European community of practice for sustainable textile ecosystems. These efforts resulted in an initial list of 34 platforms.

To refine the list, each platform was systematically reviewed to assess its relevance and scope. Platforms were excluded if they lacked a specific focus on fashion, or more precisely on clothes and textiles, which are central to waste generation in the industry's linear take-make-waste paradigm (Ellen MacArthur Foundation, 2017), or if they operated broadly across multiple sectors. Another key criterion was the presence of multi-sided interactions, as these are essential for understanding how digital platforms orchestrate participant engagement and generate network effects. Following this refinement process, we identified 19 platforms, listed in Table 2. Our analytical framework, summarized in Table 1, allowed us to identify four main orchestration strategies used by circular fashion platforms and evaluate their role in shaping local circular economies and fostering sustainable production networks. For each platform, we conducted an in-depth analysis of its coordinating structures by examining types of participants involved, forms of circular value creation facilitated, network effects generated, generativity potential, assessing how platforms enable new interactions and collaborations within the circular fashion sector, and socio-spatial considerations, evaluating whether localized networking and resource flows were explicitly incorporated into platform orchestration strategies. We also examined how these dimensions are operationalized through specific platform features, such as stakeholder directories, product lifecycle management (PLM), project collaboration dashboards, resource catalogues, business management tools, spatial relation visualizations, or sustainability assessment tools. We organized this data in a spreadsheet and grouped platforms according to recurring patterns across these dimensions. This thematic grouping formed the basis for identifying four distinct types of orchestration, each reflecting the platform feature that serves as its primary component. Accordingly, this study employs an exploratory research approach, focusing on aggregating, categorizing, and analyzing the structural and functional characteristics of existing digital platforms in this domain.

Table 2. List of selected circular fashion platforms.

Type	Platform name	Governing body	Link
Marketplace	The Fabric Connector	Private organization	https://fabric-connector.com
Marketplace	Aloqua	Private organization	https://www.aloqia.com
Supply chain for recycling	Cibutex Exchange	Nonprofit organization (by Cibutex cooperative)	https://cibutexchange.com
Supply chain for recycling	Refashion	Nonprofit organization (producer responsibility organization)	http://refashion.fr
Networking	Common Objective	Private organization (under Ethical Fashion Group Ltd.)	https://www.commonobjective.co
Networking	Ellie Connect	Private organization (under Ariadne Innovation)	https://ellieconnect.com
Networking	Maker's Row	Private organization	https://makersrow.com
Networking	Manufy	Private organization	http://manufy.com
Networking	RegioGreenTex	EU-funded project	https://www.regiogreentex.eu/dashboards/home
Networking (PLM)	Circular.fashion	Private organization	https://circular.fashion
Networking (PLM)	Delogue	Private organization	https://www.delogue.com
Networking (PLM)	Foursource	Private organization	https://foursource.com
Networking (PLM)	Sqetch	Private organization	https://sqetch.co
Networking (PLM)	Supply Compass	Private organization	https://supplycompass.com
Data analytics	Circulareconomy.earth	Part of a project of an independent policy institute (British think tank Royal Institute of International Affairs, also known as Chatham House)	https://circulareconomy.earth/trade
Data analytics	Import Yeti	Private organization	https://www.importyeti.com
Data analytics	Open Supply Hub	Non-profit organization	https://opensupplyhub.org
Data analytics	Supply Trace	Research project at Northeastern University (multi-stakeholder advisory board)	https://supplytrace.org
Data analytics	Tex.tracer	Private organization	https://www.tex-tracer.com/solutions/brands-retailers

4. Findings

4.1. Market Orchestration Enabling Deadstock Material Transactions

Our exploratory analysis of circular fashion platforms highlights four main types of platform ecosystem orchestration. The first is market orchestration, which focuses on establishing a coordinating structure that enables platforms to function as marketplaces for the exchange of surplus or deadstock textile material. Digital platforms that enable transactions of excess resources are common in circular economy business

models (Blackburn et al., 2022; Ciulli et al., 2020). Through its coordinating structure, platforms support the matchmaking process between suppliers such as manufacturers with surplus textile inventory, and buyers such as designers and brands seeking materials for reuse. These platforms design features around material directories with customizable search filters on price, dimensions, material type, fiber type, color, and patterns, and standardized order submission pages. By defining the rules of engagement and material transaction processes, these platforms help overcome common frictions in textile reuse, such as heterogeneous material quality, lack of standardized inventory data, and fragmented market access (Kazancoglu et al., 2020).

As a result, market orchestration platforms that facilitate excess textile transactions contribute to circular value creation by enhancing resource reuse and reducing reliance on virgin material production. In this context, collective action involves instigating and sustaining transactional engagement among participants to realize these circular outcomes. For example, Aloquia emphasizes that both suppliers seeking to offload their surplus inventory and buyers searching for excess materials derive mutual benefit by participating on the platform. The effectiveness of these platforms is amplified by network effects. As more suppliers list surplus materials, the marketplace becomes increasingly attractive to buyers, and vice versa, creating a self-reinforcing cycle of participation.

To further incentivize the generativity potential of platform participants, market orchestrators offer additional features and tools. For instance, Aloquia provides impact reports that quantify and communicate the environmental benefits of inventory utilization for platform participants, reinforcing value creation beyond simple transactions. Similarly, Fabric Connector curates web pages to educate participants on circular economy practices and provides assessment questions for marketplace participants to evaluate the circularity of their material sourcing practices.

In terms of socio-spatial aspects, market orchestrating platforms facilitate textile transactions across multiple spatial scales, maximizing the reach of supply and demand. The global scale of transactions enables deadstock material valorization, which would be difficult for local sourcing alone to achieve. However, some platforms strategically promote regional exchanges of materials to align with sustainability objectives such as reducing transport-related emissions and supporting local suppliers. For instance, Fabric Connector collaborates with Manufy, a platform dedicated to sustainable textile and fashion manufacturing in Europe (categorized under networking orchestration), to encourage deadstock circulation within the EU. This illustrates how collaborations between digital platforms can enhance both market creation and circular economy outcomes at different spatial scales.

4.2. Supply Chain Orchestration Enabling Textile-To-Textile Recycling

The second type of platform ecosystem orchestration in a circular fashion enables textile-to-textile recycling. Similar to platforms that enable deadstock material transactions, the coordinating structure of platforms that facilitate recycling establishes an intermediary marketplace that connects the supply and demand for feedstock used in textile recycling. However, these platforms operate within a more complex material flow structure, as recycling involves multiple stages, including collection, sorting, preprocessing, and recycling, each requiring specialized industrial actors and technological infrastructure. By coordinating these interactions, platform orchestration focuses on connecting and establishing supply chains that involve

participation of diverse actors such as brands, material suppliers, recycling solution providers, sorting centers, and industrial users of recycled materials. Cibutex Exchange, for instance, aims to bring together the supply, demand, and logistics of textile recycling by automating the process of aggregating textile volumes and directing them to recycling facilities. The matching of material types to suitable recycling technologies is particularly critical, as different fibers require different treatment methods (e.g., mechanical vs. chemical recycling; Sandvik & Stubbs, 2019).

Collective action in supply chain orchestration is actively promoted by launching collaborative projects and continuous innovation and experimentation among platform participants. Platforms such as Refashion actively support R&D by issuing calls for expressions of interest from sorting centers, preprocessing facilities, and recyclers to collaborate on pilot projects. Similarly, Cibutex Exchange organizes pilot projects to strengthen recycling supply chains and create markets for recycled products, such as its kitchen towel made from recycled textiles. The economic viability of these markets ensures network effects to take place, where the more recyclers, sorting facilities, and industrial buyers that participate in these platforms, the greater the economic viability of recycled material markets. This is especially important, yet challenging, given that many textile recycling markets remain underdeveloped or economically unattractive compared to conventional linear production models (Sandvik & Stubbs, 2019). As discarded textiles turn into feedstocks of value in markets, this in turn creates opportunities for generative potential in the form of continuous contribution and innovative adaptation of platform participants to experiment with new sorting techniques, fiber processing, and closed-loop recycling models.

In orchestrating supply chains for recycling, platforms also re-territorialize supply chain formation. For example, Refashion integrates mapping visualizations into its platform interface, encouraging the development of European-level recycling value chains. These visual tools help platform participants identify nearby sources of recyclable feedstocks and available processing infrastructure, promoting regionalized recycling loops that minimize carbon footprints. Given that recycling involves the shipment of materials at various processing stages, localized and shorter supply chains enhance overall sustainability and economic feasibility. Moreover, textile recycling initiatives align with extended producer responsibility policies, making a regional orchestration strategy more practical and legally relevant, particularly in the European context.

4.3. Network Orchestration Enabling Cross-Sector Collaboration

The third type of platform orchestration in a circular fashion focuses on facilitating networking and collaboration. If the focus of the previous orchestration types, that is, in textile reuse market and recycling supply chain orchestration, was primarily on facilitating market transactions and matching of supply and demand among textile industrial actors, networking-enabling platforms foster collaborations by connecting diverse stakeholders across and beyond the textile and fashion value chain. These platforms bring together actors from multiple sectors, including fashion, manufacturers, governments, research institutes, social enterprises, and circular economy solution providers. By expanding participation beyond traditional supply chain actors, these platforms help cultivate cross-sectoral partnerships, enabling systemic solutions that address the complexities of circular fashion transitions.

A subset of networking-enabling platforms includes PLM platforms, which primarily facilitate collaboration between brands and suppliers for production management, traceability, and compliance. Unlike platforms

that orchestrate broader cross-sectoral networking, PLM platforms typically focus on structured communication between brands and suppliers, which enables seamless coordination of production orders, design modifications, and material specifications. PLM platforms such as Delogue also integrate circular design guidelines and regulatory compliance tools, ensuring that supply chain interactions align specifically with sustainability mandates. Hence, while PLM platforms streamline supply chain management for fashion industry actors, broader networking platforms enable open-ended, cross-sector collaborations.

From a platform orchestration perspective, networking-enabling platforms structure interactions through customizable directories and matchmaking tools that facilitate strategic collaborations. The coordinating structure of these platforms prioritizes ease of navigation and visibility, for instance, by allowing participants to search for potential partners based on specific criteria such as sector and geographical location. Coordination can also help participants find solution providers for specific challenges. For example, on the Ellie Connect platform, participants can post challenges that specify the partners they are seeking. This approach fosters tailored project formation and collaboration among participants. Therefore, the coordinating structure of network orchestrating platforms is tightly linked to fostering collective action, as circular value creation centers around supporting collaboration opportunities and community making. Furthermore, as more participants join the platform, the network effects intensify, increasing the diversity of expertise and collaboration opportunities.

To amplify generativity potential, networking-enabling platform orchestrators provide curated content streams, including newsletters, reports, podcasts, and research briefings. These insights keep participants informed about emerging trends, new technologies, regulatory updates, and best practices, so that platform participants are able to continuously seek partnerships and collaboration opportunities in circular practices. Furthermore, by offering trend monitoring and regulatory intelligence, platforms help participants navigate the shifting landscape of circular economy regulations and market demands, increasing the strategic value of platform participation.

In terms of socio-spatial considerations, some network orchestrating platforms also strengthen local collaborations by encouraging geographic concentration of interconnected actors. For example, RegioGreenTex, in collaboration with Ellie Connect, promotes the development of textile recycling hubs where industry, research institutes, and governments collaborate. These orchestration strategies extend beyond digital matchmaking to active community-building, reinforcing place-based network effects.

4.4. Supply Chain Data Analytics Orchestration

The fourth type of digital platform orchestration in a circular fashion focuses on supply chain analytics and data management. These platforms play a crucial role in enhancing transparency, monitoring environmental and social impacts, and supporting evidence-based decision-making for circular economy transitions. By leveraging data analytics, life cycle assessments, and supply chain risk assessments, they provide actionable insights that help businesses, researchers, and policymakers address inefficiencies, risks, and sustainability challenges within textile and fashion supply chains.

From a platform orchestration perspective, the coordinating structure of data analytics platforms promotes collective data stewardship, allowing a broader range of participants, including researchers, civil society

organizations, and regulatory bodies, to contribute to and access supply chain datasets. These platforms improve accessibility of information on trade flows, labor conditions, and environmental footprints. A key objective is to enhance the completeness and reliability of global supply chain data, addressing the long-standing issue of opaque and fragmented supply chain visibility in the fashion industry, which is a key challenge in promoting circular and sustainable fashion practices (Kazancoglu et al., 2020). By fostering collective action on data-sharing practices, these platforms enable supply chain transparency and policy-oriented research, expanding their role beyond corporate sustainability reporting to public accountability and monitoring. As more platform participants share data, the network effects of these platforms grow, leading to more comprehensive, real-time, and granular insights into the global textile supply chains.

The generativity potential of these data analytics platforms is also amplified by supporting research and training initiatives to input and utilize platform data. To help a diverse range of participants use these data sets and insights to monitor and shape sustainable supply chains, platforms such as Open Supply Hub offer information sessions and knowledge-sharing tools tailored to their varied needs. Further refinement, precision, and verifiability of supply chain data strengthen trust among stakeholders and reduce information asymmetries. From a socio-spatial perspective, however, supply chain data analytics orchestration focuses on global datasets to enhance transparency across complex, transnational supply chains. What remains largely underdeveloped is the application of micro-level, bottom-up analytics that capture city—or even neighborhood-level resource flows and supply chain actors involved.

5. Discussion

Foregrounding the potential role of digital platforms in supporting circular manufacturing in cities and local regions, this study asked what typology of platform ecosystem orchestration best represents existing circular fashion platforms and how each type coordinates participant interactions to foster localized resource flows. As summarized in Table 3, our exploratory analysis identified four main types of digital platform orchestration: orchestration of residual material marketplaces, recycling supply chains, cross-sectoral networking, and supply chain data analytics. Each type establishes coordinating structures for platform participants to collectively contribute to circular value creation in a continuous and collaborative manner.

Our analysis also expands the platform ecosystem orchestration literature by emphasizing the spatial relationships that can be facilitated by the four types of circular fashion platform orchestration. This also responds to the call for more exploration of the role of space in management studies (Suwala et al., 2022). For platforms focused on circular textile market creation, coordinating structures can encourage participants to prioritize localized transactions. To support this, platform interfaces often feature customizable filtering tools and visual maps to help users identify potential partners by location. Additionally, these platforms collaborate with local-facing networking platforms to expand access for participants seeking localized partnerships. In turn, networking platforms aim to strengthen localized collaboration by fostering the development of local hubs and clusters for circular textile and fashion activities. For supply chain data analytics platforms, while global datasets enhance transparency in complex textile and fashion supply chains, incorporating micro-level, bottom-up analytics could strengthen the orchestration of localized resource management.

Table 3. Summary of findings on the typology of circular fashion platforms and their orchestration strategies.

	Market orchestration for textile reuse	Supply chain orchestration for textile recycling	Networks orchestration	Data analytics orchestration
Coordinating structure	Create a marketplace that enables the exchange of surplus textile materials between suppliers and buyers	Coordinate supply chain actors for the delivery of textile-to-textile recycling	Foster matchmaking across and beyond textile and fashion industry actors	Collective data stewardship by standardizing supply chain data and automated aggregation
Circular value creation	Enhance resource efficiency and reduce reliance on virgin material production	Create recycling supply chains and markets	Support collaborations and community making	Enhance transparency, completeness, and reliability of the global textile and garment supply chain data
Collective action	Instigate collective action by enrolling more suppliers and buyers to engage in excess resource exchange	Organize collaborative projects for recycling supply chain actors	Develop platform features to facilitate collaboration and project formation among participants and solution providers	Promote collective data stewardship by facilitating participant data contribution to generate more comprehensive and accurate insights into global textile and garment supply chains
Generativity potential	Develop tailored features and tools for participant engagement	Demonstrate and enhance the economic viability of recycled textile products for continuous contribution and innovation	Provide curated content streams on best practices, regulations, market trends, and challenge sharing to incentivize collaborations	Support research and training initiatives that utilize platform data
Socio-spatial considerations	Support localized transactions of materials by collaborating with local-facing platforms or network facilitators	Support localized supply chain formation by enhancing visibility of local recyclers, sorters, and processors	Promote matchmaking to strengthen local collaborations or the formation of local hubs	More granular insights and local-scale data collection are needed
Examples	Fabric Connector and Aloquia	Cibutex Exchange and Refashion	Ellie Connect, RegioGreenTex, Manufy, and PLM providers	Open Supply Hub and data analytics service providers

Therefore, while platform ecosystem orchestration literature has not explicitly addressed the socio-spatial relations that orchestration can incentivize, platform features and strategies can be designed to enhance the participation of local producers in circular practices, fostering ecosystems of localized circular fashion. More

importantly, as scholars such as Pauli et al. (2021) note, digital industrial platforms often struggle to develop effective strategies for attracting both supply and demand and generating network effects. In this context, fostering relational ties at the local scale may serve as a crucial starting point for collective action, with network effects gradually emerging as the platform's geographical reach expands.

Urban planning practitioners can contribute to locally grounded processes and advance their initiatives through the collective action these efforts enable. While planning and regional studies have emphasized the role of institutional intermediaries in supporting urban manufacturing and maker businesses, planners could also adopt platform-based tools to foster local ecosystems centered on circular value creation. This involves considering how different forms of platform orchestration structure participation, generate collective action, and support innovation in circular manufacturing. Planners might partner with platforms, often private organizations, as our analysis shows, and explore how such collaborations can help build the ecosystems local industries need for a circular transition. In doing so, planning's role could evolve from intermediation to orchestration of productive urban ecosystems through platform technologies.

Moreover, planning practitioners could enable platforms to address spatial inequalities or identify geographic areas where participation and visibility are low. In other words, the spatial relations orchestrated by digital platforms could lead to place-connecting strategies, as discussed by Lowe and Vinodrai (2020). Additionally, collective action and network effects could be fostered to create place-specific identity, transforming "sources of shared vulnerability into collective cross-regional identity" (Lowe & Vinodrai, 2020, p. 7). Furthermore, while platforms, particularly cross-sectoral networking platforms, provide industrial updates and learning materials for participants, an orchestration model akin to labor market intermediation, as identified by Clark (2014), has yet to emerge. As Lüthje (2019) observed in his study of platform-driven manufacturing in China's Taobao villages, the distribution-oriented platform model led by e-commerce giants, unlike more production-driven approaches, can contribute to greater fragmentation, informalization, and less innovative working conditions for supply chain actors. Planning practitioners could encourage platforms to integrate skill development and capacity-building features tailored to specific roles in a circular fashion. They could also include social enterprises as platform participants to offer training programs and develop curricula on circular fashion practices. Additionally, platforms could facilitate the matching of interns, trainees, or employees with circular fashion businesses.

Future research could further explore platform ecosystem orchestration strategies that promote local industrial activities and facilitate their transition to a circular economy. While our study focused on circular fashion platforms, other resource flows, such as food, construction materials, and plastics, also require the integration of circular economy principles in urban contexts. Platforms that enable localized and shortened supply chains in these sectors would deepen the socio-spatial implications of platform ecosystem orchestration.

Additionally, there is a need to examine the challenges platform orchestrators face in coordinating localized collective action. For instance, while network effects can drive platform growth, they may also require expanding participation beyond local contexts. Future research should investigate how orchestration strategies balance the benefits of scaling network effects against the risk of losing local focus. Beyond platform orchestrators, future studies could also explore challenges faced by platform participants, particularly urban manufacturers and other local producers such as makers. Understanding their experiences

with platform enrollment could reveal the need for capacity-building programs or training initiatives that support their participation.

Finally, while our study highlights the potential of digital platforms to create productive city ecosystems and generate positive socio-spatial effects, we acknowledge that negative consequences may also arise. Future research could examine potential exclusionary practices, unequal power dynamics in platform ecosystem orchestration, or the potential negative effects of algorithmic orchestration, and explore strategies to mitigate these risks.

6. Conclusion

This study examined how digital platforms orchestrate ecosystems in a circular fashion, identifying key typologies and their implications for urban planning and localized circular resource flows. By analyzing the key dimensions of platform ecosystem orchestration strategies, we highlighted the role of platforms in facilitating marketplaces, recycling supply chains, cross-sectoral networking, and data-driven supply chain monitoring. In doing so, we emphasized the spatial dynamics that accompany platform orchestration, suggesting that platforms not only streamline resource exchanges and production processes but also shape socio-spatial relations that influence localized dynamics in circular fashion.

For circular manufacturing to thrive in cities and contribute to their circular transitions, the varying degrees of localized interactions generated by platform orchestration can be leveraged. However, there is still room for improvement. As noted, micro-level, place-based supply chain data captured through supply chain data analytics platforms could provide urban planners with insights into where and how circular industrial activities are taking place, as well as spatial inequalities in participation in circular transitions. Furthermore, while some platforms facilitating marketplaces, recycling supply chains, and networking have developed features and partnerships to encourage localized interactions, these efforts often operate at the broader regional scale (e.g., the EU). Hence, further research and development can be made to explore how these types of platform orchestration might also activate more spatially proximate connections, potentially within cities or even neighborhoods. Additionally, our study identified the underdeveloped role of platforms in workforce development and skill-building. Expanding platform functions to include digital training programs, workforce matching, and capacity-building initiatives tailored for local manufacturers and makers would enhance the inclusivity and accessibility of platform ecosystems.

Overall, this study underscores the new opportunities that platform-based coordination presents for urban planners to actively orchestrate productive city ecosystems that support circular manufacturing. However, more importantly, we stress the need for intentional governance, equity-driven strategies for local industrial participants, and spatially nuanced orchestration. We hope that this exploratory study encourages further interdisciplinary research bridging urban planning, digital platform studies, and industrial management to ensure that these tools foster truly inclusive and sustainable circular transitions in cities and regions.

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Conflict of Interests

The authors declare no conflict of interests.

Data Availability

All data generated or analyzed during this study are included in this published article.

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Multiple Geographies of Commons-Based Peer Production

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Abstract

This article engages from a geographical perspective with commons-based peer production (CBPP), an emerging socio-economic activity based on sharing resources and outputs among individuals who collaborate in a non-hierarchical manner. CBPP was initially used to describe the intangible production of knowledge and information through online cooperation. More recently, this practice grew to include other sectors of production, like hardware development, manufacturing, or agriculture, and has spread in various geographical settings, connecting Global North and Global South, rural and urban places, and digital and physical collaborations. The combination of intangible and tangible production has been described through the concept of cosmolocalism and the principle of "design global, manufacture local," and has been analyzed through practices observed in communal spaces, like makerspaces. While CBPP has been discussed as a more sustainable and convivial mode of production in social science literature, the phenomenon remains under-researched from a geographical perspective. This article aims to contribute to the CBPP literature and current geographical debates by exploring this emerging activity from a geographical lens. By using "multiple geographies" as a methodological tool, we argue that geographical approaches can help CBPP engage more with the materiality of production, as well as identify, problematize, and potentially address power relations on multiple scales. Likewise, the CBPP literature can contribute to geographical literature that is concerned about practices for more liveable worlds.

Keywords

commons-based peer production; cosmolocalism; local manufacturing; multiple geographies

1. Introduction

This article addresses the emerging and growing phenomenon of commons-based peer production (CBPP). The development of the digital economy, initially with projects related to open-source software and collaborative content creation such as Wikipedia, Linux, or LibreOffice, allowed some of the most prominent examples of this new economic activity to emerge. CBPP is "based on sharing resources and outputs among widely distributed, loosely connected individuals who cooperate with each other without relying on either market signals or managerial commands" (Benkler, 2006, p. 60). This mode of production and valuation is considered to deviate from the current hegemonic mode of production and to demonstrate a new trajectory for economy and society (Bauwens et al., 2019) beyond the dichotomy of state and market. In recent decades, CBPP activities were catalyzed by the technological progress that made it possible for large networks to innovate and produce in a decentralized, collaborative way. Gradually, CBPP grew to include other sectors of production, like hardware development, manufacturing, and agriculture. CBPP seems to have the potential to radically transform our understanding of economy and economic relations, and shift our perceptions of value, motivation, and collaboration, leading to new perspectives within geographical literature, as well as spatial planning and policy making.

The CBPP literature has been growing in recent years, drawing interest from various disciplines, like organizational studies, economics, legal studies, and others. Nevertheless, it has gone almost unnoticed in the field of human geography, with only a few exceptions (see, for example, Gerhardt, 2019). We argue that in the light of the social, environmental, and economic problems related to how global production is currently organized (Brand & Wissen, 2021), the search for alternative modes of living, working, and producing together (and in relation to nature) is urgent, and these are actually being practiced more than one would expect. CBPP exemplifies a radically different understanding of economy, and its exploration by human geography is needed to both understand this emerging phenomenon and question to what extent it contributes to more just economic, social, and environmental futures. More specifically, we argue that rethinking CBPP from a geographical lens would benefit both discourses on alternative local futures from geography and on alternative economies from commons-perspectives. The CBPP literature can contribute to geographical literature that conceptualizes practices that can support more liveable worlds. In parallel, geographical approaches can help CBPP engage more with the multi-sited materiality of production as well as further identify, problematize, and potentially address power relations and knowledge dynamics on multiple scales.

This article aims to contribute to this mutual benefit, by (a) providing a glimpse of the literature of CBPP and underlying research gaps that a geographical analysis would potentially address; (b) connecting the main ideas and practices of CBPP with theories and concepts coming from human and economic geography, especially a "multiple geographies" perspective (Liodaki et al., 2024); and (c) presenting some initial lines of thought that come from the combination of those literatures and could potentially lead to pioneering future research. Overall, we argue that a spatial perspective is promising as digital and physical nodes of CBPP are interlinked through concrete places and communities (Schulz et al., 2020, p. 20). More specifically, by coupling the CBPP literature and practice with concerns derived from a "multiple geographies" perspective and the relevant strains of literature, we outline a framework for future research on CBPP that can shed more light on the spatiality and materiality of its relevant practices, its potential to strengthen place-based developmental logics, and its expansion to include more reproductive activities. This framework, although

not strictly bounded, contributes to the CBPP literature by highlighting trajectories for more just and sustainable developmental futures.

The remainder of this article is structured as follows. In Section 2, we present a non-exhaustive literature review on CBPP and related concepts that are important for a geographical perspective on it. In Section 3, we briefly present the multiple geographies perspective and show how we use it as a methodological tool to rethink CBPP from a geographical perspective. In Section 4, we present our main strains of thought as a result of the combination of CBPP and geographical literatures, using concepts and theories as well as secondary literature on prominent and concrete cases of CBPP practice. Finally, in Section 5, we discuss some main contributions and conclusions.

2. CBPP: A Critical Literature Review

The purpose of this section is not to provide a systematic literature review that maps the entire field of research on CBPP (for this, see Bollier & Helfrich, 2012, 2015; Broumas, 2017; Kostakis et al., 2021; Morell et al., 2016; Papadimitropoulos, 2020) but instead to identify some of the most significant issues in the field. This section draws on key strands of the existing literature to highlight issues related to the diverse geographies of socio-economic practices within this field. These issues will be coupled with a "multiple geographies" perspective to explore the complex interrelations between the material and immaterial spatialities of CBPP, and the power relations that unfold across various scales—global and local, rural and urban, central and peripheral, digital and physical—in the sections that follow. This section specifically aims to identify core features of CBPP and assist geographers in understanding its spatial dynamics. It puts forth a reconceptualization of key terms such as innovation, the commons, and both material and immaterial production. In doing so, we contrast mainstream approaches to innovation with the notion of convivial innovation (Robra et al., 2023) as expressed in the economic and social practices of user communities engaged in commons-oriented production. Finally, we illustrate how convivial innovation is embodied in the framework of cosmolocalism, which links material and immaterial production through digital commons, 3D printing technologies, open-source hardware, computer numerical control (CNC) machines, and other shared technologies. These tools are typically utilized in open co-working spaces such as Fab Labs and makerspaces, fostering diverse economies driven by open innovation communities.

2.1. Rethinking Innovation Beyond Organizational Boundaries

To present the main ideas around CBPP, we take the concept of innovation as a starting point. This concept has most often been related to the work of Schumpeter (1934), who conceived of it as the motor of capitalism. Innovation is a dynamic process of "creative destruction" driven by technological change and competition among entrepreneurs and firms, leading to business cycles that help capitalism to progress to the next evolutionary stage. Schumpeter (1934, p. 65) placed producers (entrepreneurs and firms) at the center of innovation, enabled by intellectual property rights, centralized product design, and technologies of mass production. Until the late 1980s, much innovation-related research was similarly based on firms as the central unit of analysis, in which new economic ideas and knowledge were to be created. Since then, many scholars and practitioners have acknowledged influences from external sources, exploring innovation that does not necessarily develop through the closed model of the enterprise innovating within its R&D department.

Moreover, recent decades have witnessed a paradigm shift in market economies, driven mainly by low-cost information and communication technologies (ICTs), leading to effects such as cost reduction, decentralization, modularity, and openness (Bauwens et al., 2019). This shift is coupled with sustainability transitions (Markard et al., 2012; Ostrom, 1990) and the rise of the prosumer (Toffler, 1980) that have disrupted centralized capitalist production by introducing peer production as an alternative organizational model anchored in the decentralized collaboration of peers on the internet and beyond. In organizational studies, we can see differences between the "private investment" model of innovation, that assumes returns on investment in the production of private goods protected by intellectual property rights, and the "collective action" model that assumes the collaboration of innovators to produce a public good in cases of market failure (Benkler, 2006; von Hippel & von Krogh, 2003). Several authors (Bauwens et al., 2019; Benkler, 2006; von Hippel & von Krogh, 2003) have described a hybrid model of peer production that combines elements of the private investment model and the collective action model, as evidenced in the cases of Google, IBM, and Microsoft heavily investing in open-source software production.

The literature (Bauwens et al., 2019; Morell & Espelt, 2018; Scholz, 2016; von Hippel & von Krogh, 2003; Wolf & Troxler, 2016) has thus far documented two main streams of peer production: (a) firm-hosted peer production, related to the term "platform capitalism" (Srnicek, 2017); and (b) CBPP. Whereas firm-hosted peer production is grounded in a techno-deterministic, productivist, centralized, and profit-driven model of economic growth, enclosing and privatizing knowledge, CBPP promotes beyond-growth models of convivial innovation. The concept of conviviality (see Illich, 2001) has previously been used to describe the aspects of sustainable technology (Vetter, 2018) and innovation (Pansera & Fressoli, 2021). Post-growth models question the necessity of continued economic growth for prosperity, without directly signifying negative economic growth per se. Conviviality thus translates into use-value creation, openness, sharing, solidarity, cooperation, self-governance, equitable value distribution, and sustainability. CBPP introduces alternative forms of ownership and governance to promote sustainability and empower individuals and communities against pervasive economic inequalities and power asymmetries (Bauwens et al., 2019; Benkler, 2006; Scholz, 2016). While firm-hosted peer production is hierarchical, extractive, closed, and proprietary, CBPP is conceptualized as collaborative problem-solving rooted in openness, accessibility, and sharing cultures. These changes are increasingly reflected in enterprise practices, where firms adopt open innovation strategies and source knowledge from external actors—signaling a shift toward translocal collaboration over competition.

Moreover, the concept of open innovation has been applied to explore how peripheral regions might leverage translocal knowledge partnerships to sustain competitiveness in a global economy (Vonnahme & Lang, 2019, 2021). As Benkler (2017, p. 266) argues, innovation is inherently "a collective, not individual process"—one that "depends crucially on communication" and unfolds through social interaction, making it "sticky, local, and social." Despite the conceptual potential of the open innovation paradigm, much of the related geographical scholarship continues to frame collaborative practices narrowly within a firm-centric perspective. Methodologically, many studies still privilege the single enterprise, asking how firms can extract value from mass collaboration, rather than exploring how such collaboration might give rise to alternative, more equitable modes of economic organization. Collaboration is often instrumentalized to enhance firm competitiveness, rather than being seen as a foundational principle for reimagining the economy along more cooperative and distributive lines (Sattler, 2024). Furthermore, the concept of "open innovation" may obscure underlying asymmetries of power and value capture. As Rikap and Lundvall (2022) argue, the

current landscape increasingly reflects a form of "knowledge predation," where large technology corporations convert open knowledge sourcing into mechanisms for accumulating intellectual rents and consolidating monopolistic control.

2.2. Peer Production and the Commons

CBPP blends peer production with the concept of the commons. The commons refers to distributed or shared resources and infrastructures—such as natural resources, technology, knowledge, capital, and culture—self-governed by user communities according to shared rules or norms (Bollier & Helfrich, 2012; Ostrom, 1990). As such, commons are composed of bridging elements, like a shared resource, but also a community and a commoning activity (Bollier & Helfrich, 2015; De Angelis, 2017). Over recent decades, the concept has been widely applied across disciplines, including economics, political science, and geography. As Clement et al. (2019, p. 7) note, "early commons studies have explored the ability of communities to collectively manage natural resources in a sustainable manner." Ostrom's (1990) foundational work examined numerous successful examples of collective resource management—such as forests, fisheries, and irrigation systems—highlighting how communities address environmental scarcity and degradation while supporting local livelihoods (Clement et al., 2019). Scholars have increasingly focused on the social relations related to the commons, analyzing the networks and forms of governance of the commoners (Bollier & Helfrich, 2015; Federici, 2018) and underscoring their transformative political potential (Azzellini, 2018; De Angelis, 2017).

While Ostrom's work on the commons was initially intended to illustrate the self-governance of natural resources, Benkler also mobilized the concept to describe the self-governance of knowledge creation. The results of those activities are usually used according to an open-access logic: Products are common resources that favor reproducibility and derivativeness (Morell et al., 2016, p. 28). Like the innovation communities literature, CBPP embraces the predominance of social motivations rather than monetary incentives, but moreover recognizes the centrality of the commons rather than private property, and considers alternative organizational forms (networks, communities) as equally important and valid as the predominant centrality of firms in much economic theorizing (Benkler, 2017). In this line of thought, the commons often signify an alternative property rights structure, distinct from market-based systems, emphasizing decentralized governance, non-monetary motivations, and a hybrid form of organization between the state and the market (Benkler, 2017).

CBPP has been defined as "a new modality of organizing production: radically decentralized, collaborative, and nonproprietary; based on sharing resources and outputs among widely distributed, loosely connected individuals who cooperate with each other without relying on either market signals or managerial commands" (Benkler, 2006, p. 60). Over the past decades, largely unnoticed by the general public, this mode of knowledge creation and interconnected production has spread and thrived. As Benkler (2017, p. 267) further explains, "peer production combines three core characteristics: (a) decentralization of conception and execution of problems and solutions, (b) harnessing diverse motivations, and (c) separation of governance and management from property and contract." The practices of CBPP are carried out by individuals connected through peer-to-peer networks, operating outside the traditional hierarchical and contractual frameworks of the market.

Initially, CBPP emerged in the digital economy, exemplified by open-source software and collaborative platforms like Wikipedia, OpenStreetMap, Linux, and LibreOffice. Benkler specifically draws on the work of the sociologist Manuel Castells to connect the emergence of CBPP with the development of a networked information economy. The most prominent examples of CBPP have been information-sharing ventures, forms of online entrepreneurialism, and open-source activism. As Benkler argues, CBPP can flourish in a digital environment that has low costs of reproduction, decentralized human–computer interaction, and low communication costs (Papadimitropoulos, 2018, p. 840). Some scholars, however, argue that early CBPP scholarship focused too narrowly on digital commons and immaterial production, thus neglecting the material dimension of the commons (Papadimitropoulos, 2018). For CBPP to serve as a foundation for a broader economic model, it must also encompass material production. Therefore, it is an open question how "the immaterial production of the digital commons can replicate into material production" (Papadimitropoulos, 2018, p. 832).

2.3. Cosmolocalism, a Partner State, and Diverse Economies

The potential merge of the digital commons with material production aligns with Manzini's (2015) notion of "cosmopolitan localism" or "cosmolocalism," which advocates for locally grounded systems that remain intelligible and controllable by communities, while also drawing upon global flows of knowledge and innovation. Manzini envisions a distributed production paradigm where a network of interconnected local initiatives balances autonomy with interdependence. Within these networks, the exchange extends beyond technical knowledge to include cultural values and social practices. As such, the cosmolocal model promotes principles of open collaboration, ecological stewardship, and decentralized innovation, advancing CBPP as a framework for both sustainable production and democratic participation.

The monolithic emphasis on online services within open innovation communities and CBPP is increasingly being challenged by the concept of "design global, manufacture local." This approach bridges the gap between immaterial and material production in CBPP frameworks (Kostakis et al., 2016). It aligns with broader scholarly interest in collective and collaborative production and consumption practices (e.g., Buxbaum-Conradi, 2024, on the Fab City movement). The push to incorporate materiality is not merely theoretical; it also reflects practical trends in applying CBPP principles to domains such as wind turbine development and agricultural technologies (Robra et al., 2023). This shift toward a production-oriented model is sometimes discussed under the term "open production," signaling a broader scope than the traditional open-source software movement. As Kostakis et al. (2015) argue, commons-oriented communities ideally operate at the intersection of local embedding and global connectivity. Understanding the complex dynamics between globally distributed open design and locally embedded manufacturing is therefore essential to fully grasp the evolving landscape of CBPP.

Concerning this shift, scholars have emphasized the need to better understand the relationship between CBPP, the market, and the state, while much attention has been given to the political and legal dimensions of the commons. Kostakis and Bauwens (2014), for instance, propose a transition toward a peer-to-peer mode of production in which the state plays a proactive role by establishing foundational infrastructures to support this transformation. They advocate for a "partner state" that facilitates CBPP through public funding, legal frameworks, educational programs, and technological infrastructure. On the other hand, De Angelis (2017), while recognizing the potential for strategic collaboration with various actors, including the state,

when such engagement serves the broader goal of contributing to the commonwealth, envisions CBPP as part of a post-capitalist trajectory that seeks greater autonomy from both state and market institutions. Further, CBPP as an emerging mode of production can be understood through the lens of diverse economies. This approach reframes the economy not as a system limited to markets, commodities, and for-profit enterprises, but as a heterogeneous terrain composed of forms of labor (e.g., informal or unpaid work), enterprise (e.g., cooperatives, community businesses), property (e.g., commons), transactions (e.g., gifts), and finance (e.g., interest-free loans; Gibson-Graham & Dombroski, 2020). Crucially, the diverse economies framework recognizes that all wealth creation ultimately depends on the labor-mediated appropriation of nature to meet human needs, wants, and desires. It not only highlights the co-existence of a wide range of economic practices—formal and informal, paid and unpaid, capitalist and non-capitalist—but also offers analytical tools to explore how these practices interact and shape one another (Smith & Stenning, 2006). This multiplicity and "messiness" of economic interactions leads to what Naylor (2022) conceptualizes as "multiple developments," acknowledging that economic change does not follow a singular or linear path.

2.4. Open-Source Hardware, Makerspaces, and Material Production

In recent years, the scope of CBPP has expanded beyond the digital domain, increasingly encompassing physical production. The expiration of key 3D printing patents, coupled with advances in CNC machines, microprocessors, and sensors, has expanded the scope of open-source software into hardware. Following the copyleft logic of open-source software (Gay, 2002), open-source hardware production is built on the legal premise that designs, assembly instructions, and bills of material are made publicly available for anyone to study, replicate, modify, and sell, including the hardware created (Thomas, 2019, pp. 35–36). The term "hardware" applies to any type of tangible artifact, for instance, whether electronic, mechanical, or textile. Additive manufacturing technologies programmed with open code interconnect the production of intangible goods, such as designs, information, and knowledge, with tangible goods such as agricultural tools, windmills, and prosthetics (Bonvoisin et al., 2021). Arduino, for instance, applied open collaboration and shared knowledge principles to the development of physical hardware (Ramos, 2021). Other initiatives have emerged across sectors such as agriculture—e.g., Bioleft, the Open Source Seed Initiative, and L'Atelier Paysan—and manufacturing—e.g., OpenBike, Tzoumakers, Enspiral, and Las Indias. Some of these ventures reflect broader systemic efforts: The Open Source Pharma movement, for example, aims to transform drug discovery and development into a more collaborative, transparent, and socially oriented process. Its mission is to provide affordable, accessible medicines through commons-based innovation rather than profit-driven models.

A key aspect of tangible CBPP is the material space where collaborative production occurs. To support this, communities have established makerspaces—publicly accessible workshops equipped with digital fabrication tools like 3D printers and CNC machines. Makerspaces can potentially promote alternative economic models and foster community engagement (Liodaki, 2024a, 2024b; Simons et al., 2016). Rooted in CBPP principles, they emphasize shared resources, open access to tools and knowledge, and a "do-it-together" ethos that blurs the line between producer and consumer. By enabling encounters among people from diverse backgrounds, makerspaces become hubs of inclusion, sustainability, and creative autonomy (see also Moritz et al., 2024). They challenge traditional production models by democratizing access to industrial technologies, supporting global design and local manufacturing (Kostakis et al., 2015), and advancing sustainability through localized, collaborative innovation. Makerspaces variously aim to contribute to

ecological sustainability by reducing transportation and related carbon footprints, encouraging reuse, customization, and knowledge sharing, extending product lifespans, reducing waste, and supporting a circular economy overall. A sustainability index has already been developed in recent research, including a Digital Product Passport for hardware (Roio et al., 2024; Santander et al., 2020). However, while the marginal cost of producing one unit in software nears zero, hardware incurs multiple costs (materials, machines, personnel, overheads, physical space, energy). Open-source hardware production may also include long and often-intertwined supply chains and sophisticated product certification (Thomas, 2019, p. 105). Therefore, open-source hardware production is more costly and complex compared to open-source software production.

Beyond enabling sustainable and decentralized production, makerspaces have also emerged as educational hubs that promote lifelong learning and informal skill-building. Emphasizing knowledge as a shared resource, these spaces reflect CBPP principles by facilitating open access to tools and learning opportunities. Most are organized as associations or public entities with minimal profit orientation, allowing them to prioritize community access and collective ownership over revenue generation (Kurzeja et al., 2021). Their reliance on open-source software and hardware further supports inclusivity and aligns with CBPP's commitment to the free exchange of knowledge. As counterspaces to dominant, profit-driven production models, makerspaces foster environments that emphasize use value over exchange value, quality over quantity, and diversity over uniformity (Liodaki, 2024a; Nicolosi, 2020), while connecting with like-minded alternative initiatives at local and non-local levels (Liodaki & Stockdale, 2025). By supporting local, small-scale manufacturing, they aim to produce sustainable alternatives to mass production while embodying the collaborative ethos of CBPP.

The literature (Morell & Espelt, 2018; Thomas, 2019; Wolf & Troxler, 2016) has thus far documented a diversity of open-source hardware business models featuring a wide spectrum of value propositions, revenue streams, stakeholder interactions, incentives, and licenses. Stakeholders interacting with Fab Labs/makerspaces may include universities, students, firms, experts and freelancers. Incentives may vary considerably, from generating income or building human capital to the joy of participating in a common cause, altruism, peer-to-peer learning, sharing, socializing, and so on. Thomas (2019) has identified different logics for open-source hardware production, including the community level that corresponds to communities that manufacture products from the bottom-up (e.g., Farm Hack, L' Atelier Paysan), the inter-organizational level that corresponds to firms collaborating with communities (e.g., Renault, Volkswagen, Kreatize), and the ecosystem level that corresponds to all stakeholder interactions including the state, municipalities, universities, organizations, and start-ups. The Maker Movement has shifted from a DIY-bricolage phenomenon to a global ecosystem with thousands of spaces (Fab Labs, makerspaces, and open workshops) spread across more than 100 countries (Diez et al., 2018; R. Mies et al., 2024; Moritz et al., 2024).

Eventually, CBPP, both in its immaterial and material dimensions, provides unique opportunities for many-to-many innovation and the development of a more ethical, sustainable, and inclusive economy. At the same time, CBPP is rife with numerous tensions, contradictions, and obstacles, such as the "tragedy" of the (digital) commons (Hardin, 1968; Sharma, 2023), capitalist cooptation (Birkinbine, 2020; Kostakis & Bauwens, 2014), asymmetric competition versus incumbents, volunteerism and precariousness, hidden hierarchies and patriarchy, a lack of funding, a lack of sustainable business models, a lack of relevant cultural and institutional contexts, a lack of proper branding and marketing, a lack of well-designed incentive mechanisms and protective licenses, and so on (Papadimitropoulos, 2020, 2022). Given these complexities,

as well as the multiple potentials of CBPP and the implications this emerging mode of production may have in spatial planning and policy making, a more nuanced geographical perspective is needed to critically assess the strengths and limitations of CBPP and to explore its future potential.

3. A Geographical Perspective as a Methodological Tool

As stated in the introduction of this article, CBPP has so far not attracted much attention from geographers (cf. Gerhardt, 2019). However, geographers have a longstanding interest in researching alternatives to capitalist organizing and development from a spatial perspective. Following the non-exhaustive literature review above, in which we attempted to address some main topics regarding CBPP, we now outline our methodological insights in order to make a geographical perspective to CBPP fruitful. More specifically, in order to rethink CBPP from a geographical lens, we will further conceptualize it using the multiple geographies perspective (Liodaki et al., 2024). The term "multiple geographies" has gained increasing attention in recent decades. It reflects a growing recognition that space is not homogenous, bounded, or uniform, but encompasses multiple layers of meaning, power dynamics, and social constructions embedded in historically and geographically specific sociospatial and ecological configurations (Chhabria, 2019; Dionisio & Carr, 2022; Kabachnik et al., 2014; Papatzani et al., 2022; Toly et al., 2012; Van Sant et al., 2023). Recent research (Liodaki et al., 2024) shows that this approach is strongly embedded in ongoing debates within political, urban, postcolonial, and feminist geographies that aim to advance a radically different perception of the production of space. This perception may equip geographers to better understand how contemporary crises, such as rising economic and housing inequality, climate change, social injustices, neocolonial exploitation, and war, are deeply intertwined with sociospatial dynamics and manifest unevenly across different spatial contexts. This article is an attempt to use the theoretical underpinnings of "multiple geographies" as a methodological framework for further research, in order to deepen understandings of CBPP and highlight under-researched topics related to it.

More specifically, a multiple geographies theoretical approach follows a threefold conceptual underpinning: (a) paying attention to the multiple exclusions of the Global South (as key ventures and relationally connected sites) while bringing to light alternative visions of the world and subaltern practices that challenge the singularity of the one-truth Western narrative and embrace pluriversal thinking; (b) intersecting with theories of uneven geographical development and highlighting how spatially uneven processes give rise to a multiplicity of experiences or—in other instances—how the multiple geographies of specific processes result in spatially uneven outcomes; (c) engaging with feminist and intersectional literatures to demonstrate how various social groups and individuals, with diverse identities, navigate multiple socio-spatial exclusions and express a spectrum of experiences within space. Overall, following these three theoretical strains in human geography, without overlooking their overlaps and tensions, a multiple geographies approach: denotes plurality, illustrating the coexistence of diverse worlds; signifies unevenness, elucidating the power dynamics and conflicts among different places within economy; and connotes diversity, emphasizing the varied spatial experiences among different social groups and the emergence of counter-examples and counter-practices in the here and now.

A multiple geographies perspective can recalibrate the question of how to study the impacts of CBPP economic activities. We assume that CBPP has implications both on the local level of survival (e.g., for its contributors and their communities) as well as for a wide range of users, places, and communities. Given the

assumed, spatial non-boundedness of CBPP activity, it is mandatory to view this process as occurring unevenly throughout space, creating synergies, conflicts, and collaborations in a plethora of places. The proposed conceptual framework sees socioeconomic activity as a spectrum of diversity, and it allows us to ask which role "place" plays in CBPP-related practices. Overall, we assume that a reconceptualization of CBPP following a multiple geographies framework brings the question of space into the relevant discussions and sees CBPP practices as activities coexisting with a multitude of actors in a multitude of sites that affect their implementation. More specifically, in the following section, we attempt to rethink CBPP by analyzing it anew using literature from the three theoretical strains of human geography proposed in the "multiple geographies" theoretical framework: post-colonial, uneven development, and feminist geographical thought. We thus outline three subsections that aim to address some leading arguments that emerge from the relevant literature and CBPP scholarship and practice. Unraveling this geographical multiplicity of CBPP can contribute to a deeper understanding of this emerging phenomenon and its potential to transform the economic relations of our time, while opening up questions and directions for future research.

4. Three Insights for the Multiple Geographies of CBPP

In this section, we present our conceptual suggestions and avenues for future inquiry based on our effort to combine the insights from multiple geographies with CBPP. We highlight three insights from this engagement, shedding light on major geographical issues that emerge from the literature. More specifically, the three strains of geographical literature highlighted in the multiple geographies framework have unraveled some basic pathways for rethinking CBPP as a practice that can expand the relevant literature. In the three following sub-sections, we show how post-colonial, uneven development, and feminist geographical concerns can fuel CBPP thought and further deepen its endeavors, while renewing geographical thought with new empirical insights. These pathways, although inspired by empirical insights documented in the CBPP literature, illustrate potential directions for further research that can bridge the multiple geographies framework and CBPP practice.

4.1. Spatiality and Materiality of Production in CBPP

The first concern for a multiple geographies perspective on CBPP would be the issue of the underrepresentation of the Global South in CBPP-related research so far, despite recognition in the literature that the Global South has a paramount role to play. We start with the observation that most cases in the CBPP literature are derived from the Global North, with only a few cases emerging in the Global South, such as Bioleft, an open-source seeds initiative—similar to other initiatives in the Global North (Louwaars, 2019)—which collaboratively develops and distributes seeds within community networks in Latin America (Cremaschi & van Zwanenberg, 2020). Even within allegedly global initiatives such as Wikipedia, many groups and especially the Global South remain underrepresented (Graham et al., 2014). Despite the aspirations for global design and local manufacturing, it seems that within the documented and analyzed examples of CBPP, both design and manufacturing primarily take place in the Global North. One option, therefore, is to put more energy into identifying hitherto unknown or emerging instances of CBPP without problematizing its current conceptualization. This approach might bring similar ventures, such as Bioleft, to the fore.

In parallel, multiple developments across diverse places are also related to the spatiality and materiality of production that so far have not been sufficiently addressed in literature. Generally, we argue that CBPP can

benefit from a more geographically informed vision around the spatiality and materiality of both knowledge and physical production. CBPP literature has problematized the assumption that global knowledge flows can be understood as entirely immaterial, while only local manufacturing relates to material production. Instead, it recognizes that this understanding vastly underestimates the materiality of global knowledge flows and the digital economy in general (Kostakis et al., 2016). Nevertheless, issues of multiple developments are also related to the multiplicity of production places in "local manufacturing."

We will briefly illustrate our reasoning in relation to Arduino, an open-source venture whose main products are boards for electronic devices. Arduino has thrived on the contributions of a global community of enthusiasts, developers, and hobbyists (Pearce, 2012). While its knowledge dimension thus subscribes to the premises of global design, it is debatable whether its production can indeed be called "localized" and whether its effects on reproduction can also primarily be grasped at the local level. The majority of Arduino boards are assembled in Italy by Arduino's partner, Alba PCB Group. Only a small portion of boards are produced in makerspaces or other places. Wherever and however the boards are assembled "locally" (whether in a for-profit company or convivially in a makerspace), we want to emphasize that such boards transcend such local socio-material relations. A board can also be conceived as the sum of its constituent parts, embedded in specific labor processes and places elsewhere.

We know from other literature that electronic boards more generally rely on components sourced from various global locations, often with questionable labor conditions and social and environmental impacts (Clément et al., 2020; Moreau et al., 2021). Recent studies stress the importance of questioning where the metals and minerals for high-tech artefacts come from, and the implications for labor and the environment these have (Sovacool, 2019). Kostakis et al. (2023) propose a new category for technological artefacts that may offer more effective solutions, combining the low-tech—which tend to be cheap and easy to deploy—with the high-tech. They call this in-between zone "mid-tech," aiming to contribute to socio-technical imaginaries of the future and overcome the issues of geographical unevenness that arise from romanticizing high-tech solutions (Bihouix, 2020; Vetter, 2018).

Focusing on the spatiality and materiality of production, including its ramifications for people and planet, helps to address the variegated effects of CBPP on different places and communities. In the literature, we identify a debate around whether CBPP initiatives should be seen as embedded in the cycle of the market or the cycle of the commons (which is assumed to conflict with the market and capital). According to Bauwens in his interview with Gerhardt (2019, p.6), CBPP "has to be associated with value realisation and distribution. If you can't make a living and reproduce yourself, if you cannot produce the products and services needed for maintaining human communities, it is not yet a mode of production." An interesting concept that aims to resolve this tension is that of "transvestment," describing the process of taking funds from the cycle of the market and investing them into the cycle of the commons. To better understand the potential of transvestment, Bauwens himself suggests looking into geographical concepts, such as the new nomadism of the digital knowledge class. Future studies should look into the old and new supply chains and networks that manage to do more with less, following a cosmolocal model, which will be particularly relevant in the current polycrisis. However, it is also particularly insightful to rethink the spatiality of transvestments, exploring where the transvestments take place in particular and with what kind of effects.

4.2. Place and (Place-Based) Development in CBPP

We argue that the CBPP literature can benefit from a more fine-grained engagement with the concept of place, understood here as open to flows of ideas, beings, and objects (Massey, 1994), to assess its developmental implications. We assume that CBPP-induced activities have implications both on the local level of survival (e.g., for its contributors and their communities) as well as for a wide range of users, places, and communities. A geographically informed perspective can highlight nodes in the respective networks of CBPP ventures that are so far only partially illuminated, precisely because conventional economics—but also existing conceptualizations of CBPP—have rendered them outside the purview of "economic" analysis. This crucially relates to how the interplay of material and immaterial production affects not only the contributors themselves, but a wide range of relationally connected actors, ranging from suppliers, households, and nature as the basis of creating wealth, to broader communities of users, consumers, and prosumers.

Given the assumed spatial non-boundedness of the production activity, it is mandatory to view this process as occurring unevenly throughout space, creating synergies, conflicts, and collaborations in a plethora of places. A more geographically informed framework of CBPP sees economic activity in a spectrum of diversity and can potentially provide us with more insights about the motivations and collaborations of CBPP participants, the diversity of labor practices, the reasons people engage in CBPP projects without or beyond monetary motivations, and the role of the broader community in that process. Thus, it allows us to ask which role "place" plays in CBPP. Place is not peripheral to the discussion of what "surviving well together" entails, and how to satisfy social needs, but one of its preconditions. Place thus emerges as an alternative approach to tackle questions of survival and sustainability by weaving together prior forms of displacements, misplacements, replacements, and, analytically most important, emplacements (Barron et al., 2020). Emplacements here are understood as transformational processes through which survival can be re-organized to make places more survivable for the (more-than-human) communities that inhabit them. By positioning places center stage, CBPP can examine and tackle problematic and historically concrete forms of dis-, mis-, and replacements (of people, animals, plants, objects) that hinder the satisfaction of needs for current and future generations.

Moreover, as diverse economic practices interact with each other (Smith & Stenning, 2006), the CBPP literature could also shed more light on the variegated effects of its activities, e.g., if open-source hardware is assembled at a particular location, can we confine our analysis to the assembly place? Do we need to take into account the places in which sourcing of inputs occurs? How does CBPP affect places and cultures of consumption? Does interlinked re/production address problematic forms of dis- and misplacements in the respective nodes through forms of re- and emplacement, and if yes, how so? Such questions have the function of transcending a predominant and simplifying "universal development" versus "pluriversal alternatives to development" debate or ideal types of production modes such as "capitalist production" versus "commons-based peer production." The multiplicity and messiness of interacting economic practices can rather lead to a conceptualization of "multiple developments" (Naylor, 2022), potentially grounding CBPP more in its everyday messy entanglements in and between place, rather than as a normative foundation for an alternative mode of production. We draw on the emerging multiple geographies approach, also inspired by diverse economies thinking, because it allows us to better think through the multiplicity of economic activities and the multiplicity of places implicated in economic activities.

4.3. What "Production" in Commons-Based Peer Production?

Finally, we attempt to rethink the concept of "production" in CBPP. By referring to the multiple geographies literature, we highlight how the dominant conceptualizations of production erase under-the-radar and invisibilized economic practices. To further integrate them into an analysis of CBPP has the potential to enlarge the phenomenon and make more visible contributions by subaltern actors, including actors from the Global South. We argue that the CBPP literature can benefit from this more feminist and postcolonial way of conceptualizing production. This can make possible a more cosmopolitan perspective in knowledge production that not only includes cases from the Global South but also destabilizes potential productivist epistemologies in CBPP.

Feminist geographers who inspired the multiple geographies approach can help to articulate the need to rethink production. By challenging the prevalent technology-centered production-centrism based on goods and services, feminist scholars highlight the crucial role of social reproduction as the condition of possibility for production. Reproduction is typically associated with feminized labor (e.g., care and emotional labor sustaining social ties) as the precondition of both more "productive" labor (Federici, 2004) and the production of life (M. Mies, 2014). This way of conceptualizing production—by asking questions about labor—has only begun to emerge within CBPP literatures (Deka, 2021; Schneider, 2022; Toupin, 2021). Developing it further requires more theoretical and empirical efforts. We argue for the need to also challenge the clear-cut distinction between production on the one hand, and reproduction on the other. Only in a capitalocentric reading, in which capitalism defines what is "normal," is it possible to define "the household as the space of 'consumption' (of capitalist commodities) and of 'reproduction' (of the capitalist workforce) rather than as a space of noncapitalist production and consumption" (Gibson-Graham, 2006, p. 8).

The same is true for all kinds of subsistence economies that feminist scholars associate with the production—and continuous reproduction—of life (M. Mies, 2014; Salleh, 2010). Especially in the (semi-subsistence) agricultural realm, collaborative, commons-based practices are well attested to in the Global South (Berkes & Davidson-Hunt, 2010; Cima, 2020). Reproduction, therefore, often comes with "productive" connotations (although such use values might not be traded or consumed by others, much in line with how CBPP connects to debates of prosumption). Production, too, has clear references to reproduction: of capitalist class relations; of households, including children; of nature through the labor process (Foster, 2000). Therefore, we propose that a multiple geographies-informed research agenda might more readily circumscribe its phenomenon as commons-based peer re/production, in which the emphasis is expanded to grasp the substance of "re/production" through an investigation of labor.

This reconstructed framework of commons-based peer re/production comes with a twofold contribution to CBPP literature. First, it extends potential cases in the Global South and the Global North, in which a variety of commons-based re/production processes are occurring in the here and now, but perhaps not in areas such as open-source hardware (Toupin, 2021). So far, many CBPP-aligned practices have fallen under the radar due to (often implicit) ways of theorizing production as related to manufacturing goods and services, but not necessarily to the re/production of life. Second, through a problematization of the "labor" underpinning re/production, it becomes possible to ask critical questions regarding the working conditions of contributors to CBPP, which so far are poorly investigated (cf. Bauwens & Niaros, 2017, for an exception). This also includes examining the so-far invisibilized emotional and care activities within such communities.

We would explicitly add consideration of the wider households and communities that sustain them to the analysis of contributors' re/production. Contributors need time, energy, and support to participate in CBPP. What is the role of reproductive labor by others (household and beyond) in this? Especially for pivotal CBPP cases such as Linux, whose contributors are predominantly men (Grzegorzewska, 2021), such analyses are so far relatively absent. Conversely, there is an understanding why women are underrepresented, including "increased caring responsibilities, which often limit the time they can spend on other paid and unpaid activities, including getting involved in open source communities" (Grzegorzewska, 2021).

5. Discussion

This article explores the intersections between CBPP and geographical thought, emphasizing how a geographical lens can provide critical insights into fostering productive localisms. CBPP, with its emphasis on shared resources, decentralized production, and collaborative networks, offers an alternative to traditional, centralized economic models that prioritize global efficiency and private ownership over local resilience and equity. CBPP should be more closely researched in relation to space and planning, as it has the potential to foster local economic development, reduce reliance on long-distance supply chains, and promote environmentally sustainable practices by maximizing the use of local resources.

As illustrated in Figure 1, by engaging with a multiple geographies perspective, we have highlighted the potential of CBPP to challenge conventional dualisms such as global/local and central/peripheral, while

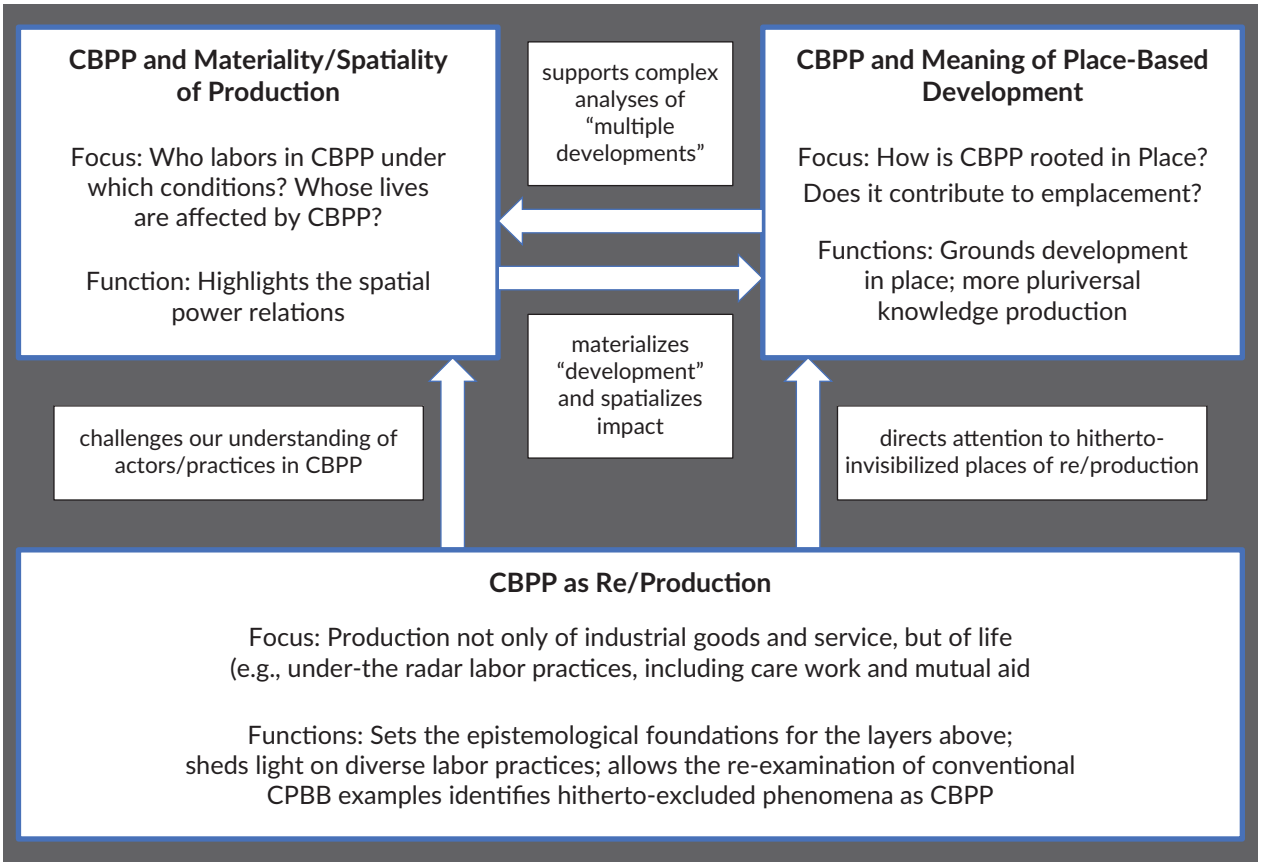

Figure 1. Rethinking CBPP through multiple geographies.

outlining pathways for further research. More specifically, issues raised by post-colonial geographies may shed light on the materiality and spatiality of CBPP; the geographical literature on uneven development leads us to concerns related to place-based developments; and feminist geographies can renew our understanding of what kind of production is highlighted in the CBPP literature. Of course, those strains of thought are not rigid and bounded, but overlap and connect to each other in diverse ways, leading us to some main concerns and pathways for future research on CBPP practice and outlining a renewed way to approach the phenomenon. A key point of this study is the recognition that while the digital realm facilitates global collaboration, the material conditions necessary for local manufacturing are unevenly distributed. Power relations, access to resources, and the materiality of production should be critically examined to ensure that CBPP does not inadvertently reproduce or exacerbate existing inequalities. The term "production" can be rethought from a feminist and post-colonial point of view to include invisibilized reproductive labor practices: emotional support and care work within CBPP communities, but also the supporting care work by households and/or other persons to sustain contributors' energy, time, and labor. A perspective informed by the insights of "multiple geographies" thinking moves beyond a simplistic localization of production and instead compels us to analyze how CBPP initiatives interact with place-specific socio-economic structures on multiple sites and scales. A critical engagement with power dynamics is essential to understanding how benefits and burdens are distributed within CBPP networks and how more marginalised communities, particularly in the Global South, can harness CBPP for socio-ecological reproduction and survival.

Given these insights, and without overlooking the previous efforts of CBPP scholars to touch upon the important issues we have presented in the previous section, this article shows that future research should shed more light on key areas. More specifically, comparative studies examining CBPP initiatives across different geographical contexts could offer valuable perspectives on the factors that contribute to their success and the challenges they face. These studies should investigate how CBPP ventures incorporate and value local knowledge, address power imbalances, and contribute to culturally revitalizing development pathways. Additionally, research on power dynamics within CBPP networks could illuminate the ways in which governance structures influence equity, particularly in relation to Global South–Global North relations and the rethinking of center–periphery dynamics. Another important area for future investigation is based on place-based (post-)development approaches that emphasize community-led initiatives experimenting with CBPP principles in locally grounded ways.

This study has certain limitations. First, the connections between CBPP and geographical literature are not exhaustive. Other overlaps could be highlighted between the two lines of thought, leading to other results. This article focuses on matters that are related to a "multiple geographies" perspective and thus leads us to specific claims regarding CBPP. Second, while it presents a conceptual engagement with CBPP and geographical thought, further empirical research is necessary to substantiate these theoretical claims. Future studies should focus on case-based and place-based (but not place-bound) analyses to better understand how CBPP operates in different geographical contexts. By doing so, scholars can provide deeper insights into the relationships between digital collaboration, material production, and socio-spatial inequalities, thereby advancing both CBPP and geographical research in meaningful ways. Nevertheless, by embracing a multiple geographies perspective, CBPP research can contribute to knowledge production that is more sensitive to feminist, decolonial, and "multiple developments" demands. Being attuned to these calls can help further unlock the transformative potential of CBPP. This approach thus aligns with broader calls for a

pluriversal understanding of development, where diverse, autonomous, but globally interlinked and digitally mediated pathways emerge. This requires a commitment to decolonizing knowledge production, empowering local communities to define their own well-being pathways, and rethinking the materiality and spatiality of CBPP. In this way, CBPP can foster more just, sustainable, and culturally diverse futures that move beyond the limitations of traditional development models.

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Conflict of Interests

The authors declare no conflict of interests.

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Integrating Manufacturing: Strategies and Legal Approaches Dealing With Noise Conflicts in German Urban Planning

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Abstract

This article examines the integration of urban manufacturing into German urban land-use planning, with a focus on mixed-use strategies, legal approaches, and the role of court decisions in resolving conflicts related to noise. Building on the findings of a German working group of inter- and transdisciplinary experts on urban manufacturing, we explore planning strategies within the current legal framework to secure and promote urban manufacturing. The research analyses nine preparatory and 87 binding land-use plans from 23 large German cities, alongside 15 court cases where companies contested municipal binding land-use plans due to noise regulations. The findings reveal that zoning, frequently cited as a tool to protect urban manufacturing, can withstand judicial scrutiny. However, municipalities often fail to adequately address conflicts or comply with procedural requirements, particularly in noise management and immission control. The analysis highlights the potential for both coarse- and fine-grained mixes of uses, suggesting that tailored zoning approaches can enable integration of residential and productive areas. Nevertheless, industrial gentrification remains a significant challenge, as preparatory and binding land-use plans rarely address this issue. These findings contribute to the broader international discourse on sustainable and integrated urban areas, in line with contemporary urban development concepts such as the New Leipzig Charter. The article calls for further empirical research and advocates for stronger legal frameworks to support the coexistence of residential and manufacturing spaces.

Keywords
court decisions; industrial gentrification; land-use planning; mix of uses; planning law; productive city; urban manufacturing

1. Introduction

Since the 1970s, the global division of labour and the relocation of production to countries with lower factor costs have led to the rise of (knowledge-intensive) services and the tertiarisation of cities in the so-called Global North. This trend aligns with broader discussions about the emergence of a post-industrial society (Bell, 1976). As manufacturing jobs and companies declined, Commercial (Gewerbegebiet, GE; § 8 BauNVO) and Industrial Areas (Industriegebiet, GI; § 9 BauNVO) underwent significant transformation. Urban development policies focused on fostering a post-industrial city centred on creative and knowledge-based service industries, although this approach has also been subject to critical scrutiny (see Sassen, 2009).

In recent years, however, various developments have brought renewed attention to the topic of "urban manufacturing"—the (re-)integration of manufacturing into urban settlement structures (Gärtner & Meyer, 2023). Key drivers include the financial crisis, which prompted a shift away from a purely service-oriented economy (Brandt et al., 2017); the recognition that promoting knowledge-based services alone is insufficient for achieving socially equitable structural development (Trippl et al., 2023); advancements enabling lower emission production (Bauer & Lentes, 2014; Herrmann et al., 2015); and the increasing need for local material flows (Fromhold-Eisebith, 2023). New planning paradigms, such as the European mixed-use city, have revived interest in functional land-use mixes, exemplified by the concept of the "productive city" (Bundesministerium des Innern, für Bau und Heimat, 2020). Even finance and tech hubs like New York, London, and San Francisco acknowledge the necessity of accommodating local manufacturing companies and providing spaces for them within the city (Meyer, 2023; Pratt Institute Center for Community and Environmental Development, 2001). These spaces are critical for supplying daily necessities (e.g., food), periodic purchase goods (e.g., clothing, electronical devices), repair and maintenance services (e.g., tradespeople for heating or water tap repairs), and waste processing (Grodach et al., 2023).

However, a further decline in urban manufacturing has been observed in Germany (Brixy et al., 2023) and other countries of the Global North, such as the UK (Ferm & Jones, 2017), Belgium (De Boeck & Ryckewaert, 2020), the US (Leigh & Hoelzel, 2012), and Australia (Martin & Grodach, 2023). While the specific reasons for this decline in Germany remain under-researched, potential factors include offshoring, industrial gentrification, a lack of succession or skilled labour, and reduced competitiveness against new market players. In London, Ferm (2023) identified industrial gentrification as a significant issue, encompassing two forms: direct and indirect. Direct industrial gentrification describes the displacement of manufacturing companies by higher-value land uses, such as housing and offices, which offer higher returns on investment, which can also mean intra-industrial gentrification, referring to displacement within industries themselves (e.g., warehouse or logistics instead of production plant). Indirect industrial gentrification refers to the displacement of manufacturing companies resulting from changes in the surrounding area, such as the construction of new residential buildings, which can limit opportunities for expansion.

In Germany, the prioritisation of inner-city development projects, particularly in the field of housing, has clearly intensified. This focus on necessary housing development often leads to the rezoning and the displacement of manufacturing from mixed-building neighbourhoods (Schoppengerd et al., 2020). These developments have contributed to the establishment of a regional working group of experts on urban manufacturing in the German state of North Rhine-Westphalia (Baumgart et al., 2024). Supported by the ARL-Forum North Rhine-Westphalia, Academy for Territorial Development in the Leibniz Association (ARL), the working group consisted of both practitioners and scientists. This diverse composition, complemented by additional external expertise, facilitated the generation of valuable synthetic knowledge. The concept of urban manufacturing, as the name suggests, encompasses both territorial (urban) and sectoral (production) dimensions, making it inherently complex and lacking a unified definition. In examining conflicts between housing and manufacturing, as well as planning strategies for realising the mixed-use city, we partially build on the findings of the two-year working group in which the authors participated, which focused on material production. The working group concluded (Baumgart et al., 2024) that the primary challenges for urban manufacturing lie in safeguarding existing urban manufacturing companies and preventing industrial gentrification driven by housing developments. To further explore these processes and discuss strategies for retaining and reintegrating manufacturing, we incorporated empirical data from two additional research projects and conducted secondary analysis regarding our research questions for this article.

One research project examined how cities have addressed inner-city development, including industrial gentrification, by analysing preparatory (*Flächennutzungsplan*) and binding land-use plans (*Bebauungsplan*). This empirical investigation aimed to answer the question: How do preparatory and binding land-use plans address sites for urban manufacturing in contemporary land-use planning? The findings indicate that while the creation of new residential neighbourhoods was often prioritised over the (re-)development of manufacturing sites, conflicts related to noise frequently emerged as significant obstacles to achieving mixed-use cities. To determine whether these conflicts represent genuinely insoluble challenges or are the result of procedural shortcomings, we conducted a review of court decisions regarding binding land-use plans in Germany. The basis was a second study that analysed court decisions in which companies were plaintiffs, with a particular focus on noise-related conflicts that might have led to the annulment of binding land-use plans during judicial review, for example in cases where encroaching residential development could restrict future expansion due to anticipated noise conflicts—an instance of indirect gentrification. This empirical investigation addressed the question: Why, and under what circumstances, have companies invoked the right of defence (*Abwehrrecht*)?

This article aims to explore whether, beyond the general lack of formal instruments to prevent industrial gentrification, the existing German planning law is not being adequately utilised. We hypothesise that this is partly due to noise emissions being perceived as an insurmountable conflict, which reinforces the principle of separating residential and production areas according to § 50 of the Federal Immission Control Act (Bundes-Immissionsschutzgesetz, hereafter BImSchG; *Trennungsgrundsatz*). Dillmann et al. (2018, p. 186) have noted that concerns relating to immission control are insufficiently addressed and that noise conflicts are inadequately managed in three-quarters of the cases examined.

In the following section, we define urban manufacturing and situate it within the German planning context. We then review concepts and developments discussed in previous literature, highlighting both challenges and potential solutions. Section 3 outlines our methodology, based on the analysis of secondary material, while

Section 4 presents and discusses the results. Finally, Section 5 offers conclusions and identifies areas for further research.

2. Status Quo of Urban Manufacturing and German Planning Law

In this article, we do not distinguish between the terms urban production and urban manufacturing. According to Hill (2025), a distinction could be made: While urban manufacturing refers specifically to the manufacturing sector, urban production may serve as a broader term encompassing the productive city, including construction, resource management, and other foundational sectors. For this study, we follow the definition provided by Brandt et al. (2017)—"urban manufacturing is the making and converting of tangible goods…in densely populated areas" (p. 27)—with one exception: Urban agriculture is excluded. Under German planning law, urban agriculture is regulated separately, as horticultural companies are permitted only in MI and not in GE or GI (see Schoppengerd, 2023). In the following, we further specify the term urban manufacturing and urban production (Section 2.1), provide background on the German planning context (Section 2.2), and address the most pressing current challenge for urban manufacturing: noise protection in relation to encroaching residential development (Section 2.3).

2.1. Status Quo of Urban Manufacturing

Meyer and Schonlau (2024) emphasise the heterogeneity of urban manufacturing, which includes trendy consumer goods (e.g., coffee roasting, 3D printing), traditional crafts, and industries (e.g., mechanical engineering, metal production). They classify urban manufacturing across sectors using NACE codes—such as agriculture (NACE A), manufacturing (NACE C), waste treatment (NACE E38), construction (NACE F), repair services (NACE G45.2 & S95), selected retail trades (NACE G47.76, G47.77 & G47.78.1), and independent artists and restorers (NACE R90.03.3 & R90.03.4)—to identify optimal locations for companies (Meyer & Schonlau, 2024). Brixy et al. (2023) conducted the first comprehensive analysis of the development of urban manufacturing in Germany between 2000 and 2017. The study revealed a 16.5% decline in urban manufacturing companies all over Germany, and a significant decline, with a reduction of 24%, in the unitary authority cities. This trend is particularly striking given that urban manufacturing companies accounted for only 4.1% of all companies in these cities in 2017 (6.7% in 2000), the lowest proportion compared to urban counties (8.2% in 2017), rural counties with incipient urbanisation (8.9% in 2017), and sparsely populated rural counties (9.9% in 2017; Meyer et al., 2024). The low proportion of urban manufacturing in these cities could be attributed to higher land prices and rents (direct gentrification) or conflicts arising from encroaching residential developments (indirect industrial gentrification). Furthermore, building regulations for changes in business use in large cities may have led to the displacement of more tangible industries (Meyer, 2023). However, the specific causes have not been thoroughly examined. Studies from the UK (Ferm & Jones, 2017), the US (Leigh & Hoelzel, 2012), Belgium (De Boeck & Ryckewaert, 2020), and Australia (Martin & Grodach, 2023) point to factors such as (intra-)industrial gentrification and the persistent emphasis on the post-industrial city. In the review of court decisions we refer to the NACE codes of urban manufacturing by Meyer and Schonlau (2024).

2.2. German Planning Law and Noise Regulation

In Germany, a range of informal, formal, and cooperative instruments is available to preserve existing urban manufacturing locations and protect them from encroaching residential development (Meyer et al., 2024). This article focuses primarily on formal instruments. Both international literature (De Boeck & Ryckewaert, 2020; Ferm, 2023; Martin & Grodach, 2023) and German research (Baumgart et al., 2024; Meyer et al., 2024) agree that zoning systems allow a coarse-grained mix of uses. In Germany, the main formal instruments are preparatory and binding land-use plans, which operate at the municipal level. All municipalities are required to develop a preparatory land-use plan in accordance with § 5 of the German Building Code (Baugesetzbuch, hereafter BauGB), covering the entire municipal area and reflecting intended urban development in line with foreseeable needs. However, binding land-use plans (§ 9 BauGB) are typically created only for specific areas within a municipality. § 9 BauGB defines the content that may be regulated in binding land-use plans, and these regulations are further specified in the German Building Utilisation Ordinance (Baunutzungsverordnung, hereafter BauNVO). BauNVO establishes specific land-use areas, ranging from Residential-Only Areas (Reines Wohngebiet, WR; § 3 BauNVO) to Mixed-use Areas (Mischgebiet, MI; § 6 BauNVO) and GI, detailing which activities are permitted in each area (see Table 1). In municipal areas lacking a binding land-use plan, § 34 BauGB applies. In § 34-Areas, the permissibility of companies is determined based on the type and extent of building use and the character of the surrounding development.

For final building approval within areas covered by a binding land-use plan or regulated under § 34 BauGB, compliance with planning law is assessed alongside building regulations, such as fire safety and environmental protection. A key factor for the approval of companies is adherence to permissible industrial noise levels. These levels are assessed in accordance with the Technical Instructions on Noise Abatement (Sechste Allgemeine Verwaltungsvorschrift zum Bundes-Immissionsschutzgesetz - Technische Anleitung zum Schutz gegen Lärm, hereafter TA Lärm), which assigns maximum allowable immissions to areas requiring protection, depending on the area types specified in the BauNVO (see Table 1). For example, in MI, only activities that do not exert a disruptive effect on residential use are permitted. By contrast, GI can accommodate significantly disruptive companies and should therefore primarily serve as locations for such activities. While GE and MI allow for a variety of business activities—and may explicitly exclude "retail"—they have not yet explicitly designated "manufacturing" as a use to be promoted.

The TA Lärm specifies the relevant measurement point as "0.5 m outside, in front of the centre of the open window of the most noise-affected sensitive room" (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, 2017). Consequently, traditional passive noise protection measures, such as soundproof windows, have limited applicability in mitigating industrial noise (Lamker et al., 2017). However, this approach partially extends protection to outdoor living areas, including balconies and gardens.

Table 1. Permissibility of companies by disruption and noise level by specific land-use area.

Specific Land-use Areas (§ 1 BauNVO)	Possibility of General Permissibility of Types and Companies by Disruption	Possibility of Exceptional Permissibility	Noise Level (Day)	Noise Level (Night)
Industrial Area (Industriegebiet, GI)	Exclusively significantly disruptive (*erheblich belästigend*) commercial companies not permitted in other land-use areas		70 dB(A)	70 dB(A)
Commercial Area (Gewerbegebiet, GE)	Commercial companies which are not seriously disruptive (*nicht erheblich belästigend*)		65 dB(A)	50 dB(A)
Mixed-use Area (Mischgebiet, MI)	Other commercial companies that do not exert a disruptive effect (*nicht wesentlich störend*) on residential use; horticultural companies		60 dB(A)	45 dB(A)
Urban Area (Urbanes Gebiet, MU; since 2017)	Other commercial companies that do not exert a disruptive effect on residential use		63 dB(A)	45 dB(A)
Village Area (Dorfgebiet, MD)	Other commercial companies that do not exert a disruptive effect on residential use, and artisanal companies serving the area		60 dB(A)	45 dB(A)
Rural Residential Area (Dörfliches Wohngebiet, MDW; since 2021)	Secondary agricultural and forestry companies, and other commercial companies that do not exert a disruptive effect on residential use	Agricultural and forestry economic establishments, related dwellings and residential buildings, and horticultural companies	There are neither immission limit values nor immission guide values	
Core Area (Kerngebiet, MK)	Other commercial companies that do not exert a disruptive effect on residential use		60 dB(A)	45 dB(A)
Special Residential Area (Besonderes Wohngebiet, WB)	Shops, other commercial companies, and companies and facilities compatible with the residential use		There are neither immission limit values nor immission guide values	
General Residential Area (Allgemeines Wohngebiet, WA)	Shops serving the needs of the area; non-disruptive (*nicht störend*) artisanal companies	Other non-disruptive commercial companies and horticultural companies	55 dB(A)	40 dB(A)

Table 1. (Cont.) Permissibility of companies by disruption and noise level by specific land-use area.

Specific Land-use Areas (§ 1 BauNVO)	Possibility of General Permissibility of Types and Companies by Disruption	Possibility of Exceptional Permissibility	Noise Level (Day)	Noise Level (Night)
Small Residential Estate Area (Kleinsiedlungsgebiet, WS)	Shops serving the needs of the area; non-disruptive artisanal companies	Other non-disruptive commercial companies	55 dB(A)	40 dB(A)
Residential-Only Area (Reines Wohngebiet, WR)		Shops and artisanal companies for daily needs that do not exert a disruptive effect on residential use	50 dB(A)	35 dB(A)
Special Area (Sondergebiet, SO)		Potentially usable for training centres of artisanal trades, provided the area significantly differs from §§ 2–10 BauNVO	There are neither immission limit values nor immission guide values	

Sources: Own representation based on the BauNVO and on Lärmkontor (2023), Marschall (2022, p. 10), and Spannowsky (2019).

In response to persistent concerns that a mixed-use city could not be effectively planned using the existing area types—e.g., the existing MI has been deemed inadequate due to requirements for an equal mixing ratio, permitted density, and noise levels—a new area type, the MU (§ 6a BauNVO), was introduced in 2017. The MU was developed to encourage high-density, fine-grained mixed-use development, accommodating residential purposes alongside commercial companies and social, cultural, and other facilities that do not disrupt residential use. With a daytime noise immission limit of 63 dB(A) according to the TA Lärm, this threshold is 3 dB(A) higher than the immission limit for MK (§ 7 BauNVO), MD (§ 5 BauNVO), and MI (§ 6 BauNVO), which, prior to the introduction of the MU, marked the maximum level ensuring healthy living conditions (Köppen & Mitschang, 2019, p. 763; Marschall, 2022). This higher threshold represents, for the first time, a weakening of the traditional principle of separation (Berkemann, 2021). Furthermore, unlike MI, the MU does not require an equivalent mixing ratio. Under § 6a (4) No. 4 BauNVO, provisions can be made in MU to favour commercial uses by designating a specific proportion of permissible floor space or a defined floor area per building site within the binding land-use plan (Spannowsky, 2019, p. 70). Additionally, there is the possibility of converting GE into mixed-building neighbourhoods (including MD, MDW, MI, MK, and MU), where residential use may significantly dominate (Spannowsky, 2019, p. 102).

However, concerns have been raised that an imbalance between residential and commercial uses could promote industrial gentrification in the absence of specific provisions (Schoppengerd et al., 2020, p. 12). For example, a binding land-use plan might stipulate that residential use on a ground floor facing the street is either prohibited or only exceptionally permitted. Despite the intention to achieve a greater mix of uses, including manufacturing, the MU has not yet succeeded in this goal. Manufacturing companies have been reluctant to relocate to these areas, while developers and landowners continue to prioritise the conversion of commercial or industrial spaces into higher-value commercial or residential properties (Beibl, 2021).

2.3. Noise Protection for Encroaching Residential Buildings

Immission control requirements affect not only the approval of new businesses but also the safeguarding of existing businesses. Changes to neighbourhoods, such as new residential developments, can impose restrictions on existing commercial uses. Commercial operations are considered facilities under § 3 BImSchG. While most businesses do not require special licences under the BImSchG, they must operate in accordance with the state of the art and consistently comply with applicable standard levels (§ 22 BImSchG). In such cases, authorities may impose additional measures (§ 24 BImSchG) to ensure compliance with immission control requirements for protected objects (Sparwasser & Heilshorn, 2020, Section 1).

This dynamic adjustment obligation represents a significant distinction between building permission for commercial facilities and residential buildings, as residential uses benefit from comprehensive protection as existing structures (Schimpfermann & Stühler, 2018, Section 184). When residential developments encroach on MI or GE, the planning law principle of mutual consideration (*Rücksichtnahmegebot*) must be respected (Pützenbacher, 2024, Section 90). In general, industrial noise conflicts must therefore be addressed during building permit procedures. However, it should be the task of urban land-use planning to resolve the noise conflict in accordance with the principle of conflict management (*Grundsatz der Konfliktbewältigung*) in the binding land-use plan (Dillmann et al., 2018, p. 187).

Furthermore, the general principle of separation applies to residential developments encroaching on MI or GE requiring consideration of economic and environmental interests (§ 50 BImSchG; § 1 BauGB). Additionally, the TA Lärm must be indirectly applied, as full compatibility with planning standards is a prerequisite for building permits. The precise application of the TA Lärm and the extent to which passive noise protection measures (e.g., soundproof windows, facade insulation, shielding of outdoor living areas) are inadmissible remain subjects of a controversial debate (Oerder & Beutling, 2013; Reidt, 2020).

Current ambiguities in the legal framework and discourse regarding the TA Lärm cause significant uncertainty in the practical application of industrial noise regulations in municipal urban land-use planning. Inadequate consideration of these issues may adversely affect companies, granting them the right to take legal action under § 47 of the German Administrative Court Code (Verwaltungsgerichtsordnung, hereafter VwGO) to challenge binding land-use plans in court. How companies utilise these rights of action is not well-documented and is explored further in Sections 3 and 4.

2.4. Interim Conclusion

In summary, the German planning law framework presents various challenges for the protection and promotion of mixed-use developments and urban manufacturing. One issue is that disruptive companies are not permitted in MI, which risks the disintegration of urban manufacturing even in MU. Additionally, the complex regulations on noise protection and the measurement point defined by the TA Lärm necessitate careful consideration of potential immission conflicts in practice, particularly between GE and WA. When residential buildings encroach on GE, additional operational requirements may be imposed on manufacturing sites, thereby posing further challenges to their viability.

3. Methodology

To examine whether preparatory or binding land-use plans address industrial gentrification, potential conflicts affecting its development, and possible planning strategies to overcome these challenges, we re-analysed documents of land-use plans from an existing research project as a first step (see Section 3.1; Eichholz & Schoppengerd, 2022). In a second step, we assessed whether such conflicts can be resolved by reviewing court decisions on urban land-use planning in Germany (see Section 3.2). The methodological approach is described below.

3.1. Analysing Nine Preparatory Land-Use Plans and 87 Binding Land-Use Plans

To explore how cities have managed the industrial gentrification to date, we analysed nine preparatory land-use plans (2007–2018) and 87 binding land-use plans from 23 large German cities, all focused on inner-city development (2011–2021). These plans were selected and examined as part of a research project investigating conflicts of interest in inner-city development and potential solutions in urban land-use planning. Additionally, qualitative expert interviews were conducted with urban planning officials in five of these cities. The research project focused on large cities with populations exceeding 100,000 inhabitants, as these cities are more likely to undertake significant inner-city development projects.

For the preparatory land-use plans, all newly drafted plans in major German cities between 2007 and the conclusion of the research in 2018 were analysed. The nine cities included in the preparatory land-use plan analysis formed the basis for selecting the binding land-use plans. This selection was supplemented by additional cities experiencing growth or having implemented significant inner-city development projects in recent years. The final selection ensured representation of at least one large city per federal state. Based on these criteria, 14 additional large cities were included. The primary criterion for selecting the binding land-use plans in each of the 23 cities was their location within inner-city areas. Binding land-use plans were chosen if they covered at least one hectare and were as recent as possible. The selection also accounted for plans defining different types of land use. Altogether, this resulted in a total of 87 binding land-use plans. The number of plans analysed per city varied depending on the availability of potentially suitable plans (Eichholz & Schoppengerd, 2022).

3.2. Review of Court Decisions Regarding Noise, When Companies Were Plaintiffs in a Judicial Review

The second methodological step was based on an analysis of court decisions related to noise conflicts as judicial review (*Normenkontrollverfahren*) that could lead to the failure of binding land-use plans during the judicial review of standards. In an abstract judicial review (*abstrakte Normenkontrolle*) based on § 47 VwGO, the validity of a development plan is reviewed independently of any specific cause. In contrast, a concrete judicial review (*konkrete Normenkontrolle*) takes place in the context of a specific legal dispute, e.g., planning permissions.

The analysis focused on court decisions (judgments and rulings) on binding land-use plans pursuant to § 47 VGO. These decisions were issued by the Higher Administrative Courts (Oberverwaltungsgerichte, hereafter OVG) or the Administrative Court of Appeal (Verwaltungsgerichtshof, hereafter VGH) between 1 November 2016 and 31 October 2021. The decisions were subjected to a structured document analysis.

The search for relevant decisions in abstract judicial review proceedings was conducted across all case law databases of the OVG and VGH in Germany's federal states, as stipulated in § 2 VwGO. Using the available automatic search functions, publicly accessible databases (of the courts of the federal states and the online legal database Beck-Online published by C. H. Beck) were queried with defined search terms such as "Normenkontrolle," "abstraktes Normenkontrollverfahren," "Bebauungsplan," and "Bauleitplan" to gather the largest possible dataset of relevant decisions.

In the initial step, a total of 1,073 decisions were identified across all federal states. The dataset was subsequently refined to exclude irrelevant statutes, such as those addressing change restrictions, misappropriation statutes, conservation ordinances, outdoor area statutes, and legal ordinances for landscape conservation areas, which were not directly related to binding land-use plans. This approach aligns with the survey methodology used by Dillmann et al. (2018).

Finally, the remaining decisions were screened for the keyword "Lärm" (noise) within the text of each decision to ensure a focused analysis of noise-related conflicts. This refinement reduced the dataset to 157 court decisions for detailed analysis. For our study on the integration of urban manufacturing, mixed-use strategies, and legal approaches in German urban planning, the decisions were filtered based on the plaintiff for the judicial review. Only decisions in which companies according to the abovementioned NACE codes (Meyer & Schonlau, 2024) were the plaintiffs were included in the analysis.

This approach enabled the examination of 15 decisions to identify conflicts related to the integration of urban manufacturing within binding land-use plans. The companies involved came from diverse industry sectors, including waste management and disposal, chemical production, electronics, heating and sanitation, arts and crafts, agricultural machinery production, locksmiths, and others.

Once the data were collected, the court decisions were analysed using Mayring's qualitative content analysis (Mayring, 2016). The material was analysed using a category system based on § 313 German Code of Civil Procedure (Zivilprozessordnung), which ensures that court decisions in Germany are structured in a largely similar way. It comprises the following categories: court, headnote, operative part, facts of the case, description of the dispute between the plaintiff and the defendant with cause of action, and the court's decision and ruling (see Table 2). Further content-related provisions were derived from the description and decision, for example regarding the planning area and main conflicts.

4. Empirical Results

First, this section presents the empirical results of the analysis of the preparatory and binding land-use plans and then discusses the results of the court decisions.

4.1. Land-Use Plans

In urban land-use planning, there are different planning approaches, ranging from the regulation of the types of use in the preparatory land-use plans to detailed regulations, e.g., details of noise protection in the binding land-use plans. This section (4.1) describes in more detail which regulations are applied in the land-use plans.

4.1.1. Preparatory Land-Use Plans: MI vs. GE

The analysis of plans revealed a significant emphasis on creating new residential and mixed-building neighbourhoods in urban inner-city redevelopment, compared to the development of pure GE. In particular, preparatory land-use plans show a trend of converting formerly GE within inner cities into WA or MI, thereby reducing the available space for disruptive industries. However, due to the inconsistent reporting in the preparatory land-use plans, the total volume of converted land could not be directly compared, and these plans do not distinguish the location of the land within the municipality. Qualitative analysis of the justifications underlying the decision, however, reveals a clear trend: GE in the city centre are declining, while new designations are increasingly located on the city's outskirts.

4.1.2. Binding Land-Use Plans: Focusing Residential Development

Among the 87 binding land-use plans, 63 designated new WA (§ 4 BauNVO), 33 MI, two MU, 14 GE, four restricted GE, and three GI. Despite the focus on residential development, some strategies to preserve urban manufacturing were evident. Many plans designated more than one area type. Of the 44 plans limited to a single area type, 32 were WA. Plans combining multiple area types—e.g., MI and GE or WA and GE—enabled a coarse-grained mix of uses, allowing disruptive companies to integrate into neighbourhoods while mitigating displacement risks. For instance, in Hamburg, a GE was chosen over an MI to protect industrial operations from stricter noise limits imposed in MI:

> If a MI is designated for the entire planning area, the existing residential use would consequently have to accept the immission guide values permitted in MI. In return, only companies that do not exert a disruptive effect would be permitted. With this plan variant, there would be a risk of displacement of the proportionately desired commercial use and thus the dissolution of the existing mix of uses. (Bezirksamt Altona, 2015, p. 7)

4.1.3. Industrial Noise as a Central Issue

To analyse which noise conflicts occur in planning practice and how they are resolved, all explanatory reports of the preparatory and binding land-use plans were evaluated. In addition to the plans themselves, conflicts and possible solutions were identified. Conflicts related to industrial noise remain a key challenge in urban redevelopment. Due to the city-wide perspective, noise was addressed in all preparatory land-use plans, but it was also often a topic in the binding land-use plans. Noise conflicts were cited in 90% of the examined binding land-use plans, with industrial noise mentioned in 49%, second only to traffic noise (73%). These conflicts were more frequently addressed in plans designating GE (73%) than WA (36%). These conflicts arise both around existing industrial sites and in the designation of new GE. These varying problem situations are also mirrored in diverse approaches to solutions in planning practice.

Preparatory land-use plans frequently address noise issues through zoning strategies, such as:

- Gradual zoning transitions (e.g., from GE to MI to WA as buffers), for example the transformation of old harbour areas into urban city districts with residential uses and the simultaneous preservation of existing commercial uses in some areas (Bremen);

- Reclassifying high-emission areas (e.g., converting GE into MI), for example in the case of former GE with WA in the surrounding neighbourhood (Recklinghausen);
- Transforming sensitive areas (e.g., from WA to MI), for example in urban areas where a mix of uses is intended (Bremen);
- Creating buffers to sensitive areas (e.g., green strips or traffic routes), for example the development of a green belt between a GE and a nearby WA (Hamm);
- Differentiating between GI and GE instead of the general land use areas, for example GE with usage restrictions due to their proximity to existing WA (Potsdam).

When conflicts could not be resolved at the preparatory land-use plan level, they were deferred to binding land-use plans. For example, some preparatory land-use plans, like the one in Göttingen, explicitly highlight neighbouring conflicts by using tools such as "immission lines" to address the proximity of industrial and residential uses. In the analysed binding land-use plans, 37 out of 87 included small-scale measures to resolve noise conflicts. Active noise protection measures, such as emission quotas for permitted industrial noise or exclusions for disruptive uses (§ 9 (1) No. 1 BauGB in conjunction with § 1 BauNVO), were particularly applied when planning new commercial development areas. Such regulations offer good immission protection for neighbouring uses worthy of protection, but at the same time limit the emission values in companies and mean that further disruptive companies can no longer be permitted in the areas. Passive noise protection measures for industrial noise were implemented in 25 of the analysed plans. Instead of classic soundproof windows, non-openable or specialised windows were specified according to § 9 (1) No. 24 BauGB (Lamker et al., 2017). The use of specific window constructions, commonly referred to as "Hamburg windows," is particularly prevalent in plans from Hamburg. Additionally, regulations concerning ventilation systems and the design of residential buildings are stipulated in accordance with § 9 (1) No. 24 BauGB.

4.1.4. Industrial Gentrification in Land-Use Planning

Unlike noise conflicts, industrial gentrification—frequently discussed in our working group—was rarely addressed in the plans, and only a few planning approaches exist to tackle it. In addition to the designation of GE described earlier, the analysis identified measures aimed at limiting industrial gentrification, such as protecting manufacturing companies from displacement by higher-value uses. In five of the analysed plans, restrictions on retail or amusement arcades were justified by concerns that these affluent uses could displace the commercial or industrial sector. In most cases, the plans also included special provisions allowing manufacturing companies to sell their own goods. Such restrictions can be implemented within the framework of the BauNVO, as these types of use are explicitly defined in the BauNVO and do not constitute the central uses of the respective area type.

4.1.5. Summary

In summary, the analysis demonstrates that planning law provides tools to manage noise conflicts in mixed-building neighbourhoods and to integrate disruptive companies into the urban context by incorporating small GE. However, these strategies are not yet widely adopted and are sometimes highly complex. Consequently, uncertainties persist in planning practice, particularly regarding the use of passive noise protection, which is further complicated by an unclear legal framework. Furthermore, few mechanisms exist to prevent industrial gentrification, particularly intra-commercial gentrification.

4.2. Court Decisions

Almost half of all stipulations violating the requirement of certainty under construction planning law, which result in the failure of binding land-use plans during administrative court judicial review proceedings, are related to immission control (Dillmann et al., 2018, p. 184). Judicial statistics highlight that immission control is a key challenge in such cases (Marschall, 2022).

Manufacturing companies are repeatedly confronted with conflicts in the context of urban land-use planning, prompting them to initiate legal action against binding land-use plans as part of judicial review procedures to avoid the risk of indirect industrial gentrification. These conflicts often emerge at the intersection of companies' operational interests and those of local authorities. The main reasons for such legal disputes are analysed below. First, the court decisions are categorised according to the types of company operations involved. Next, the designated land-use categories in the contested binding land-use plans are presented, offering an overview of the planning law context in the analysed cases (see Table 2). The plaintiffs in the analysed court proceedings are companies from various sectors, including waste management, chemical production, and others. Their business operations are directly affected by the contested binding land-use plans. The overriding reasons for the companies' complaints regarding their rights of defence include economic restrictions imposed by the plans; insufficient consideration of economic interests in urban land-use planning; unclear or contradictory regulations; and conflicts between immission control regulations and economic development objectives. All of the companies argued that their private rights of use were impaired by the plans and that their competitiveness was jeopardised as a result.

Table 2. Fifteen cases of court decisions on land-use plans in which companies were plaintiffs—the respondent was the municipality in all cases, and "plan" means "new binding land-use plan."

Case	Plaintiffs	Cause of Action	Party to the Court Proceedings	Specific Land-Use Area	Court	Court Decision
1	Waste management company, recycling plant	The company maintains an area for recycling via heritable building rights and argued that its private interests (noise emissions) were not sufficiently considered when noise contingency measures were set.	Operator of event grounds	Not provided	OVG Berlin-Brandenburg	Plan invalid
2	Waste management company, recycling plant	The company, operating a depot, contested the conversion of an industrial estate to residential development, fearing restrictions due to existing noise pollution.	Neighbouring property owner (metalworking and equestrian business)	MI, SO (from GE)	OVG Lower Saxony	Plan invalid

Table 2. (Cont.) Fifteen cases of court decisions on land-use plans in which companies were plaintiffs—the respondent was the municipality in all cases, and "plan" means "new binding land-use plan."

Case	Plaintiffs	Cause of Action	Party to the Court Proceedings	Specific Land-Use Area	Court	Court Decision
3	Chemical company	The company's site adjoins a newly planned residential and GE and objected to the plan requiring protective measures against its possible noise emissions, which could hinder the planned site expansion and restrict production.		MI, GE	OVG Rhineland-Palatinate	Plan valid
4	Electrical installation company	The company opposed restrictions on commercial activities, citing economic disadvantages, as the new regulations limited its development and utilisation options, and insufficient consideration of its interests.	Real estate developer for residential buildings	WR, MI	OVG North Rhine-Westphalia	Plan invalid
5	Waste management company, recycling plant	The company and the landowner contested the new designation of a "special area for waste disposal," arguing that the plan restricts their operational development and utilisation options.		SO	VGH Baden-Württemberg	Plan invalid
6	Heating and sanitation company	The company claimed that noise emissions were the main source of conflict, significantly restricting its operations under the new regulations.	Operator of a planned care home	Not provided	OVG Berlin-Brandenburg	Plan valid
7	Multiple owners of residential and commercial properties	Owners fear unacceptable exposure to traffic noise and air pollutants. A procedural error is alleged, as the environmental assessment did not take sufficient account of significant noise pollution in the surrounding area.	Operator, residential buildings, and other uses	Not provided	OVG Hamburg	Plan valid (procedural error correctable)

Table 2. (Cont.) Fifteen cases of court decisions on land-use plans in which companies were plaintiffs—the respondent was the municipality in all cases, and "plan" means "new binding land-use plan."

Case	Plaintiffs	Cause of Action	Party to the Court Proceedings	Specific Land-Use Area	Court	Court Decision
8	Neighbouring property owner	The owner argued that noise contingency was insufficiently publicised, the interests of the owners were not sufficiently considered, and the environmental assessment contained significant deficiencies.		GE, MI	OVG Hamburg	Plan invalid
9	Commercial enterprise	The company argued that inadequate provisions in the plan could restrict its commercial activities and future development opportunities.		Not provided	OVG Lower Saxony	Plan valid
10	Two companies as property owners	The plaintiffs complained that the downgrading from GI to a restricted GE is not in line with overriding planning objectives (regional plan) and significantly impaired their ability to utilise the properties commercially.		GE (from GI)	OVG North Rhine-Westphalia	Plan invalid
11	Sweeper manufacturer	The company claimed the plan's provisions exert a disruptive effect on its commercial activities.	Real estate developer for neighbouring residential buildings	WA (adjacent to the company)	OVG Berlin-Brandenburg	Plan invalid
12	Forging and locksmith business	The plaintiff argued that the noise barrier and the plan would have a significant negative impact on the business.		WA	VGH Baden-Württemberg	Plan invalid
13	Agricultural machinery trading and repair business	The company objected to the designation of a WA, citing risks to its commercial activities.		WA (planned adjacent to the company)	OVG Lower Saxony	Plan invalid
14	Heating and sanitation company	The company claimed noise emissions as the main source of conflict and saw its commercial use considerably restricted by the new regulations.	Operator of a planned care home	WA (planned adjacent to SO)	OVG Berlin-Brandenburg	Plan valid

Table 2. (Cont.) Fifteen cases of court decisions on land-use plans in which companies were plaintiffs—the respondent was the municipality in all cases, and "plan" means "new binding land-use plan."

Case	Plaintiffs	Cause of Action	Party to the Court Proceedings	Specific Land-Use Area	Court	Court Decision
15	Forging and locksmith business	The plaintiff argued that immission control requirements would impair their rights.		Expansion of MI encroaching on GE	VGH Hesse	Plan invalid

The analysis shows that conflicts between manufacturing companies and municipalities' binding land-use plans in urban areas often arise due to conflicts of use and clashes of interests at the interface between operational requirements and urban development planning objectives. Companies take legal action against the municipalities to protect their economic interests, protect existing operating rights, and safeguard future development opportunities. The reasons that prompt companies to take legal action are diverse and can be categorised as protection of existing rights, restrictions on company expansion, inadequate balancing of interests, violation of the principle of separation, and procedural errors.

4.2.1. Protection of Existing Rights

Companies perceive new binding land-use plans as a threat to their existing rights, particularly when planned uses, such as residential developments, could assert stronger protection claims (e.g., for noise protection). For instance, the decision by VGH Hesse (Case 15) concerned an application for a review of standards by a commercial operator in the metal processing industry, which was directed against the amendment of a binding land-use plan. The plan aimed to extend an MI into a neighbouring GE to create additional residential and commercial space. The plaintiff, whose company was located adjacent to the proposed area, argued that the planned residential development would significantly restrict their commercial operations. The operator feared that new residential uses would assert protection claims, potentially limiting operating hours and emissions, thereby endangering the viability of their business. The plaintiff also criticised methodological errors in the noise report, including inaccurate noise levels, and alleged a failure to appropriately weigh their interests. The court declared the binding land-use plan invalid, citing the following key points:

- The noise calculations contradicted realistic immission values.
- Conflicts between residential and commercial uses were inadequately considered.
- The planning violated the principle of separation, which mandates appropriate spatial division between GE and WA.

The court ruled that the methodological flaws and insufficient consideration of the plaintiff's interests justified the revocation of the binding land-use plan.

4.2.2. Restrictions on Company Expansion

Companies criticise binding land-use plans for hindering their expansion opportunities, such as by imposing restrictive usage regulations or failing to adequately account for their growth needs (indirect gentrification). For example, OVG Rhineland-Palatinate (Case 3) dismissed the complaint of a chemical company taking

action against a binding land-use plan that designated MI and GE near its site. The plan included noise quotas and usage restrictions that could potentially impact the company's planned expansion of its premises. The plaintiff criticised inadequate consideration of possible industrial uses, errors in the noise report, inadequate balancing of its interests, particularly regarding safety distances to hazardous incident sites, and the inappropriate deferral of conflicts to subsequent approval procedures.

However, the court upheld the binding land-use plan, stating that formal requirements had been fulfilled and relevant concerns had been adequately addressed. Safety distances and noise limits were properly observed, and no failure to investigate relevant issues could be established. The plaintiff's proposed commercial expansions were not considered a planning factor, as they had not been formally specified. Industrial use was excluded due to the presence of existing residential development, and transferring unresolved issues to subsequent approval procedures was deemed appropriate. The court concluded that the municipality's planning decision complied with applicable laws and did not unlawfully restrict the plaintiff's operations.

4.2.3. Inadequate Balancing of Interests

Companies criticise methodological errors in noise reports or inadequate impact assessments of alternatives, which lead to incorrect considerations in the planning process. For instance, in Case 4, an electrical installation company contested the construction of apartment buildings on a neighbouring property. The company argued that the densification of the area would negatively impact customer traffic and operational processes, particularly night deliveries. The plaintiff claimed that the binding land-use plan jeopardised its operational processes due to conflicts arising from the planned residential use. Furthermore, the company criticised the insufficient consideration of its interests during the planning assessment. The court annulled the binding land-use plan, citing inadequate consideration of the company's interests, immission conflicts that were not sufficiently addressed, and a failure to appropriately balance operational and residential needs.

4.2.4. Violation of the Principle of Separation

Residential development in close proximity to noisy commercial operations is often deemed a violation of the principle of separation (§ 50 BImSchG). In Case 2, a binding land-use plan was declared invalid because it permitted residential development near a waste management company's depot. The plan converted a GE into an MI and extended a SO (§ 10 BauNVO) for a horse riding centre. The plaintiff, the operator of the waste management depot, argued that the plan failed to adequately consider the noise generated by the depot, particularly during nighttime operations. Deficiencies in the noise reports and a lack of effective noise mitigation measures were identified. The court found that the principle of separation had been violated, as the plan failed to ensure sufficient spatial separation between noise-intensive operations and residential use. Additionally, a balancing error was identified, as the interests of the depot—particularly its authorised operating hours—had not been adequately taken into account.

4.2.5. Procedural Errors

Companies identify shortcomings in planning procedures, including the unlawful use of accelerated procedures, inadequate environmental assessments, or the absence of an environmental report. In Case 11,

the operator of a sweeper production facility filed a judicial review. The company's premises partially fell within the scope of a municipality's binding land-use plan, which designated a WA and proposed the construction of a traffic turning area on part of the company's land. The plaintiff argued that the plan significantly affected its operations, particularly due to the loss of operating space and insufficient consideration of its economic interests. It also criticised procedural errors, specifically the unlawful use of an accelerated procedure under § 13a BauGB and the absence of an environmental assessment, despite parts of the plan area being classified as an outer area. The court declared the binding land-use plan invalid, citing the following reasons:

- The accelerated procedure was deemed unlawful.
- The absence of an environmental report constituted a significant procedural error.
- The proposed traffic turning area was unnecessary, as the original plan could not be implemented.
- The plaintiff's economic interests were inadequately considered.
- A lack of clarity regarding noise protection measures resulted in further deficiencies.

As a result of these procedural and balancing errors, the court annulled the binding land-use plan in its entirety.

4.2.6. Summary

Overall, the cases demonstrate that companies' rights of defence can be effectively used to enforce their interests. However, the analysis also indicates that the companies initiating legal action tend to be larger entities, such as waste disposal or chemical companies, which are, in general, likely less embedded in an integrated urban context (see Meyer & Schonlau, 2024). Smaller companies appear significantly less likely to utilise their legal options to challenge municipal urban land-use planning decisions. The courts find themselves navigating between municipal interests and the rights of companies. Decisions are dependent on whether the municipalities' considerations are deemed plausible and comprehensible. This analysis highlights the complex challenges that arise at the intersection of economic and municipal interests in urban land-use planning. Furthermore, it is important to recognise that court decisions can have far-reaching implications beyond the specific case. By interpreting undefined legal terms, they influence the application of the law in subsequent years. In some instances, court decisions bring critical issues to the forefront of municipal planning. For example, the implementation of the EU directive on the control of major-accident hazards involving dangerous substances (Seveso Directive) was highlighted in a key court decision (Schoppengerd, 2015, pp. 201–203).

5. Conclusion

The findings indicate that companies can effectively protect themselves from potential legal displacement (such as encroaching residential development) through judicial review procedures when a new binding land-use plan drawn up by the municipality affects their site or a neighbouring one. Zoning, as highlighted in international literature (see Section 2), is an effective tool for protecting urban manufacturing and has withstood judicial scrutiny. The success of corporate lawsuits suggests that noise conflicts could be mitigated through various planning instruments. However, in most of the court decisions examined, the municipalities either failed to adequately identify and assess these problems or committed procedural errors. This may partly result from the complexity of legal regulations.

It should also be noted that courts assess whether a plan complies with applicable law, but their decisions do not necessarily reflect whether the plan represents good planning practice in terms of content. For example, if a company is planning a future expansion, it must obtain planning permission, enabling the municipality to consider that when balancing private and public interests and developing neighbouring properties. Both coarse- and fine-grained mixes of uses are required to accommodate companies with different noise levels (see Section 4.1.3). A combination of these approaches is evident in many of the binding land-use plans analysed. Zoning can, in some cases, facilitate the integration of WA and (productive) GI, provided individual solutions are appropriately defined.

Consequently, legally watertight planning is not automatically an expression of a good planning concept. Conversely, new plans that are contested in court are not always bad, as even ordinary/trivial procedural errors can lead to the failure of a binding land-use plan. Court decisions can reveal conflicts that affect specific planning concepts and, when such conflicts occur frequently across a large sample of cases, highlight broader challenges and uncertainties in planning practice. For example, complex legal structures make noise an aspect of planning that carries a high degree of legal uncertainty. A scientific and systematic analysis of court decisions can therefore reveal conflicts at various levels and support sound planning practice, both de jure and de facto.

Nevertheless, these findings require further empirical validation. For instance, it must be examined whether large companies have greater resources to defend their rights in court compared to small or medium-sized enterprises (SMEs). Questions remain about the fate of companies lacking access to urban planning expertise, human capital, or financial resources for legal representation. Larger companies may be able to hire more experienced lawyers, whereas smaller municipalities might struggle to adequately defend their plans due to limited human and financial resources. Further research should investigate whether companies only pursue legal action when they are confident of success.

Simply demanding that municipalities "do their homework," develop better solutions, and ensure compliance with planning law oversimplifies the issue. Municipalities often lack the personnel and resources to achieve this. Based on our empirical findings, we recommend that urban planners consider companies—especially small and medium-sized urban manufacturing companies—when balancing interests during the planning process to minimise the likelihood of legal disputes.

Additionally, political will is essential, as the analysis of preparatory and binding land-use plans indicates a clear trend toward conversions prioritising residential development, which does not prevent industrial gentrification. The analysis of preparatory and binding land-use plans further reveals that economic industrial gentrification is rarely addressed, with only limited planning approaches available to manage it. While some restrictions exist—for instance, limiting retail or amusement centres to prevent industrial gentrification—these constraints can be implemented within the framework of the BauNVO, as they pertain to usage types explicitly mentioned and do not constitute the central uses of the area type.

We identify a significant shortcoming in German planning law: The BauNVO does not classify "productive industry" as a type of use. This omission limits the ability of urban planning to adequately safeguard and promote urban manufacturing within the legal framework.

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Conflict of Interests

In this article, editorial decisions were undertaken by Lech Suwala (Technical University Berlin), Robert Kitzmann (Humboldt University Berlin), and Sebastian Henn (Friedrich Schiller University Jena).

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

LLMs Disclosure

To ensure responsible use of AI and LLMs and to preserve the integrity of our publication, we note that we used ChatGPT (version ChatGPT with GPT-4-Turbo) and DeepL (version 25.1.4.15077) as generative AI technologies during the research and writing process. ChatGPT was used to create an overview of the court decisions, which was then manually reviewed by the researchers. Both ChatGPT and DeepL were used to optimise the linguistic correctness of our manuscript; in particular, linguistic improvements were made in terms of grammar and style.

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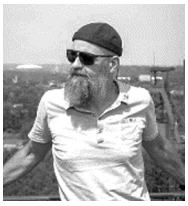

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Reviewing Environmental Benefits of Urban Manufacturing: Arguments and Evidence for Carbon, Resource, and Space Efficiency

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Abstract

Urban manufacturing has emerged as a key concept in the discourse on sustainable urban development, yet its precise contributions to sustainability remain incompletely understood. This article presents a systematic literature review that examines the role of urban manufacturing in promoting low-carbon, energy-, resource-, and space-efficient urban economies. By analysing 163 relevant articles on urban manufacturing identified in the Web of Science and Scopus databases, this review synthesises key sustainability arguments and empirical evidence with a focus on environmental impacts. Findings are structured along three key dimensions of efficiency: carbon, resource, and space. These are subdivided into two underlying logics that emerged as central themes in the scientific literature: sustainability by proximity and sustainability through urban synergies, which are possible when urban manufacturing is functionally integrated into the city. While theoretical and anecdotal claims of environmental benefits abound, empirical validations across different contexts are lacking and require further research. In conclusion, the positive impact of urban manufacturing on the environment depends on integrating advanced technologies into specific spatial, environmental, and socio-economic contexts. This does not mean that we lack confidence in the arguments regarding urban manufacturing's positive environmental impact. Rather, it is a call for more empirical research. Future research should prioritise the analysis of technologies and their implementation in different urban environments to engage with this discrepancy between the large number of arguments and the limited and only partially transferable evidence.

Keywords
circular economy; productive city; resource efficiency; urban manufacturing; urban planning; urban production

1. Introduction

Over the past decade, urban manufacturing has attracted growing attention from planning and economic development agencies, particularly in countries of the Global North. This renewed interest is driven by the decline of well-paid and diverse jobs (Brandt, Butzin, et al., 2017), as well as increasing concern over poor working conditions, environmental impacts, and global dependencies resulting from the relocation and concentration of production in rural areas and emerging countries (Gärtner & Schepelmann, 2023). At the same time, urban manufacturing faces challenges such as land scarcity and rising competition for land (industrial gentrification), which threaten the viability of manufacturing companies in cities and, by extension, the resilience and supply security of local economies (Ferm & Jones, 2017; Hill, 2020). This interest can be attributed to several interrelated developments.

First, the paradigm is shifting toward mixed-use urban areas (see e.g., the European New Leipzig Charter; Bundesministerium des Inneren, 2020), promoting the integration of productive activities and moving away from the traditional model of functionally separated zones outlined in the Charter of Athens. In this context, manufacturing is increasingly seen as a key element of mixed-use cities. For years, urban development focused on residential expansion and the service sector as the primary source of employment and growth. However, digital technologies and new work patterns—such as remote work—have led to new forms of employment, often less dependent on centralised office space. At the same time, it is increasingly acknowledged that not all workers can participate in such digital forms of employment and that employment in the (digital) service-sector may be challenged by artificial intelligence. Therefore, various cities aim to preserve and promote productive uses like manufacturing in the urban fabric. Examples include London's Strategic Industrial Locations (Mayor of London, 2016) or San Francisco's Strategy of Production, Distribution, and Repair (San Francisco Planning Department, 2002).

Second, the ongoing structural changes affecting urban landscapes due to globalisation and offshoring of manufacturing from the Global North, as well as the expansion of the service sector, require innovative approaches to urban land use and local economic development. Furthermore, presently arising challenges for global production networks due to shifts in trade policy or supply chain issues led to calls for reshoring (Ellram et al., 2013; Kalvelage & Tups, 2024) or for strengthening local supply security, combined with neolocalist ideas (Xu et al., 2024).

Third, the growing focus on green production and consumption practices that adhere to planetary boundaries highlights the potential of urban manufacturing in creating resource-efficient urban economies and enabling circularity (Hill, 2020).

From the latter perspective, urban manufacturing is said to offer a chance to address societal and environmental challenges and advance green urban economies, yet the exact interconnection between urban manufacturing, sustainability, smart technologies, and the green economy remains underexamined

(Amjad & Diaz-Elsayed, 2024). In this context, different authors have investigated the role of urban manufacturing or urban agriculture in promoting low-carbon, energy-efficient, and resource-efficient economies through synthesising knowledge in comprehensive literature reviews (Amjad & Diaz-Elsayed, 2024; Herrmann, Juraschek, et al., 2020; Salisu et al., 2024; Tsui et al., 2021; Ulrichs & Mewis, 2015). While these reviews give initial hints on different arguments and evidence, they are narrow in scope, as they focus only on specific sub-topics or methodologies (e.g., life cycle assessment [LCA]), include only literature listed in a single database, or use limited queries ("urban manufacturing"), all of which leads to the risk of overlooking relevant findings reported under other terms (e.g., "urban production," "urban factory"), from other disciplines, or evidence collected using other methods.

A comprehensive assessment of the literature on the positive contributions of urban manufacturing to more sustainable urban economies is still lacking. This article addresses this gap by focusing specifically on the environmental dimension of sustainability. We examine how carbon, resource, and space efficiency can result from the geographic proximity between housing and production. The aims of this article are, therefore, threefold: (a) to summarise the current state of research by compiling empirical evidence on the environmental impacts of urban manufacturing, (b) to identify key arguments and underlying logics behind recurring claims, and (c) to derive questions that can guide further empirical assessment.

The objective is, thus, to synthesise the extant body of knowledge concerning urban manufacturing through a systematic literature review (SLR). This synthesis serves to identify evidence and arguments that demonstrate whether urban manufacturing reduces environmental impacts or simply redistributes them. For this, a range of queries applied in two databases were incorporated. The following selection and assessment involved three key steps: (a) systematic review of 711 articles on urban manufacturing listed in Web of Science and Scopus to identify a short-list of 163 relevant articles, (b) analysis of key arguments and empirical evidence in these, and (c) discussion of the findings and contextualisation with further research from planning, engineering, and environmental sciences.

2. Urban Manufacturing: An Ambiguous Concept With Uncertain Contributions to Sustainability?

Urban manufacturing describes producing and processing material goods in densely populated areas using local resources and value chains (Brandt, Gärtner, & Meyer, 2017). It is said to be based on low-emission and resource-efficient processes and transport methods due to proximity to residential areas (Brandt, Butzin, et al., 2017). As such, urban manufacturing is a concept uniting both spatial ("urban") and sectoral ("manufacturing") elements, which is why there are various interpretations of the phenomenon (e.g., Hill, 2020; Nischwitz et al., 2021; Piegeler & Spars, 2019).

While there are other conceptualisations which include the production of intangible goods, such as software, in the definition of urban manufacturing, this article builds on a sectoral understanding that emphasises the material nature of urban manufacturing (Brandt, Gärtner, & Meyer, 2017). Manufacturing is defined as the transformation of physical materials using labour, tools, and machinery (Hill, 2020). Our primary focus lies on the environmental benefits associated with the urban production of tangible goods and manufacturing processes. By this, we respond to recent calls for a stronger integration of materiality in spatial research, as it cannot be overlooked considering global challenges like climate change and environmental depletion—both

of which are connected to resource use and the material nature of manufacturing (Angstmann, 2025; Njøs et al., 2024).

The term "urban," on the other hand, is conceptualised in a broad sense to encompass the diverse interpretations found in the literature we reviewed. Although we acknowledge the conceptual fuzziness connected to the term (Fedeli et al., 2020; Gärtner et al., 2021; Meyer & Schonlau, 2024; Mistry & Byron, 2011; Roost & Jeckel, 2021), we decided to not further restrict our understanding as urban manufacturing is a global phenomenon and can thus be found in different urban locations such as metropoles, larger conurbations, as well as smaller cities.

Urban manufacturing can be subdivided into different types. One taxonomy looks at distributed, local, and inclusive manufacturing (Bonello et al., 2022). Another one divides it into (a) small-scale urban manufacturing in the form of small and medium-sized enterprises that produce high-value goods on a small scale (often clean, high-tech, vertical; Park, 2023); (b) larger-scale urban industries that rely on automated processes and division of labour adapted to urban contexts; and (c) urban agriculture as the professional cultivation of crops (Brandt, Butzin, et al., 2017; Brandt, Gärtner, & Meyer, 2017; Hertwig, Werner, et al., 2024). While urban industries were central in the last century, when large industrial firms were integrated into the urban fabric and offered large-scale employment, this type of manufacturing is declining globally due to modern zoning approaches and competition for land (Hearn et al., 2023; C. Zhang, Di Yao, et al., 2022). As a result, the current academic debate often focuses on small-scale producers (Park, 2023) or novel solutions for urban agriculture. This article examines all three types and draws specific conclusions where appropriate.

With the New Leipzig Charter, European cities promote urban manufacturing to implement the productive city paradigm, aiming to reintegrate small-scale production and integrate urban agriculture while addressing global challenges (Bundesministerium des Inneren, 2020). Planners and urban development agencies often justify support for urban manufacturing based on its economic, spatial, and environmental advantages (Betker & Libbe, 2019; Brandt, Gärtner, & Meyer, 2017; Gärtner & Schepelmann, 2023; Haselsteiner et al., 2019). From this perspective, the outsourcing of polluting or resource-intensive production processes to countries with lower environmental standards must be seen as a negative development (Gärtner & Schepelmann, 2023). Urban manufacturing provides a strategy to reverse the long-standing spatial separation of housing and manufacturing—and, by extension, of consumption and production—through regulatory and planning instruments.

This article focuses on the concept of green urban manufacturing (GUM), which is derived from Deif's (2011, p. 1553) definition of "green manufacturing": environmentally sound manufacturing embedded in urban areas, aiming for reduced emissions, efficient resource use, and spatial integration. By summarising the current state of research, we aim to clarify whether the widely claimed ecological benefits are supported by evidence or remain largely speculative (Gärtner & Stegmann, 2015) and outline directions for future research.

3. Methods and Dataset

We conducted an SLR to comprehensively identify and evaluate relevant literature and empirical evidence on how urban manufacturing can contribute to carbon, resource, and space efficiency in cities. The SLR method allows us to rigorously locate, select, and assess existing studies, ultimately synthesising data to

clarify what is known and unknown about a topic (Denyer & Tranfield, 2009). It provides objective and reliable findings by reducing potential biases (Tranfield et al., 2003). Denyer and Tranfield (2009) outline five key steps for SLR: (a) formulation of the research question, (b) location of studies, (c) selection and evaluation of studies, (d) analysis and synthesis, and (e) reporting and usage of findings. SLRs go beyond merely summarising literature, providing critical insights and identifying gaps (Briner & Denyer, 2012).

Literature reviews are not a novel approach in research on either GUM or its environmental aspects. Herrmann, Juraschek, et al. (2020) performed a literature review focusing on urban factories. Amjad and Diaz-Elsayed (2024) conducted an SLR with Web of Science data, limiting their search to "urban manufacturing." Tsui et al. (2021) used the Scopus database to identify articles employing the LCA methodology.

To capture a wide range of contributions, we included articles, book chapters, and conference proceedings listed in two databases, Web of Science and Scopus. We applied various queries aligned with the diversity of terms existing in the discourse about urban manufacturing to reflect the regional and disciplinary diversity of research on this topic (see Figure 1). We opted not to use "sustainability" as a filter in the query to capture a broad spectrum of relevant literature, including studies that may not explicitly use the term but discuss related concepts (e.g., green manufacturing, low-emission factories, green economies) and thus decided to filter the results manually, considering their contribution to the sustainability discourse.

The initial queries identified 711 articles, which were screened based on pre-defined relevance criteria (Denyer & Tranfield, 2009, p. 671). For this, two coders assessed each article's connection to "urban," "manufacturing," "planning," and "sustainability" independently. Articles were earmarked as relevant, partially relevant, or not relevant. Those with unclear relevance underwent further review before inclusion or exclusion in the final dataset.

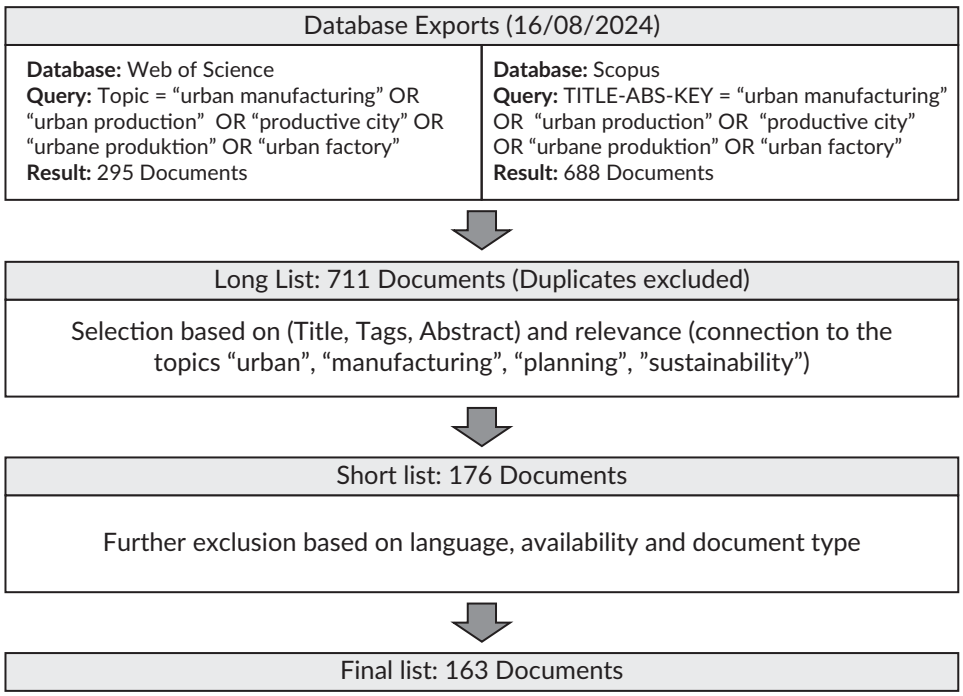

Figure 1. Dataset and systematic approach.

The final dataset comprises 163 documents published between 1993 and 2024, with most articles dealing with GUM published after 2019. The dataset consists of 79 peer-reviewed articles, 36 book chapters, 42 conference proceedings, and 6 other documents (editorials, reports, bulletins, short articles, or reviews; for details see Figure 2 or the supplementary material). We chose to retain a wide range of publications given the interdisciplinary nature of urban manufacturing research, with planners typically publishing articles or chapters and engineers often disseminating results through conference proceedings. This allowed us to capture a wide range of arguments and perspectives.

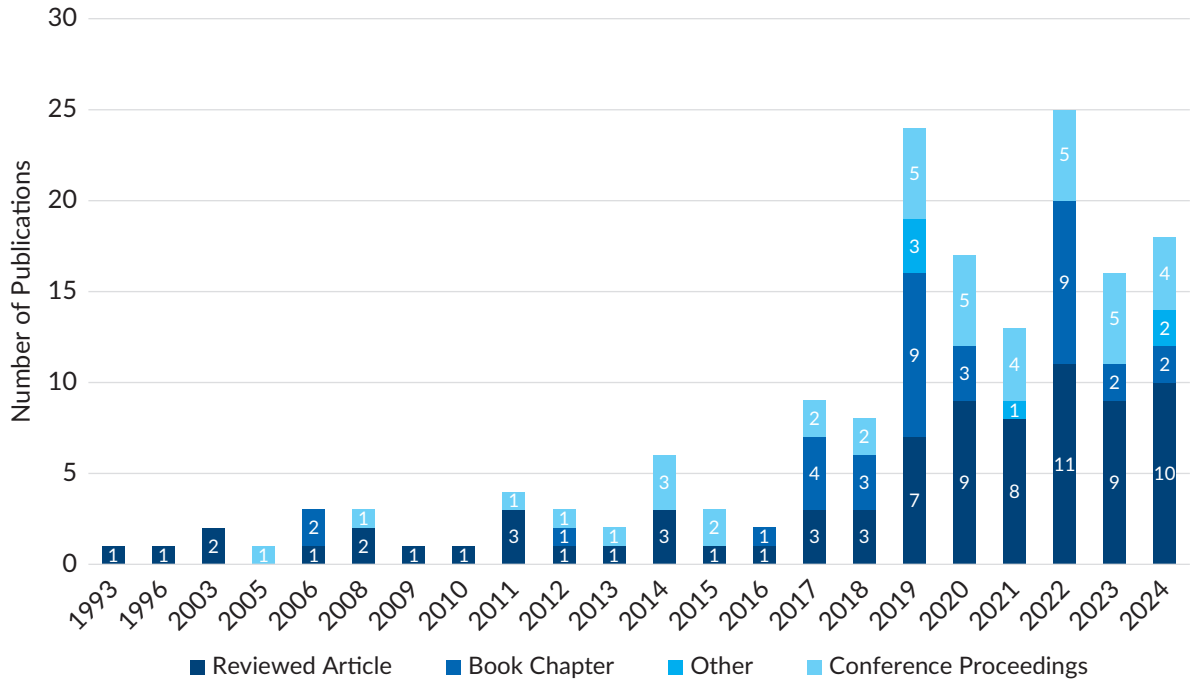

Figure 2. Publications dealing with urban manufacturing and sustainability by publication year.

The term "urban production" is used in 100 documents (61%), another 68 use the term "urban manufacturing" (42%), while 34 documents use both terms interchangeably (21%). The term "sustainability" appeared in 135 articles (82%), with most articles further specifying different types of environmental benefits (e.g., carbon efficiency and reduced emissions [82 documents, 50%], resource efficiency [77 documents, 47%], and space efficiency [38 documents, 23%]).

In our content analysis, we employed an inductive approach to derive insights from the reviewed literature without imposing predefined theoretical frameworks. We used MAXQDA to code key topics across the selected studies and to categorise findings following a grounded approach. Specifically, we first screened the articles and categorised statements, arguments, and evidence using the wording provided in each document. In a second step, we merged these codes into overarching categories (e.g., "lower CO_2 emissions" → "Carbon Efficiency"). To synthesise central findings (Denyer & Tranfield, 2009), we structured the analysis in two steps. First, we assessed the methods used in different studies and regional contexts to understand how evidence on the environmental effects of urban manufacturing was generated. Second, we focused on recurring arguments often connected to the ecological impacts of urban manufacturing, specifically carbon, resource, and space efficiency. These three categories illustrate the breadth of considerations regarding the various ways urban manufacturing may contribute to green urban economies.

Following a thorough analysis of GUM literature, we have identified two key logics: proximity and urban synergies. Proximity to consumers is beneficial in terms of reducing transport emissions and fostering a heightened awareness of production and its consequences. Here, geographical proximity is particularly relevant, as most articles suggest environmental benefits resulting from reduced transport distances. However, the reduced geographical distance between producers and consumers may also foster greater cognitive and relational proximity, thereby increasing awareness of production (Balland et al., 2022). Urban synergies describe a more complex relationship between manufacturing and other urban uses: Integrating manufacturing into the city's fabric may create or extend functional interconnections that lead to certain kinds of sustainability-focused agglomeration effects (Fahmy & Kamiya, 2019). This connects with perspectives from industrial ecology and urban metabolism research, depicting cities as complex systems where manufacturing can be seamlessly integrated with other urban functions (Kennedy, 2016). By employing different kinds of functional integration, urban manufacturing can enhance system-wide sustainability (e.g., city-wide energy efficiency), offering more profound benefits than (geographic) proximity alone.

Understanding these logics and how they are connected to different urban manufacturing categories (urban manufacturers, large-scale industries, and urban agriculture) and with respect to different goals of ecological sustainability, such as carbon, resource, and space efficiency, allows us to summarise the state of research on GUM and its effects thoroughly and across different institutional and regional contexts.

4. Methodologies and Approaches in Urban Manufacturing Research

Reviewing the literature on urban manufacturing reveals a growing body of evidence supporting its environmental benefits, although the overall evidence base remains limited. Out of the papers examined, 66 (40%) provide direct insights into areas like energy efficiency, carbon emissions, and resource use associated with urban manufacturing. Research in this field employs a variety of methods, including quantitative models, case studies, technological assessments and LCAs, each offering unique perspectives. These approaches are applied across different scales, from city-wide analyses to detailed examinations of individual companies or manufacturing processes.

4.1. Models, Quantitative and Spatial Analyses

Past research employed various models to analyse the impact of urban manufacturing systems (34 articles, 21%). These models focus on different impacts, for example on space (Burggräf et al., 2022), and on the local environment, due to pollution or water consumption (Görgens et al., 2023; Huang et al., 2021; Lopez, 2018; Zeng et al., 2017). These studies include city-wide assessments, particularly in the Asian context, analysing the nexus between manufacturing, environmental impacts, labour markets, and regulation (L. Chen et al., 2014; Feng et al., 2022; Ji et al., 2014), while others illustrate urban–rural interconnections (Güven, 2024). It is shown that the development of labour costs and environmental regulations is closely interconnected with the development of urban manufacturing (Daitoh, 2003, 2008; T. Zheng et al., 2019). While manufacturing is seen as a driving force behind increasing carbon emissions and water consumption (L. Chen et al., 2014), changes in urban emissions are closely connected to structural industrial change (tertiarisation), as decreased industrial activity leads to lower emissions (Zhao et al., 2014). In this context, urban economic modelling focusing on urban manufacturing also illustrates a shift from "producer" to "consumer" cities (S. Zheng et al., 2010). These

models primarily analyse urban economic systems rather than specific modes or technologies of production, depicting sectoral contributions to pollution and emissions.

4.2. Qualitative Case Studies

Beyond models, urban manufacturing research relies on context-specific or company-level case studies and urban design proposals (38 articles, 23%). Various case studies, mainly from the US, Europe, or Australia, show that urban manufacturing can address sustainability goals—environmental, economic, and social. For example, case studies on urban agriculture, including container gardens and rooftop farms, demonstrate how it can effectively utilise underused urban spaces (Bhatt et al., 2008) and illustrate how small-lot farming is compatible with other urban uses (Bonello et al., 2022; Di Maria et al., 2022). At the technology level, a variety of studies conduct experiments, compare technologies, or use production data to assess impacts. They often contrast large-scale conventional manufacturing with small-scale urban manufacturing (Juraschek, 2022), while case studies in urban industrial areas demonstrate how cross-sectoral synergies may enhance resource efficiency (Al-Asadi et al., 2024). Some studies use a multimethod approach to validate models by combining them with case studies (Sajadieh & Noh, 2024). Researchers employing case studies often report that their findings are closely connected to specific local conditions, for example geographical setting or institutional support (Büth et al., 2020; Rappaport, 2020).

4.3. Technology Analyses, Experiments, and LCAs

A third strand of research focuses on the assessment and simulation of technologies used in urban manufacturing, including their environmental impacts (Freeman et al., 2017; Rudolf et al., 2023). This encompasses evaluations of technology maturity (e.g., urban smart factories; Sajadieh & Noh, 2024) and analyses of infrastructure implications, such as increased strain on local transport systems (Juraschek, 2022).

To fully assess the environmental impact of specific technologies and their applications, it is essential to understand both upstream and downstream processes—such as indirect impacts from resource extraction, processing, and end-of-life handling—that are not directly attributed to the producing firm. LCAs, which incorporate the entire product life cycle, are therefore a central tool for thoroughly identifying these impacts. LCAs evaluate environmental effects from resource extraction to disposal, providing detailed insights into the sustainability of specific products and processes. For example, LCAs have highlighted successful strategies such as using composted coffee grounds in construction materials (Grodach et al., 2023) and achieving 50% water savings in aquaculture and hydroponics (Ulrichs & Mewis, 2015), demonstrating innovative approaches to end-of-life management and resource efficiency. However, findings are not always easy to interpret. Some studies report mixed results. For instance, urban manufacturing of eyeglass frames shows environmental benefits, whereas urban and non-urban asphalt production have similar impacts due to the dominant role of raw material extraction and transport (Juraschek, Becker, et al., 2019). Urban dairy systems emit more overall, but have the lowest emission intensity (Berhe et al., 2020). Rooftop greenhouses and photovoltaic systems are both viable but compete for space and depend heavily on local climate conditions, limiting the transferability of findings (Corcelli et al., 2019). Aquaponics can improve energy and water efficiency through symbiotic processes (Büth et al., 2020).

These findings, thus, show that urban system effectiveness is context-dependent when it comes to solutions in agriculture. While recent research indicates urban agriculture can emit six times more than conventional methods, using specific crops can reduce this footprint drastically (Hawes et al., 2024). One major topic in different studies is water consumption in urban agriculture, where vertical farming solutions may lead to a higher water use efficiency than conventional methods (Carotti et al., 2023). However, while hydroponics and aquaponics systems achieve water savings (Hasan, 2020; Salisu et al., 2024; Ulrichs & Mewis, 2015), studies examining other parameters, like nitrogen utilisation (Y. Zhang, Zhang, & Li, 2022) or energy expenditure (Benis et al., 2018), reveal that these technologies may only deliver benefits in some parameters compared to conventional agricultural practices.

4.4. Summarising Methods and Scope of Previous Research

Research on GUM provides a variety of insights on different scales of assessment. On a city-scale, there are analyses of whole urban systems and their associated pollution or environmental impact, which often allow only limited conclusions about specific cases or approaches. On a firm-level scale, there is a variety of studies that focus on specific firms in specific contexts. Case-based or technology-based findings provide detailed contextual information, and it becomes clear that findings always rely on specific geographic and operational conditions and challenges (Corcelli et al., 2019; Juraschek, Becker, et al., 2019).

As a result, findings require cautious interpretation. Local factors, such as water availability, access to renewable energy, or regulatory constraints, play a critical role in shaping both environmental outcomes and implementation feasibility (Tsui et al., 2021). In urban agriculture, for example, legal restrictions on livestock, soil imports, or chemical use can limit certain practices, even with policy support (Lawal-Adebowale & Alarima, 2011; Pfeiffer et al., 2015). In some cases, environmental conditions such as soil contamination may render specific solutions infeasible altogether (Bhatt et al., 2008).

This complexity of results challenges a general synthesis of previous empirical findings and generalisation. Nevertheless, understanding the granularity of previous interdisciplinary research—which combines various methods and perspectives to produce findings that may hold true in some contexts but not others—is fundamental for reviewing key arguments. These arguments propose that urban manufacturing could be a solution for enhancing ecological sustainability in urban economies, along with the underlying logics related to different types of environmental impacts.

Furthermore, most of the literature in our review did not empirically test hypotheses about the sustainability of urban technologies or manufacturing solutions. Research in urban planning and engineering often focuses on developing conceptual frameworks for integrating urban manufacturing, creating methods to assess environmental impacts, or conducting literature reviews on specific technologies. Only about 40% of the articles offered direct empirical evidence, while a significant portion derived sustainability claims indirectly—either by referencing other sources (39 articles, 24%) or through theoretical reasoning and logical argumentation (36 articles, 22%).

5. Exploring Sustainability Arguments in Urban Manufacturing Research

Although empirical evidence on the environmental benefits of urban manufacturing remains limited, most articles in our dataset (141 out of 164) contain arguments or claims about its potential to reduce environmental impacts. Using the analytical framework presented in Figure 3, we categorise and evaluate these claims across multiple dimensions. The framework focuses on key environmental factors—carbon, resource, and space efficiency—and identifies two overarching sustainability logics: proximity benefits (e.g., reduced transport distances, greater visibility of production) and urban synergies (e.g., industrial symbiosis, shared infrastructure, optimised land use). It further distinguishes between three types of urban manufacturing—urban industries, urban manufacturers, and urban agriculture—each of which contributes to environmental sustainability in different ways based on its interaction with urban settings.

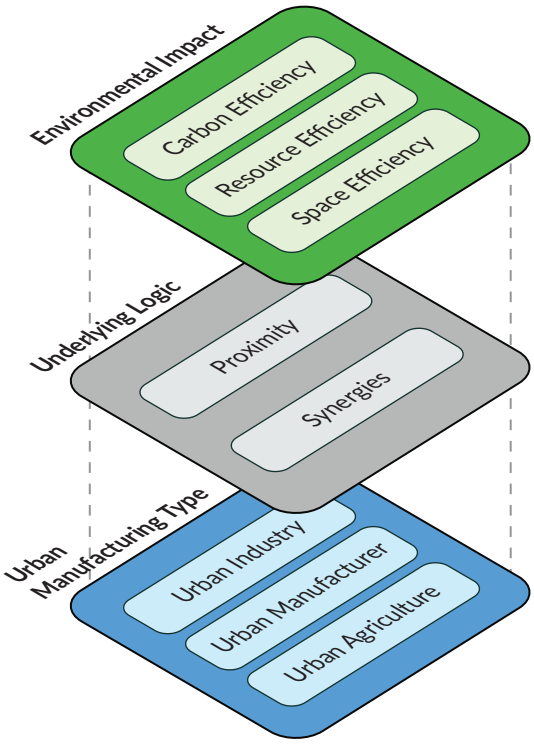

Figure 3. Synthesis: Environmental impacts, underlying logics, and types of urban manufacturing.

5.1. Carbon Efficiency

Urban production systems have been observed to exhibit higher emission intensities for both carbon dioxide and methane compared to economic activities in other sectors, highlighting their substantial impact on the environment (Berhe et al., 2020; L. Chen et al., 2014; L. Fu & Wang, 2022). Simultaneously, urban manufacturing is often conceptually linked to more sustainable modes of production compared to conventional manufacturing outside urban areas, with various authors promoting ideas such as "ultra-efficient urban manufacturing" (Singh, 2017, p. 324) or "ultra-efficient production systems" (Schutzbach et al., 2021, p. 1781). Furthermore, urban manufacturing is often associated with the use of green energy (Buchholz et al., 2005; Darling, 2020; Hasan, 2020).

5.1.1. Proximity

It is frequently argued that urban manufacturing may contribute to sustainability by reducing transport emissions and enhancing logistical efficiency (mentioned in 43 (26%) of the articles). Localising production in urban settings reduces distances to potential markets, shortening supply networks (Ball & Badakhshan, 2023; Barni et al., 2018, 2019; Diez, 2020; C. Fu et al., 2021; Grodach et al., 2023; Hertwig, Nowak, et al., 2024; Hildebrandt et al., 2021; Ijassi et al., 2023; Juraschek, 2022c; Krenz, Saubke, et al., 2022). This closeness to customers reduces delivery times and can improve resource sourcing (Barni et al., 2019). Studies suggest that shortening transport distances can reduce greenhouse gas emissions by 0.8–2.6%, reflecting potential environmental benefits (Tsui et al., 2021). Therefore, efficient city logistics are often seen as a critical component of urban manufacturing as they allow for streamlined supply chains and reduce transportation distances (Stiehm, 2019).

Urban agriculture, in particular, is frequently mentioned when it comes to proximity benefits, as it offers the dual benefits of reducing emissions and enhancing local urban ecosystem services. Local food systems are widely recognised for their potential to significantly decrease emissions by reducing the distance food must travel to reach urban consumers, thereby lowering the carbon footprint associated with food transportation (Ulrichs & Mewis, 2015). Several researchers conclude that maintaining local food production on-site and reducing food miles can significantly contribute to more sustainable urban environments (Benis et al., 2018; Bonello et al., 2022; Borowski et al., 2012).

Another strand of arguments draws the connection to positive impacts due to employees being able to lower emissions through lower commuting distances and the possibility for employees to use sustainable urban transport infrastructures (Bonello et al., 2022; Ferm, 2023; Hauge et al., 2021; Juraschek, Bucherer, et al., 2018; Juraschek et al., 2017; Lopez, 2018; Meyer, 2023; Rappaport, 2017; Singh et al., 2017; Yin & Yao, 2024).

Technological innovation is seen as fundamental as it enables low-emission production processes that can be situated in urban contexts (Ball & Badakhshan, 2023; Benis et al., 2018; X. Chen et al., 2024; Di Maria et al., 2022; Rappaport, 2017; Roost & Jeckel, 2021; Singh et al., 2017; Vidal et al., 2022). Throughout the literature, there is a broad consensus that urban manufacturing often leverages sustainable modes of production, evident in the concept of "city-compatible manufacturing" characterised by carbon efficiency and low-emission production processes (Antczak et al., 2023; Benis et al., 2018; Darling, 2020; Grodach et al., 2023; Herrmann, Juraschek, et al., 2020; Juraschek, Kreuz, et al., 2019; Kreuz et al., 2020; N. L. Martin et al., 2024; Meyer, 2023; Monaghan & Beacham, 2017; Roost & Jeckel, 2021; Singh et al., 2017; Spath & Lentes, 2013; Tricarico, 2024).

Recent research often provides general advice on technological development strategies (e.g., biologically inspired green technologies; Schutzbach et al., 2021) or analyses specific technologies significant for small-scale urban manufacturing (e.g., vertical factories, CNC milling, additive manufacturing) that enable production facilities to be close to residential areas due to their reduced environmental impact (Barni et al., 2019; Meyer & Schonlau, 2024). This also encompasses technologies for sustainable urban agriculture (Benis et al., 2018) and synergistic, resource-efficient production in aquaponics systems (Y. Zhang, Zhang, & Li, 2022). A further strand analyses new materials for manufacturing processes, like biodegradable, reusable, or recyclable materials, as well as thermoplastics (Barni et al., 2019). In general, these strands of research

argue that innovation may enable city-compatible manufacturing processes, which inherently produce lower emissions and are thus particularly suitable for integration into urban environments (Matt et al., 2020; Singh et al., 2017).

Urban manufacturing based on city-compatible production, either due to its smaller scale (Bundesministerium des Inneren, 2020; Grodach et al., 2023) or use of specific technologies, is, therefore, often seen as sustainable manufacturing in general. Compact urban areas are conducive to fostering low-carbon lifestyles and production practices, which aid in reducing carbon emissions by minimising transportation needs (Yin & Yao, 2024). To conclude, the need to use efficient technologies when producing in an urban location, as well as proximity to consumers, are key mechanisms by which urban manufacturing is often said to be more energy- and carbon-efficient.

There are, however, caveats. First, high-tech does not always equate to low pollution, as demonstrated by Yoshida (2008). Second, although small-scale technologies may be well-suited for urban manufacturing, there is debate about the extent of their sustainability impact in a global context. Basic materials and components are often produced outside urban manufacturing processes—in distant facilities—contributing significantly to overall value chain emissions and environmental impacts (Singh et al., 2017). Further, the efficiency gains associated with larger manufacturing scales might be lost when production is downscaled to fit urban contexts. Consequently, although local environmental impacts might decrease, the global impact per unit produced could increase (Juraschek, 2022). Third, when it comes to the impact of transportation, only a limited number of sources provide detailed evidence to underscore how these operate and why their operation is, indeed, more efficient. Effective logistics flows may reduce traffic volumes and emissions, thereby providing a potential sustainability advantage for urban manufacturing (Reineke et al., 2021). However, transport emissions in many products or production processes only make a minor contribution to emissions when the whole life cycle of the product is analysed (Tsui et al., 2021). Fourth, the studies on urban agriculture provide mixed evidence on its impact. In some cases, the higher emissions associated with activities like energy consumption for vertical farming or resource-intensive practices can offset the gains achieved from reduced transportation (Berhe et al., 2020). This nuance suggests that the environmental performance of urban agriculture can vary significantly depending on the methods and technologies employed.

Producing in cities—especially in countries with strict environmental legislation on emissions and pollution and planning systems based on zoning—leads to the impetus to use low-emission technologies. However, positioning low-emission production as both a prerequisite for urban manufacturing and a justification for its sustainability may create a circular argument. This perspective suggests a scenario where urban manufacturing is seen as sustainable largely because it is designed to be low-emitting, which is a principal expectation set for its implementation, not being sustainable because it is urban. Meaning that the technology could also be applied in other non-urban contexts. These arguments, grounded in specific technologies, should, therefore, be seen with caution.

5.1.2. Urban Synergies

Further arguments emerge when considering carbon efficiency not only at the company level but also at the city level. Various proposals aim to functionally integrate manufacturing within the urban fabric, generating synergies both with other economic actors and with civil infrastructure.

Industrial agglomeration is argued to have the potential to lower emissions by enabling the efficient use of shared resources and infrastructure (Huang et al., 2021). The increased concentration of production facilities in urban areas may result in strain on existing infrastructure, necessitating careful management and strategic planning to maximise the potential sustainability benefits without overwhelming city systems (Herrmann, Juraschek, et al., 2020; Juraschek, 2022b), a consequence that is not often given sufficient consideration.

Additional solutions include companies acting as energy suppliers or green fuel producers (Barni et al., 2019; Juárez-Casildo et al., 2022; Tötzer et al., 2019). In these cases, the benefits of urban manufacturing arise from integrating manufacturing into the broader urban fabric or consumption and production systems, rather than from individual firms' technology use. Local companies and crafts are also needed to implement the urban energy transition (Meyer, 2023). A limited number of studies have explored integrating efficient production processes into the urban environment, harvesting potentials from the built environment. An example is the efficiency of rooftop greenhouses that capitalise on local energy and resources while optimising sunlight due to their exposure (Peña et al., 2022). However, while a variety of arguments support the contribution of urban manufacturing to carbon efficiency at the city level, empirical analysis often focuses on the firm or technology level.

5.2. Resource Efficiency

Urban manufacturing plays a key role in resource efficiency and circular economy integration (318 mentions in 44 documents). As cities consume 60–70% of global resources and generate about 50% of waste (Ijassi et al., 2023), they hold potential as hubs for sustainable production and consumption. Urban manufacturing is seen as integral to connecting local supply and demand cycles, promoting resource efficiency (Ball & Badakhshan, 2023; Ferm, 2023). Despite past trends favouring service-oriented space use, separating production from consumption, and creating linear systems dependent on the hinterland, scholars highlight urban manufacturing's role in circular economy practices (Hausleitner et al., 2022). By fostering symbiotic relationships and closing resource loops, urban manufacturing can turn waste into production inputs (Juraschek, Kreuz, et al., 2019; Matt et al., 2020). Therefore, researchers suggest that cities can advance a circular economy by supporting repair, refurbishment, and recycling in urban areas (Benis et al., 2018; Ijassi et al., 2024).

5.2.1. Proximity

Urban manufacturing companies focused on repairing, recycling, and reusing materials are crucial for resource efficiency, supported by technological advancements. A key circular economy strategy is reducing resource use. Distributed manufacturing employing additive technologies (e.g., 3D-printing) can lower energy and material consumption, enabling customised, efficient, small-scale, or spare part production with reduced environmental impact (Bonello et al., 2022; Kreiger & Pearce, 2013; Moerlen & Evrard, 2021; Tsui et al., 2021). Extrusion-based processes and platforms for resource reuse optimise material cycles, decreasing raw material dependence (Barni et al., 2019; C. Zhang, Di Yao, et al., 2022). Urban agriculture innovations, such as vertical farming and soilless cultivation methods like hydroponics, might increase yields while minimising resource inputs, especially water consumption (Carotti et al., 2023; Salisu et al., 2024; Ulrichs & Mewis, 2015).

As cities grow, the more crucial they become for reuse and recycling strategies (Benis et al., 2018). "Urban mining" repurposes end-of-life products for reuse, remanufacturing, or recycling, transforming cities into repositories of secondary resources (Herrmann et al., 2019; Juraschek, 2022a). Manufacturing in cities, from this logic, means manufacturing near a possible source of future secondary resources. Urban agriculture, in particular, illustrates how circular value chains may function, as it can utilise local compost and recycled water (Buchholz et al., 2005; Büth et al., 2020; Pfeiffer et al., 2015).

Beyond conventional manufacturers, makerspaces and Fablabs (373 mentions in 30 documents) are also depicted as pivotal for advancing urban resource efficiency and circular economy practices. They emphasise "reduce, reuse, and recycle" through repair cafés, second-hand shops, and Fablabs, fostering community-oriented sustainability and the circular economy (Elwakil et al., 2023). As hybrid environments for artistic and manufacturing experimentation, they foster innovative circular solutions and community sharing, building local circular economy circuits (Tricarico, 2024). The "Fab City" model envisions cities producing what they consume locally while sharing knowledge globally (Diez, 2020).

Despite its potential, urban manufacturing faces practical limitations. Many conceptual proposals lack operational feasibility, and although technologies like distributed manufacturing can reduce energy and material use, their impact in practice depends heavily on product design, production chains, and local regulations (Freeman et al., 2017). Furthermore, most urban and conventional factories focus primarily on the manufacturing phase of a product's life cycle, while material sourcing and end-of-life processes often receive little attention in the urban context. As a result, circular practices have yet to be widely adopted (Juraschek, Becht, et al., 2018).

Furthermore, methodological challenges arise when comparing conventional and urban manufacturing. Some studies assume urban manufacturing technologies are inherently more resource efficient: "Waste reduction differentiates urban factories from classic industry, with disposable items replaced by reusables to avoid waste" (Moerlen & Evrard, 2021, p. 416). However, these findings do not confirm urban manufacturing's inherent efficiency but show the benefits of using certain associated technologies or resources that are also applicable in non-urban locations.

5.2.2. Urban Synergies

For local manufacturing to become relevant in a global competitive economic environment and to foster the local sustainable transformation, it must focus on key benefits: situating production near consumption, leveraging local demand, and utilising urban resources (Krenz, Stoltenberg, et al., 2022). By fulfilling local demand and using urban resources, the concept of urban factories emphasises the potential of "urban mining" to repurpose waste as a secondary resource (Ijassi et al., 2024). In this context, end-of-life products can be reused, remanufactured, or recycled, reducing disposal and capitalising on waste materials (Herrmann et al., 2019; Juraschek, 2022a). Recycling factories participate in closed-loop flows, using local waste (Juraschek, 2022). Urban agriculture, utilising local compost, improves soil quality and yields (Dasylva et al., 2018; Pfeiffer et al., 2015). Technological advances in recycling allow for the integration of local resources into sustainable systems (Krenz, Saubke, et al., 2022).

Urban industrial symbiosis (204 mentions in 45 documents) is one central strategy for local resource utilisation, connecting different urban economic actors through waste and by-product streams. Here, urban

manufacturing may be used to close material and energy streams, improving urban internal metabolism (Keeffe, 2012). Cities offer cooperation opportunities among manufacturers (Herrmann, Büth, et al., 2020). Collaboration boosts efficiency, optimising resource use with shared investments (Lentes & Hertwig, 2019). Zero-emission parks illustrate shared resources and cooperation for GUM (Hüttenhain & Kübler, 2021), and symbiotic relationships can cut waste up to 15%, as one study of an industrial park shows (Al-Asadi et al., 2024). In this context, firm networks of urban manufacturers can redirect waste outputs to reduce environmental impact and costs (Al-Asadi et al., 2024; Ben & Wang, 2011). Furthermore, companies benefit from shared infrastructure and resource sharing, which lowers expenses (Spath & Lentes, 2013). Synergies like these can be developed within eco-industrial parks or between manufacturers and other urban entities, for example waste heat utilisation for heating residential areas (Afshari et al., 2018). In this sense, multifunctional land use supports sustainable growth by enabling synergies and efficiency gains on the city level (van Veenhuizen, 2011; Yang et al., 2020).

While symbiotic relationships in urban manufacturing are desirable, their implementation remains challenging. The often-cited Kalundborg (Denmark) symbiotic network demonstrates the potential of this approach; however, its complexity has rarely been replicated elsewhere, illustrating that such networks are inherently tied to local contexts and cannot be easily duplicated (Hertwig et al., 2021). Although shared infrastructure offers benefits, it frequently exists only as proposals with limited validation (Lentes & Hertwig, 2019). Effective inter-company communication and transparency are critical for building synergies and thus depend not only on proximity but also on active intermediation (Lentes & Hertwig, 2019).

When it comes to urban symbiosis, integrating not only firms but also other urban entities highlights further challenges: The real-world implementation of the idea of urban symbiosis often manifests itself in solutions of energy and heat supply, while there is less attention given to material recycling or wastewater treatment (Fraccascia, 2018). This narrow focus might not suffice to provide a comprehensive framework for urban resource management. Furthermore, diverse examples in international research reinforce the idea that many potential urban symbiosis solutions, like municipal heat exchanges or localised material recycling projects, depend heavily on context-specific factors (Neves et al., 2020).

Functionally connecting production processes in urban contexts is, however, not only said to enhance environmental benefits but is also seen as a key strategy to improve economic resilience (Juraschek, Bucherer, et al., 2018). It is often promoted in local strategic plans for its ability to strengthen local economies and reduce their dependence on external supply chains (Grodach, 2022; Hasan, 2020; Rappaport, 2020). Here, urban agriculture is said to improve food security and nutrition, which are essential for urban health (Bhatt et al., 2008). Further benefits are social inclusion and equitable employment opportunities (Al-Asadi et al., 2024; Bonello et al., 2022; D. Martin & Grodach, 2023; Meyer, 2023; Tricarico, 2024).

Urban manufacturing must therefore be considered not only from the perspective of individual company practices, technologies, or their impact, but also from the perspective of its function within the city. Synergies enabled by manufacturing within cities thus contribute to economic and social sustainability. Urban manufacturing supports sustainable urban development through resource conservation and use of public transport (D. Martin & Grodach, 2023; Meyer, 2023).

5.3. Space Efficiency

Urban areas face space scarcity for manufacturing due to dense populations and the profitability of housing and office spaces (Ferm & Jones, 2017). Space conflicts arise from competing urban activities (Juraschek, Kreuz, et al., 2019), necessitating efficient industrial land use for urban manufacturing development (C. Zhang, Di Yao, et al., 2022). Urban manufacturing can efficiently use space by re-purposing existing areas, decentralising processes, and utilising vacant plots and rooftops (Hasan, 2020; Yang et al., 2020), which is why space efficiency of some kind is mentioned as an argument for urban manufacturing in 38 of the analysed documents (23%).

5.3.1. Proximity

Technological innovations are crucial for achieving space efficiency in urban manufacturing, particularly through vertical production and noise reduction. Vertical urban factories are suggested as solutions to space constraints, minimising land use while maximising output (Darling, 2020; Rappaport, 2020). This aligns with sustainable urban development trends addressing land use efficiency and environmental sustainability. Modular production systems enhance space efficiency, allowing functionality in small spaces (Büth et al., 2020). Advances in supply chain management and urban-specific warehousing support this efficiency (Abdoli et al., 2019; Amjad & Diaz-Elsayed, 2024). In urban agriculture, vertical farming exemplifies efficient space use with high-density planting and soilless systems, maximising yield and conserving resources (Carotti et al., 2023; Salisu et al., 2024). Vertical farming also limits urban sprawl (Benis et al., 2018). Vertical growth and mixed land use facilitate overlapping functions, like combining production with retail or residential spaces, enhancing economic viability and resilience (Singh et al., 2017; Yang et al., 2020).

From another perspective, space-efficient urban manufacturing close to residential areas also offers environmental advantages as the proximity allows consumers to understand the impacts of manufacturing processes, which increases awareness of manufacturing and its environmental impact (Barni et al., 2019). In this sense, urban manufacturing fosters awareness and sensitises urban inhabitants to production practices (Cima & Wasilewska, 2023; Hearn et al., 2023; Lowe & Vinodrai, 2020). In this context, geographical proximity fosters relational, organisational, or social proximity (Balland et al., 2022; Boschma & Frenken, 2010) as manufacturers create local jobs in these industries (Feltrin et al., 2022) or involve customers in co-creation processes, for example when products are highly personalised and, thus, highly customer-oriented, while reducing supply chain emissions and attracting skilled workers (Butzin & Meyer, 2020; Sajadieh et al., 2022). Similarly, studies indicate that localised food production benefits the environment, as local farmers are more environmentally conscious and use improved fertilisers (Hall et al., 2014, as cited in Tsui et al., 2021).

However, there is a risk that small-scale and highly efficient urban manufacturing may create a misleading awareness. Urban manufacturing typically involves operations that are small-scale, downstream, and low-emission. Basic industries that extract or process primary resources—often utilised in urban production—are primarily situated elsewhere. This can result in a skewed perception focused on industries that operate within urban areas (e.g., small-scale manufacturers), while neglecting essential upstream activities like resource extraction. As one study suggests, the efficiency of urban manufacturing might lead to rebound effects due to the perceived low environmental impacts and the increased local availability of products (N. L. Martin et al., 2024).

5.3.2. Urban Synergies

Multi-use spaces enhance urban manufacturing sustainability by integrating functions within confined areas. Combining manufacturing with activities like rooftop farming supports urban food supply and sustainability (Bonello et al., 2022; Darling, 2020). This approach utilises underused spaces and integrates green infrastructure into urban environments (Bhatt et al., 2008). Multifunctional urban agriculture is said to improve food security (Benis et al., 2018; Fahmy & Kamiya, 2019). Additionally, urban agriculture contributes to carbon sequestration (Büth et al., 2020; Peña et al., 2022). Techniques such as organic farming and urban horticulture enhance urban green spaces, which are crucial for maintaining ecological balance in metropolitan areas and reducing the heat island effect (Büth et al., 2020; Kouloumprouka Zacharaki et al., 2024). Urban agriculture, thus, extends biodiversity and provides ecosystem services (Gerster-Bentaya, 2013; Peña et al., 2022).

Shared infrastructure in urban manufacturing sites provides advantages, enabling reduced capital demand (Meyer, 2023; Spath & Lentes, 2013). Vertical factories prioritise multifunctionality in urban planning (Moerlen & Evrard, 2021; Rappaport, 2017). Urban environments can integrate biological and nature-inspired technologies (Antczak et al., 2023; Herrmann, Büth, et al., 2020). Systems combining hydroponics, aquaculture, and urban waste composting create a diverse technological landscape supporting sustainability (Büth et al., 2020).

Reusing space promotes sustainability in urban manufacturing by revitalising existing infrastructure. Detroit is an example where reusing industrial spaces fosters synergy between creativity and traditional production (Di Maria et al., 2022). This creative repurposing is said to preserve historical urban fabrics while bolstering local economies by creating vibrant innovation hubs. The use of brownfield sites and vacant buildings highlights the potential that reusing urban spaces offers for production purposes. Conversion of underutilised areas, such as rooftops, into productive sites is reportedly gaining traction due to multifaceted benefits (Corcelli et al., 2019; Stiehm, 2019).

However, multi-coding urban spaces for multiple economic activities can lead to conflicts. A study comparing rooftop crop production and renewable energy generation found both as potentially viable solutions that are, however, not compatible to be installed in the same place (Toboso-Chavero et al., 2019). Furthermore, multifunctional space use can also lead to the loss of manufacturing space in the long term (Grodach, 2022). Mixed-use areas can marginalise manufacturing sectors and lead to gentrification (Grodach et al., 2023). New industries face planning hurdles in urban environments, relying on planners to understand impacts (Grodach et al., 2023).

6. Discussion: What We Know and What We Don't Know

Efficient technologies are prerequisites for urban integration given space and resource limits (D. Martin & Grodach, 2023). These advanced technologies may reduce emissions and improve energy efficiency but are not exclusive to urban manufacturing: Technologies such as additive manufacturing can be applied in urban and non-urban settings. Furthermore, focusing solely on technology can lead to unvalidated technocratic visions, possibly excluding non-"city-able" processes. One major shortcoming of previous research is that urban manufacturing case studies often focus on the end points of the supply chain, neglecting upstream

activities that have greater environmental impacts. Research shows that 90% of the environmental impacts of goods stem from supply chains rather than production, with embedded emissions being much higher than direct ones (Bové & Swartz, 2016). Carbon emissions also differ largely across product types (Meinrenken et al., 2020), making it difficult to generalise results based on a single product or manufacturing process.

The scale of production is crucial in evaluating conventional versus urban manufacturing impacts. Small-scale urban manufacturing might increase global impact compared to large-scale operations due to missed scale effects (Juraschek, 2022). However, small-scale production can be better matched to local demand and reduce strain on urban systems or ecosystems, for example in terms of traffic congestion or water consumption (Juraschek, 2022; Krenz, Saubke, et al., 2022). Furthermore, an excessive focus on small-scale, low-emission urban manufacturing may obscure pollution from larger industrial activities outside cities and potentially distort overall awareness of environmental impacts. This narrow perspective overlooks burden shifting to hinterlands, where less-efficient processes may increasingly contribute to a product's overall environmental impact.

Proximity benefits like reduced transport emissions are less impactful than often assumed, with transport emissions being only a minor portion of total emissions in some manufacturing processes (Tsui et al., 2021). While proximity can help reduce transport-related emissions, greater environmental benefits typically result from minimising waste and increasing the use of recycled materials (Benis & Ferrão, 2017; Tsui et al., 2021). In this sense, the true potential of proximity lies in enabling functional interconnections and synergies between production, consumption, and resource flows within the urban context.

Furthermore, studies suggest that networks, not merely proximity, are essential for creating synergies and symbiotic relationships (Spath & Lentes, 2013). Proximity can underpin networks but requires active building and external facilitation to achieve synergy benefits (Krenz, Stoltenberg, et al., 2022). It is, therefore, not just proximity that matters, but synergies enabled by functionally connecting manufacturing with the urban setting. This harnesses firm, sector, and community interconnections to utilise urban form for efficiency, embodying "urban" manufacturing. These synergies leverage existing infrastructure for resource sharing, supporting broader sustainability goals (Kreuz et al., 2020).

The validity of different arguments may vary depending on the three different types of manufacturing: small-scale manufacturing, urban industry, and urban agriculture. While vertical factory proposals exist, implementations remain limited (Haselsteiner et al., 2019). In contrast, large-scale industrial production is space-intensive, posing integration challenges. Urban agricultural technologies and practices can often be integrated into existing structures like rooftops or vacant spaces, and small-scale manufacturing fits well in mixed-use zones, seamlessly incorporating into the urban fabric. Finally, technologies like vertical farming can enhance urban agriculture sustainability but depend on local circumstances, indicating that effective practices in one context may not suit others (Berhe et al., 2020). This highlights the need for context-aware strategies addressing each urban environment's unique traits, as articulated by Juraschek (2022b, p. 63): "Urban production systems are connected with the surrounding quarter, city and region through input and output flows of energy, materials and information."

Finally, urban manufacturing reduces emissions through specific practices and consumer involvement, enhancing awareness for environmental impacts. Although this is a valid argument, this indirect type of

impact is particularly difficult to capture empirically, and the argument itself leads to questions concerning rebound effects (N. L. Martin et al., 2024).

Including a large international dataset allowed us to capture the breadth of the global scientific discourse on urban manufacturing. However, this approach has its limitations. Most empirical studies focus on China (21), the US (16), Germany (15), and other European countries (26). Therefore, these findings must be interpreted within the context of local economic dynamics—such as levels of deindustrialisation and tertiarisation—as the insights are shaped to some extent by the specific discourses and challenges of these regions. Furthermore, this means a lack of research on urban production and its sustainability effects in more informal planning contexts or less regulated environments. As formulated by Fahmy and Kamiya (2019), sustainability in urban settings typically results from deliberate political will and collective stakeholder engagement. Furthermore, cities that aim for sustained urbanisation in formal planning systems are more likely to preserve rural lands and environment, promote socio-economic development and inclusion, and reduce commuting time and distances, consequently minimising the cities' carbon footprints (Fahmy & Kamiya, 2019). The transferability of findings to informal planning systems is, thus, limited, highlighting the need for comparative research that considers diverse governance and spatial conditions.

The heterogeneity of empirical approaches must also be considered in relation to these regional contexts. Most of the qualitative case studies focus on North American (11), European (18), and Australian (3) cities and mainly examine specific firms while also reflecting on local planning approaches and policies. In contrast, most of the research from Asia (21), and primarily from China (19), frequently employs quantitative data and modelling at the city or country-level. This hinders our ability to compare results or generalise findings as they were gathered in different contexts, using different methods, and scopes.

In conclusion, urban manufacturing research is rich in proposals addressing carbon, resource, and space efficiency. Although ideas like vertical urban factories and modular systems are prevalent, they often lack empirical validation across different urban contexts. Suggested approaches include recycling factories with closed-loop systems (Juraschek, 2022) and urban mining (Spath & Lentes, 2013). Energy and resource efficiency efforts leverage urban proximity for symbiotic networks (Hertwig, Nowak, et al., 2024; Lentes & Hertwig, 2019; Schutzbach et al., 2021), while space efficiency targets vertical factories (Darling, 2020) and multi-use spaces (D. Martin & Grodach, 2023; van Driel, 2014). Despite numerous frameworks and strategies, empirical data are limited. Models extensively explore spatial and economic dynamics, including interactions between urban manufacturing and the city economy (Burggräf et al., 2022), as well as simulations of urban carbon emissions (L. Chen et al., 2014; Ji et al., 2014). Case studies (Al-Asadi et al., 2024; Di Maria et al., 2022) provide valuable insights, but their findings are often closely connected to the specific geographical and institutional context in which they were conducted. The same applies for technology assessments and LCAs, which typically address product- or technology-specific solutions (Carotti et al., 2023; Juraschek, Becker, et al., 2019; Ulrichs & Mewis, 2015). Certain solutions, such as rooftop greenhouses in the Mediterranean climates (Corcelli et al., 2019), or space-efficient factory designs—including vertical factories and brownfield redevelopments—may be fostered by particular planning systems (Bonello et al., 2022; Burggräf et al., 2022; Singh et al., 2017). However, transferring these solutions to different geographical or institutional contexts may not always be feasible.

Although urban manufacturing can help address some environmental challenges, it remains difficult to draw a comprehensive conclusion about its overall contribution to sustainability or to the circular economy. General models or technology analyses of "urban" and "conventional" production, often based on questionable assumptions, provide limited help. Instead, case-by-case research, especially comprehensive case studies of specific technologies in diverse real-world urban contexts (see Hawes et al., 2024), can significantly enhance our understanding.

7. Conclusion

Urban manufacturing has garnered significant interest as a potential catalyst for addressing contemporary challenges. Defined by its reliance on local resources and integration within densely populated areas, urban manufacturing aims to balance traditional production with emerging paradigms of mixed-use cities and sustainable practices. Despite widespread claims concerning the ecological and efficiency benefits of GUM, these are often based on theoretical assumptions and less on empirical validation.

Extensive research, including urban economic models, firm-level cases, and technology assessments, provides insights into specific questions within specific contexts. Modelling often provides general knowledge on sectoral developments and, most recently, developments in Asian cities, while firm-level case studies often explore Western economic and institutional contexts. Findings on technologies or specific technological solutions are typically context-dependent (e.g., agricultural technologies influenced by climate conditions) or shaped by assumptions about urban vs. conventional production (e.g., primary vs. secondary resource use).

Findings indicate that potential benefits may rely more on integration strategies than on technological solutions alone. Effectively leveraging urban manufacturing for sustainability, however, requires considering all levels (city, firm, technology) and benefits through proximity or synergies with other uses. This allows us to identify context-specific strategies that not only focus on technologies but also on their integration into the existing urban fabric. A perspective of urban manufacturing solely as production within the city falls short, as it does not include beneficial synergies with other urban functions, such as shorter commutes or the establishment of sufficiency to avoid rebound effects. Understanding interplay of solutions with the specific urban context is key to maximising urban manufacturing's potential. Future research should investigate technology implementation in varying urban contexts as well as resource and energy systems, particularly validating urban symbiosis and resource efficiency models through detailed case studies highlighting tangible benefits that can be traced across different cases and cities. Such research can then guide sustainable practices, transforming urban environments into innovative, green manufacturing hubs.

While we maintain confidence in the environmental benefits of urban manufacturing and find the supporting arguments persuasive, there remains an essential need for more integrated empirical research. Expanding the evidence base is critical to substantiate these claims and to engage a wider scholarly and policy-oriented audience beyond the echo chambers of sustainability discourse.

A limitation of this article is its focus on the ecological dimension of sustainability—there is a need to examine the interaction of this dimension with economic and social aspects. Additionally, relying mainly on English-language databases may have led to the exclusion of relevant research from other regions.

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Conflict of Interests

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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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Berlin Mix (Berliner Mischung) Revisited: An Inventory of Commercial Courtyards

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Abstract

The stylised Berlin block or *Berliner Mischung* ("Berlin Mix," a form of mixed-use development) can be defined as a multi-story inner-city housing (tenement) and working estate with one or more commercial courtyards from the early days of industrialisation. It features compact and dense rows of shops incorporated into the ground floor of the block facing the street, apartments on the floors above and in the side wings, and diverse commercial activities (retail, crafts, light manufacturing) with storage, production, and workshop facilities in the back and courtyards. Although largely abolished after the Charter of Athens, Berlin's commercial courtyards often proved resistant and even experienced a renaissance after Germany's reunification, evolving into a mixture of housing, artisans, industry, trade, and culture. The principal objective of this article is to investigate whether this mixture is still prevalent within commercial courtyards despite gentrification, a decline in manufacturing, and the tertiarisation of the economy, or precisely because of novel technologies, the resurgence of the productive city, and accompanying urban agendas. Methodologically, we investigate functional mixed-use development using an indicator-based sample of 35 former Berlin-owned commercial courtyards (now run by a commercial company), divided into four types of courtyards: Integrated Berlin Mix Courtyards, Adjacent Courtyards, Autonomous Courtyards, and Extended Berlin Mix Courtyards. Our findings reveal several "New Berlin Mix" sub-types, including an inner-city Integrated Berlin Mix Courtyard, which loses diversity to Autonomous Courtyards on the outskirts. This raises questions about the limits to the productive city in Berlin and the role of planning amidst these trends.

Keywords

Berlin Mix; commercial courtyards; economic gentrification; mixed-use development; New Leipzig Charter; productive city; urban production

1. Introduction

Mixed-use development, a guiding principle in European cities for the past three decades, is rooted in urban imperatives such as compact cities and cities of short distances. From an economic standpoint, these principles culminated in a renaissance of productive cities within the New Leipzig Charter, building on the rediscovery and return of local economies, urban manufacturing, and novel technologies—and their ability to reintegrate tangible production into inner-city areas (Suwala, Kitzmann, et al., 2025). Grounded in the historical evolution of Berlin's mixed-use development and the concept of the productive city, this article develops a working definition of the "New Berlin Mix" based on attributes of functional mixed-use development. Against this backdrop, we investigate whether the Berlin Mix (*Berliner Mischung*) is still prevalent today by linking it to four current types of commercial courtyards (Integrated Berlin Mix Courtyard, Adjacent Courtyard, Autonomous Courtyard, and Extended Berlin Mix Courtyard) and suggesting novel sub-types of the "New Berlin Mix" based on an inventory of their locations, their commercial activities, the extent of urban production, and their integration into the surrounding urban environment. The article addresses two key questions: (a) How can a "New Berlin Mix" be defined? and (b) What opportunities do specific types of commercial courtyards offer for achieving a functional mix of uses (and in which locations)?

Our analysis is based on a sample of 35 commercial courtyards from Berlin's largest private commercial property owner (GSG Berlin, formerly known as Gewerbesiedlungs-Gesellschaft), which includes a fairly representative cross-section of various courtyard typologies across the city. A multi-method framework was applied that pools web and literature research, on-site inspections, and a comprehensive quantitative inventory of all activities and surroundings with georeferenced GIS analyses and radius searches, as well as qualitative ex-post interviews. The results show that a "New Berlin Mix" integrates a broad variety of use categories, including residential use (albeit outside of the block), urban production, and vibrant environments with local amenities and social infrastructure. Interestingly, this "New Berlin Mix" can also be found in Adjacent and even Autonomous Courtyards on the outskirts, while it seems to lose ground in the city centre. This highlights trends of industrial displacement, commercial gentrification, and a rather outward shift of production activities away from the city, which contradicts the idea of the productive (inner) city.

This article is organised as follows: Section 2 provides the theoretical background about mixed-use development in general and the origins of the stylised types of Berlin Mix courtyards in particular. Section 3 elaborates on the methodology, presents results based on the theoretically informed criteria, and then summarises high-, middle-, and low-performing groups of courtyards according to their type and location before discussing them in more detail. Section 4 concludes and reflects on the research design and the relevance of a "New Berlin Mix" for urban planning and offers a brief outlook on potential future developments and possible trends—while reflecting on implications for urban planning in Berlin.

2. Theoretical Background

2.1. Mixed-Use Development: Definition, Ideas, and Operationalisation

Various contemporary spatial movements and visions, imperatives, approaches, and models such as the compact city (Breheny, 1992), the city of short distances (Wegener, 1994), along with the rediscovery of local economies (Birkhölzer, 2000; Henn et al., 2020) and urban manufacturing (M. Brandt et al., 2017;

Läpple, 2013; Martin & Grodach, 2023) within a productive city (Gärtner et al., 2021) point to mixed-use development as a fundamental ingredient and guiding principle for sustainable urban planning in Western Europe from an economic perspective (Aring et al., 1995; Coupland, 1997; Rowley, 1996; for similar developments in the US classified under new urbanism, see Gyourko & Rybczynski, 2000).

The guiding principle of mixed-use development has manifold origins. It was the subject of general debates about the "European City" and "urbanity" (e.g., Häußermann & Siebel, 1997; Montgomery, 1998), it appeared in seminal contributions about the economic and societal revival of inner-city areas (e.g., Jacobs, 1962; Witherspoon et al., 1976), and it is often quoted as an imperative in policy documents (Breuer et al., 2000; Commission of the European Communities, 1990; Department of the Environment & Welsh Office, 1995; zur Nedden et al., 2015). All of this disembogued within the New Leipzig Charter (Bundesministerium des Innern, 2020) and can be best understood as a reaction to the tendency towards an increasing spatial separation of functions in urban areas as heralded by the Athens Charter (a document advocating rational principles of town planning from 1933). The Athens Charter was driven by the availability of individual means of transportation, the emergence of large housing estates on the outskirts, and the creation of non-integrated greenfield retail locations (shopping malls), resulting in suburbanisation after World War II (Frerichs et al., 2018, pp. 65–67; zur Nedden et al., 2015, p. 14). Simultaneously, there are various arguments and reasons for mixed-use development, such as the "desire to limit sprawl, preserve open space, reduce automobile dependence, limit the expense of providing and maintaining infrastructure in low density environments, achieve housing and employment goals, and increase sustainability" (Rabianski et al., 2009, p. 206). All these imperatives have given rise to specialised discourses on mixed-use development from aesthetic-environmental, socio-relational, regulative-planned, and critical perspectives in recent decades (for an overview, see Geyer, 2024).

But what is mixed-use development from an economic perspective? As with most terms in academia, there is no widespread consensus on the definition of mixed-use development. The definition depends on the discipline, perspective, objective, and purpose of the analysis. If we depart from Jacobs, mixed-use development is one of the four decisive factors for thriving cities, next to compact building blocks, old buildings, and population density (Jacobs, 1962, pp. 150–151). Moreover, mixed-use development is a spatial organisational principle that primarily comprises the coexistence of different existential needs, such as living and working or consuming and disposing, as well as education, recreation, and participation in mobility, communication, and community life (Rowley, 1996; Wiegand, 1973). From a real-estate and economic perspective, mixed-use development needs to encompass three or more functionally and physically integrated revenue-producing uses (e.g., retail, office, residential, hotel, and/or entertainment/cultural/recreation; Schwanke & Urban Land Institute, 1987; Witherspoon et al., 1976). It aims at increasing the efficiency of land use by creating synergies, agglomeration effects, or cost–benefit relationships between different yet complementary activities (also referred to as multifunctional land use; Foord, 2010; Lagendijk, 2001; Rodenburg et al., 2003; Ryckewaert et al., 2021; Vreeker et al., 2004). In recent years, tangible commercial and industrial activities subsumed under the term "urban production" have reappeared as important and desired ingredients within economic mixed-use development as facilitators, revitalisers, and intermediaries for local economies at smaller scales in urban settings through both low-tech, high-touch, and advanced technologies (M. Brandt et al., 2017; Grodach & Martin, 2021; Herrmann et al., 2020; Läpple, 2013). The activities range from consumer goods, food products, and clothing to repair services (Meyer & Schonlau, 2024; Piegeler & Spars, 2019).

There are various quantitative and qualitative classifications and categorisation measures that help to operationalise (economic) mixed-use development (Aring et al., 1995; Breuer et al., 2000; Foord, 2010; Frerichs et al., 2018; Hoppenbrouwer & Louw, 2005; Rowley, 1996; Ryckewaert et al., 2021; Wiegand, 1973; zur Nedden et al., 2015):

- Purpose of mixed-use development: social and/or functional mix;
- Components of mixed-use development: social (e.g., income groups, ethnicity, social strata, educational levels), and functional (e.g., housing, production, trade, crafts, services, retail, culture and leisure, restaurants, tourism, social infrastructure, civic facilities, public facilities);
- Granularity/scale of mixed-use development (e.g., vertical/horizontal mix in the building, vertical/horizontal mix at the level of plots or building blocks, vertical/horizontal mix at the level of the neighbourhood or district) and its evolution in time;
- State of mixed-use development (e.g., planned, arranged, perceived, and/or lived).

and urban production therein (Brixy et al., 2024; Meyer & Schonlau, 2024; Piegeler & Spars, 2019):

- Material (e.g., tangible goods or branches), technological (e.g., high-tech, low-tech, high-touch), or sectoral delineation (e.g., IT, cultural-creative, health, crafts);
- Territorial delineation (e.g., urban, peri-urban locations according to official administration status, category, and/or land-use models based on population density);
- Variety within urban production (extent and mixture of commercial and industrial uses).

Although there is widespread consensus in Western Europe about the desirability of mixed-use development, it is no panacea. In other words, existing components of mixed-use development do not automatically lead to a desired state of lived mixed-use development (*gelebte Mischung*). Planned and arranged settings do not solely consist of tangible components but also incorporate non-tangible ingredients such as urban experiences, the actual nature of uses, understandings of public and private spaces, and a sense of belonging, among many other components that must be negotiated and often lead to substantial conflicts (Geyer, 2024). Too much diversity might lead to excessive offers, conflicting land uses, social tensions, or complex negotiation processes resulting in urban stress, residential gentrification, and undermining the sense of belonging or urban identity. By contrast, too little diversity fosters hegemonial structures, and sometimes undesired agglomerations or negative externalities of economic activities (e.g., hotspots for nightlife or rentier communities), as well as industrial displacement and commercial gentrification (Burton, 2000; Chapple & Loukaitou-Sideris, 2019; Ferm, 2016; Grodach & Martin, 2021; Heider & Siedentop, 2024; Hoppenbrouwer & Louw, 2005; Lynch, 1981; Roskamm, 2024; Sharmin et al., 2019).

2.2. Berlin Mix: Origins, Characteristics, and Ensembles

Our perspective on mixed-use development in Berlin is a functional one. It unites the tangible components (built infrastructure, functional categories of utilisation) with economic concerns, such as the existence and variety of commercial activities and urban production at the scale of a building block, particularly in commercial courtyards as the central unit of analysis. Therefore, the Berlin Mix (also known as the *Berlin Block*, *Kreuzberger Mix*, *Kreuzberg Blend*, or *Luisenstädtische Mischung*; Bodmann & Rieger, 1988; Fiebig et al.,

1984; Hausmann & Soltendieck, 1986; Hoffmann-Axthelm, 1993) serves as our starting point. Since this concept has undergone a versatile transformation since the beginning of industrialisation, which has significantly influenced its contemporary understanding, we take a detailed look at its origins, with a particular emphasis on commercial courtyards.

Rapid industrialisation, new infrastructures, consolidation of land parcels, and working opportunities in cities led to rural–urban migration and tremendous growth in metropolitan regions of Western Europe starting in the second half of the 19th century. Next to large-scale industrial production that had its original locations just in front of the medieval city gates and later moved to the outskirts of the city (Krätke & Borst, 2000; Zimm, 1959), particular inner-city commercial areas developed as a continuation of artisanal traditions on a quasi-industrial scale (e.g., Baumgart, 2001; Coupland, 1997; Suwala & Franke, 2025). In Berlin, these artisanal traditions were locally embedded, particularly in Luisenstadt (today: Kreuzberg), a southeastern extension of the medieval town where a specialised and geographically concentrated milieu of commercial areas evolved within residential areas even before the eve of industrialisation (Bascón-Borgelt et al., 1983). This is the main reason for the agglomeration of commercial courtyards in Kreuzberg to this day and why we chose Berlin as our site of investigation in the first place. In contrast, the tenement houses in northern districts of Berlin (Wedding, Moabit, Prenzlauer Berg), which were incorporated later, were merely built for workers employed by large-scale industries and conglomerates such as mechanical engineering (*Schwarzkopff*, *Borsig*, *Wöhlert*) or electricity (*Siemens*, *AEG*). The courtyards located in the rear rows served residential rather than commercial functions (Hoffmann-Axthelm, 1993; Stimmann, 1993; Zimm, 1959).

In this realm, Hoffmann-Axthelm (1984a) accentuates the structural, spatial, and organisational integration of the Kreuzberg Mix (historically more precise: *Luisenstädtische Mix*) at the end of the 19th century, both within and just outside of former medieval Berlin, as follows:

> The workshop business—or "Stockwerk" factory—was no longer a craft but an attempt by a highly specialised craft milieu to respond to the wave of industrialisation. The Kreuzberg Mix was not a question of company size, number of employees, or mechanisation, but of a particular societal culture. At its essence, it is industrialisation at the level of everyday craftsmanship, including its forms of cooperation, qualifications, time patterns, and practical design, as well as the workplace, materials, and characteristics of the product. In other words, an industrialisation within the retained culture of independent producers.…The level of cooperation in the factory was simulated based on prior artisanal collaboration by forming commercial chains. These commercial chains, within the industry…or across industries…reproduced the factory-based division of labour of the 19th century…after workshop organisation in spatial proximity came the commercial transverse buildings, and later the commercial courtyards, the side wing, and converted garages of the traditional Kreuzberg Mix. (Hoffmann-Axthelm, 1984a, pp. 16–17, own translation)

In this way, the logic of industrial rationality and mass production could be substituted and partly reproduced at the local mixed-use level by saving time and distances, and through high specialisation, without entirely abandoning the artisanal lifeworld (Stimmann, 1993).

It is worth noting that the often-romanticised depiction of the Kreuzberg or Berlin Mix as a historical role model for a felicitous mixed-use development is misleading, as paradoxes and counterbalances were and are

at play here (Murrenhoff & Stollmann, 2023; Saad, 2016; Suwala & Franke, 2025). On the one hand, the functional and social mix was desired by contemporary planners (e.g., *Hobrecht*) during its historical inception, with workshops, shed/depot factories, and, to a much more limited extent, in commercial courtyards. The built infrastructure allowed for a functional mix, even at the ground level, and was considered an adaptive system between living and working areas. In times of economic crisis, the living function would be extended, while in boom phases, the workshop space would grow. In addition, later commercial courtyards were built with universal and flexible floor plans to accommodate a variety of commercial purposes (Bodmann & Rieger, 1988; Häußermann & Kapphan, 2002; Hoffmann-Axthelm, 1984a). On the other hand, from the beginning, this Berlin-specific mixture exploited the prevailing building regulations in the land-use plan and was based on massive land speculation, while optimising the utilisation of property and land. Front residential buildings were used as decorative and aesthetic elements to cover the commercial precarity in the backyards, which had to cope with the economic realities of mass production, and which had developed an alternative model of high specialisation or subcontracting work. For this purpose, many workers who migrated from rural areas were employed in labour-intensive and rather low-technology and high-touch activities—and often resided in tight and overcrowded conditions (Baumgart, 2001; Bodmann, 1984; Hoffmann-Axthelm, 1984a, 1984b).

The original Berlin Mix was a non-altruistic community of purpose that evolved from structural, social, economic, and demographic constraints and that followed a contradictory endeavour to simultaneously separate and combine living and working functions. Even the commercial courtyard in its later form at the beginning of the 20th century had, in principle, already cancelled the "consensus of the mix through speculative ruthlessness and exploitation of permitted development area" (Hoffmann-Axthelm, 1984b, p. 58). Moreover, the widespread reminiscence and popularity of the Berlin Mix largely stems from time periods when the Berlin Mix was in danger: either from being swept away and replaced in the 1960s and 70s (Bascón-Borgelt et al., 1983), when not meeting contemporary working and living standards in the 1980s and 1990s (Stimmann, 1993), or when being gentrified from the 2000s onwards (Saad, 2016). Certain events—such as the International Building Exhibition in 1987, the reunification, and novel planning frameworks (*Flächen- und Gewerbesicherungskonzept* from 1993)—also brought renewed interest in commercial courtyards to the fore. In times of economic decline—like during the division of Germany—in West Berlin other functions (e.g., kindergartens and other social infrastructures) took over and created multifunctional neighbourhoods around commercial courtyards without too much planning. Later, between the 1990s and mid-2000s, artists, cultural/creative activities, and industries enriched and took over many courtyards, also as a consequence of an economic downturn across the entire city. In addition, unsettled property rights in the years after reunification, especially in former East Berlin, gave rise to squatting and appropriation of spaces and, in turn, introduced a novel and adjusted mix (Holm, 2014; Mundelius, 2006). Since then, residential, technological, and platform gentrification have also had displacement effects on commercial activities in courtyards, especially in central-city tenement housing quarters (Gergs et al., 2025; Glatter & Sturm, 2020; Schmidt et al., 2014), despite a great deal of planning efforts to safeguard these areas (e.g., the *Stadtentwicklungsplan Wirtschaft*, or Urban Development Plan for the Economy, in 2011, 2019, and 2024; Suwala et al., 2021).

To summarise, the original Berlin Mix—which we refer to as the Integrated Berlin Mix Courtyard (*Gewerbehof "Berliner Mischung"*) later—can be functionally defined as a multi-story inner-city housing (tenement) and working estate with one or more commercial courtyards from the early days of industrialisation. The highly compact and dense block incorporates shops into the ground floor facing the street, housing on the floors

above and in the side wings, and diverse commercial activities (e.g., retail, crafts, light manufacturing) with storage, production, and workshop facilities in the back courtyards (Bascón-Borgelt et al., 1983; Baumgart, 2001; Bodmann & Rieger, 1988; Hausmann & Soltendiek, 1986; Hoffmann-Axthelm, 1984a, 1993). Although the Berlin Mix is often considered one specific type of inner-city mixed building block, there are various types depending on the construction date. Regarding its commercial and industrial structures (*Gewerbebauten*), four historic types—workshops, shed/depot factories, factory courtyards, and commercial courtyards—were differentiated until 1945 (Bodmann, 1984; Bodmann & Rieger, 1988; Hoffmann-Axthelm, 1984b). Since 1945, those have been built on the outskirts in different settings, such as commercial centres or park courtyards (Henckel, 1981; Hüttenhain, 2012; Suwala & Franke, 2025).

2.3. A "New Berlin Mix": Contemporary Ideas and Stylised Types

Nowadays, the fundamental commercial building block of mixed-use development in general (for London, see Ferm, 2016; for the German Ruhr Area, see Meyer & Schonlau, 2024) and the Berlin Mix in particular, is based on local economies that can encompass manifold economic activities, such as urban agriculture, urban production, and urban services (Henn et al., 2020)—in addition to activities of the solidarity-based economy, which is also referred to as the social economy, community economy, and grey/informal economy (Birkhölzer, 2000; Erbstößer, 2016). These local economies feed into the productive city, which should transform "central urban areas into attractive multifunctional spaces provid[ing] new opportunities for urban development through mixed use for living, working and recreation, where manufacturing, retail and services are found alongside housing, hospitality and leisure" (Bundesministerium des Innern, 2020, p. 5). In this realm, studies refer to the "Berlin Mix 2.0" (Erbstößer, 2016) or the "New Berlin Mix" (Saad, 2016; Stimmann, 1993), which involves a smart mix that enhances the quality of life for residents while promoting sustainable economic development. This mix requires specific (planning) tasks to be accomplished, such as densifying and verticalizing areas for urban production, creating incentives for micro-, small-, and medium-sized enterprises, promoting low-emission artisanal production, implementing production 4.0, and—if applicable—integrating urban agriculture into these areas. All these measures should ensure local supply and regional sourcing in innovation-friendly environments next to the diverse universe of services, such as retail activities, accommodation, tourism, and digital commerce (H. Brandt et al., 2018; Erbstößer, 2016; Läpple, 2016; Saad, 2016). It should be noted that "mixed-use development must be conceived beyond the coexistence of residential, office and retail in a 'latte macchiato city' " (Gärtner et al., 2021, p. 6). At the same time, and this is still true today, "It is evident in numerous places that it has not become simpler in recent years to implement the idealized small-scale mix of housing, commerce and trade" (see also zur Nedden et al., 2015, p. 16; Frerichs et al., 2018, p. 67). This confirms the initial findings of the *Experimenteller Wohnungs- und Städtebau* (Experimental Housing and Urban Development) research project Mixed Utilization in Urban Development carried out almost 20 years ago: "While there are mixed-use projects in many German cities, they are exceptions compared to purely commercial and residential areas" (Breuer et al., 2000, p. 9). In other words, even in mixed-use neighbourhoods, separation processes between commercial and residential areas are on the rise.

Although there are currently many novel ideas on how to label and (re-)establish this functional mix in commercial courtyards based on old and new built substance by combining or enlarging activities with start-ups, kindergartens, and cultural or creative economies (e.g., Suwala, Becker, et al., 2025; Suwala, Kitzmann, et al., 2025; Suwala et al., 2021), we follow the taxonomy developed by Hatuka and Ben-Joseph

(2017) in their writing about industrial urbanism to help us categorise commercial courtyards. They categorise urban commercial and industrial areas into four types, which apply to commercial courtyards in Berlin (GSG Berlin, 2025; in a broader sense, see also Figure 1). Our a priori typology is a deductive-inductive description that stems both from the taxonomy above (deductive) and from our experiences during the field work (inductive). Although this typology is not a desired planning objective for commercial courtyards, it might act as a template for strategic planning endeavours.

Figure 1. Four stylised types of commercial courtyards in Berlin.

Our first type is the Integrated Berlin Mix Courtyard (*Gewerbehof "Berliner Mischung"*), which closely resembles the stylised image of the historic Kreuzberg Mix, as described in Section 2.3. It incorporates multifunctional commercial uses and residential units at the block level, partly also at the building level, and sometimes even at the floor level. The second type is the Adjacent Courtyard (*Klassischer Gewerbehof*), which was built mostly from the 1900s to 1945s without residential functions and housing facing the street; this type does not include a mix at the block level but rather at the neighbourhood level. The third type is the Extended Berlin Mix Courtyard (*Gewerbehof, Altbau und Neubau*), which enlarges the initial type with structural extensions, leading to a horizontal and vertical densification on grounds that were either destroyed in World War II or demolished during the reconstruction in the 1960s and 70s. The Autonomous Courtyard (*Moderner Gewerbehof*) is more modern, built after the 1960s and in most cases even after the reunification (especially in former East Berlin), and is only located on the outskirts. It must be mentioned that the history and development of commercial courtyards are situational, path-dependent, contingent, location-specific, and therefore not necessarily transferable to other urban areas in Germany and beyond. Whereas the consulting company *Regioteam* applies a similar typology for Berlin (Argus, 2023), the Berlin Mix Courtyard and Adjacent Courtyard sub-types fall under the same umbrella in the Commercial Development Concept for Friedrichshain-Kreuzberg (*Gewerbeentwicklungskonzept*; Baba et al., 2017). This concept also adds single so-called interspersed locations (*eingestreute Gewerbehöfe*; Baba et al., 2017, p. 19), while Baumgart concludes with different types for Hamburg (Baumgart, 2001). In general, this typology can only be partly applied to other cities in Germany (Meyer & Schonlau, 2024; Suwala, Becker, et al., 2025) and beyond (e.g., for London, see Ferm, 2016; Ferm et al., 2021), while the Integrated Berlin Mix Courtyard and Extended Berlin Mix Courtyard are unique to the city of Berlin, which is why we kept the name "Berlin" in these types. The other denominations and names are derived from the typology of Hatuka and Ben-Joseph (2017).

2.4. Objectives, Main Criteria, and Research Questions

Our objective was to examine the relevance of the Berlin Mix today, focusing on its potential for functional mixed-use development in commercial courtyards, while considering the influence of new technologies, the rise of the productive city, and urban strategies that support integrated, sustainable, and mixed-use developments. We therefore address two key questions: How can a "New Berlin Mix" be defined? And what opportunities do specific types of commercial courtyards offer for achieving such a functional mix of uses? Grounded in the historical evolution of Berlin's mixed-use development and the concept of the productive city, this article develops a working definition of the "New Berlin Mix" in the aftermath of this analysis. The evaluation framework is based on three primary criteria derived from the nature of functional mixed-use development in general (see Section 2.1) and the Berlin Mix in particular (see Sections 2.2 and 2.3), with defined indicators that serve as a basis for the analysis, rather than an exhaustive list. The first criterion, "diversity of use," examines the range of different use categories within commercial courtyards, including residential, office, material production, retail, and social infrastructure (Bundesministerium des Innern, 2020; Rodenburg et al., 2003; Schwanke & Urban Land Institute, 1987). This criterion is assessed using indicators such as "number of use categories" and "sectoral diversity within these categories" at the block level. The second criterion, "integration of the productive economy," focuses on the presence of urban production activities, such as manufacturing, industry, and urban agriculture (Aring et al., 1995; Erbstößer, 2016; Gärtner & Meyer, 2023). Indicators for this criterion include "proportion of urban production" and "sectoral diversity of urban production" at the block level, reflecting the existence and variety of production activities. The third criterion, "vibrant and integrated urban spaces," evaluates the quality and connectivity of the courtyard environments (Häußermann & Kapphan, 2002; Hoppenbrouwer & Louw, 2005; Läpple, 2016). Indicators for this criterion include "proximity to social infrastructure and local amenities," "quality of transport connectivity," and "proximity to green spaces" at the neighbourhood level.

3. Analysis and Results

3.1. Methodology

To analyse the functional mixed-use development of the assumed "New Berlin Mix" in commercial courtyards, we considered a sample of 35 commercial courtyards from Berlin's largest private commercial property owner (GSG Berlin, which once belonged to the city of Berlin), offering a fairly representative cross-section of various courtyard typologies across the city. Methodologically, we applied a multi-method framework combining web and literature research (e.g., [historical] information and structural development and pertinent websites), full on-site inspections, and a quantitative and comprehensive inventory of all activities (commercial, social, and residential) with georeferenced GIS analyses (Heinrich et al., 2024; Kuckartz, 2014). We investigated the functional mixed-use development using an indicator-driven sample of 35 commercial courtyards based on (a) the company's website, (b) on-site visits, (c) GIS-based analyses, (d) a comprehensive inventory and survey of all (commercial) activities, and (e) expert interviews in the first half of 2024. Each commercial courtyard and its surroundings were analysed individually to evaluate the aforementioned indicators and to allow for a differentiated and comparable assessment.

In a first step, the 35 commercial courtyards were categorised into the four a priori functional types according to their building structure (see Section 2.3). In a second step, an indicator-based analysis was

conducted, where each commercial courtyard was systematically assessed using an inventory documenting identifiable tenants, functional uses, and industry sectors. The inventory was compiled through on-site inspections and verifications, data from digital mapping applications, and publicly accessible information from the commercial courtyard owner, including commercial courtyard sizes and vacant spaces. The overall evaluation applied the three key criteria—"diversity of use," "integration of the productive economy," and "vibrant and integrated urban spaces"—derived from the theory. This included the aforementioned sub-indicators, operationalised within a structured framework and rated on a scale from 1 (*very low*) to 6 (*very high*) to ensure comparability and consistency. The results were compiled in an Excel database and georeferenced using GIS. This allowed for a spatial visualisation of the findings (see Figures 2, 3, 5, 7, and 9), providing a comprehensive overview of the indicator-based analysis results within the stylised types and sub-types of commercial courtyards. For the final assessment, the ratings (in points) for the three criteria were weighted equally and added up using average values (also incorporating all sub-indicators), allowing for a range between 0 and 18 points (see Table 1). The last step comprised five interviews with experts from the Berlin administration (planning), the economic promotion department of a Berlin district (policy), a Berlin-owned company that runs such courtyards (administration), a medium-sized company (economy), and a pertinent real-estate developer that constructs such courtyards (economy) which evaluated our categorisations ex post. All interviews were conducted via a video conference provider or on the phone and lasted 30 to 45 minutes.

3.2. Types, Locations, Sizes, and Vacancies of Commercial Courtyards in Berlin

GSG Berlin is one of Berlin's largest property owners, managing 35 commercial courtyards. These courtyards offer rental spaces ranging from 20 to 20,000 square meters, catering to small and medium-sized businesses across various sectors (GSG Berlin, 2024). Figures 2 and 3 provide an overview of the spatial distribution of these commercial courtyards across Berlin's districts. Based on structural characteristics, we categorised the investigated commercial courtyards into four types: Integrated Berlin Mix Courtyard, Adjacent Courtyard, Autonomous Courtyard, and Extended Berlin Mix Courtyard (see Section 2.3 and Figure 1). This typology of commercial courtyards is based on three spatial prototypes of industrial spaces, described by Hatuka and Ben-Joseph (2017), which were derived from the Commercial Development Concept for Friedrichshain-Kreuzberg (Baba et al., 2017) and influenced by an empirical study on commercial courtyards (Argus, 2023). This typology was further refined based on the findings from our own investigations and expert interviews.

Figures 2 and 3 also show spatio-structural patterns regarding both the differentiation of the deductive courtyard types and their respective locations. Of the 35 courtyards, six can be classified as Integrated Berlin Mix Courtyards, all of which are located in the district of (Friedrichshain-)Kreuzberg. Most of the courtyards, 14 of the 35 properties, are categorised as Adjacent Courtyards. These properties are located primarily in inner-city areas with a few exceptions in more peripheral districts such as Reinickendorf (northwest Berlin). The six courtyards identified as Autonomous Courtyards are predominantly situated in the city's outskirts, with one exception in Charlottenburg (central-west Berlin). The nine Extended Berlin Mix Courtyards generally feature new buildings added to existing structures and originated either from Integrated Berlin Mix or Adjacent Courtyards. Consequently, they are located in inner-city areas. Some of these courtyards were already extended between the 1970s and 1990s, such as the Prinzessinnen-Höfe and the GSG-Hof Reuchlinstraße courtyards. Over the last few years, modern office buildings have been

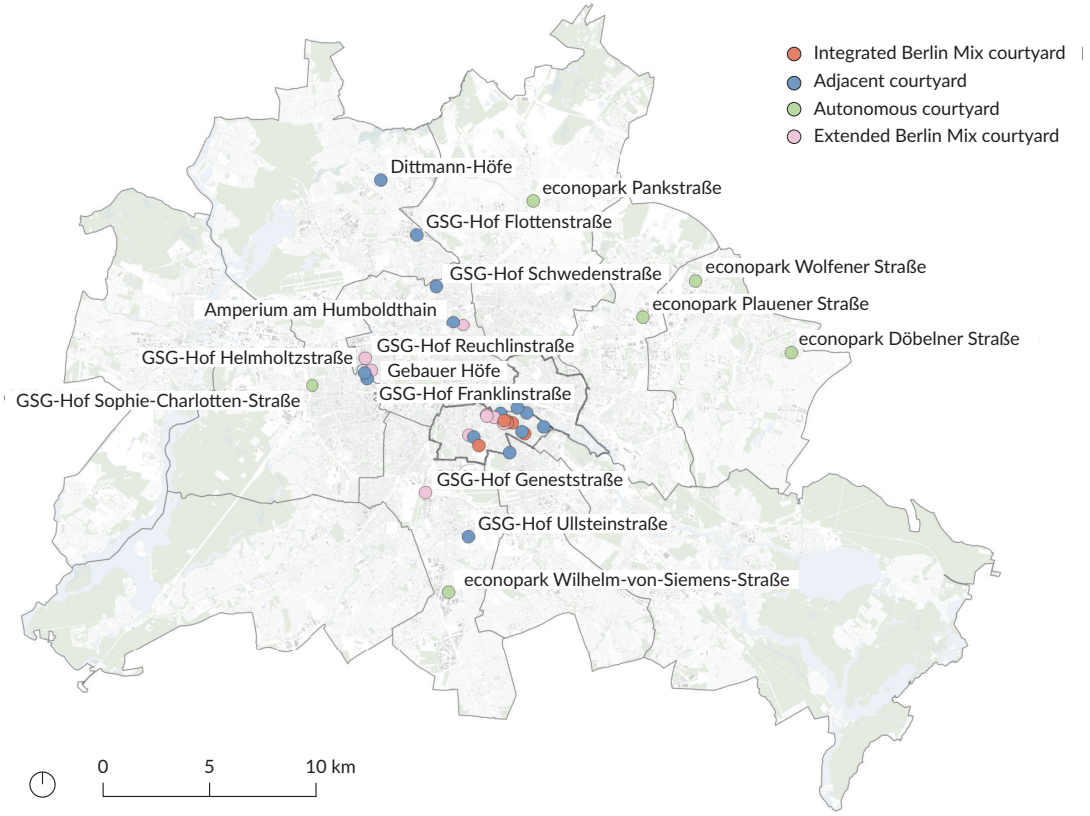

Figure 2. Location and typology of GSG commercial courtyards in Berlin.

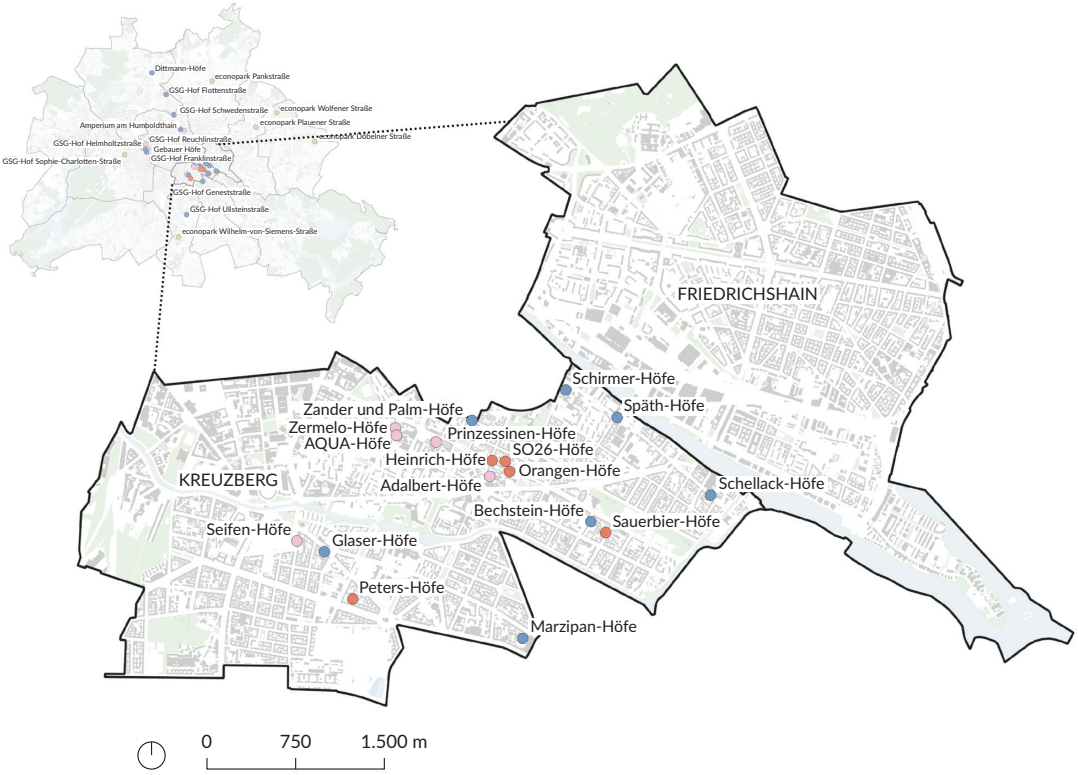

Figure 3. Location and typology of GSG commercial courtyards in (Friedrichshain-)Kreuzberg.

integrated into others, such as the Seifen-Höfe, Gebauer-Höfe, and Aqua-Höfe courtyards, with ongoing developments, including large-scale office spaces and commercial facilities. For example, the Seifen-Höfe courtyards are currently being expanded to include an office building of approximately 11,000 square meters (see also Figure 1). These extended courtyards blend historic structures with modern developments, often incorporating extra storeys and diverse commercial facilities. While these courtyards still include a rather diverse range of commercial uses, recent developments and planned projects are increasingly dominated by office spaces (own observation and location profiles).

As illustrated in Figure 4, courtyards vary significantly in average size and vacancy areas—and accompanying vacancy rates across the different typologies. The Integrated Berlin Mix Courtyards, characterised by the smallest size of 4,800 m² and 13 tenants on average, also show minimal vacancies (1.4 %). These low vacancy rates can be explained by various factors. In general, this type is now under pressure to be converted into residential or office spaces. They are very popular among capital-intensive start-ups and knowledge-oriented labs backed by larger corporations, which employ a highly skilled and often international amenity-loving creative class (Interviews 4 and 5; see also Gergs et al., 2025; Pettas & Suwala, 2023). At the same time, existing tenants with old contracts try to persist despite commercial lease laws that generally do not favour stable long-term contracts (Suwala & Franke, 2025). Therefore, it is up to the landlords, be they private or public, to decide which strategy to pursue (Interviews 1, 2, and 3). The Adjacent and Expanded Berlin Mix Courtyards exhibit comparatively medium in size, averaging approximately 25,000 m² (25 tenants) and 22,000 m² (23 tenants), but they differ in terms of vacancies. The vacancy rate in Expanded Berlin Mix Courtyards (21.4 %), however, is notably higher, almost three times the rate found in Adjacent Courtyards (8.4 %). This high vacancy rate in Expanded Berlin Mix Courtyards can be attributed to the fact that some of the new spaces have not yet been let or are too expensive, or it reflects the current oversupply of office spaces (Interviews 1, 2, and 4). In contrast, Autonomous Courtyards are the largest type on average at roughly 48,000 m² (40 tenants) and a very modest vacancy rate (3.3 %). At first sight, the average number of tenants correlates with the average size of the commercial courtyard type for all types.

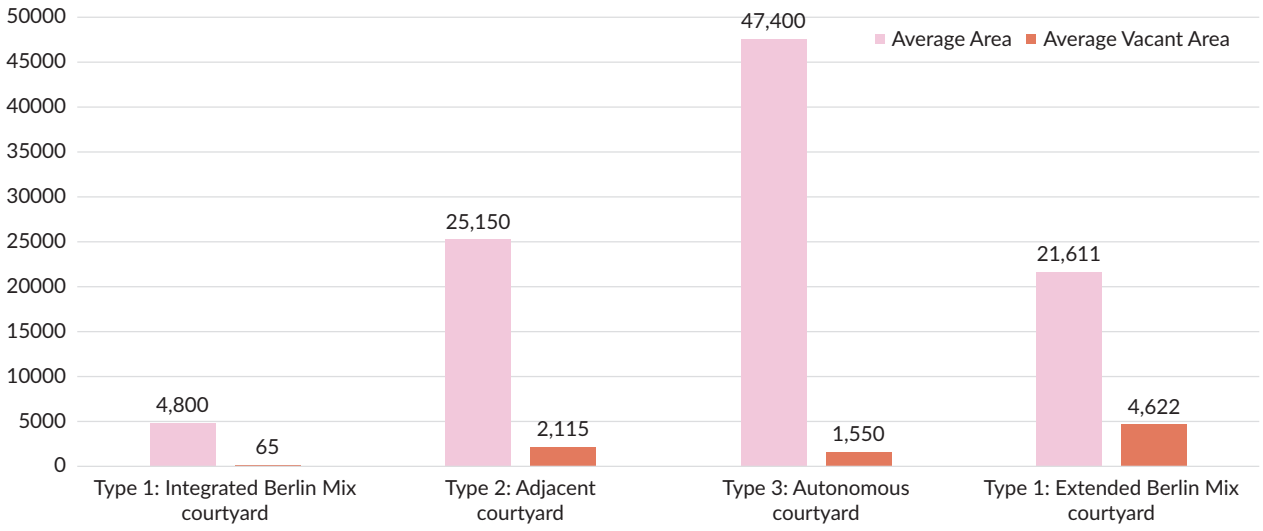

Figure 4. Total average area (in m^2, pink bars), and average vacant area (in m^2, red bars) of commercial courtyard types. Figure created by authors based on calculations and location profiles.

However, if we deduct the average vacancy rates, we obtain the following average floor space occupancy by commercial courtyard type: The Integrated Berlin Mix Courtyard has the smallest floor space occupancy per company (365 m^2), followed by the Extended Berlin Mix Courtyard (740 m^2), the Adjacent Courtyard (950 m^2), and the Autonomous Courtyard (1,150 m^2). In other words, the inner-city courtyards are home to the smallest companies (in terms of floor space) but are still relatively large on average. Extended Berlin Mix Courtyards are accelerating this trend. Therefore, it can be said that the target group is no longer comprised of either micro or craft enterprises (Interviews 1 and 2). The Adjacent Courtyards have a relatively high floor space occupancy per company. This can be explained by the higher shares of space-intensive material production combined with a low diversity of use—in other words, they house larger local companies (no information on company employees was available). Autonomous Courtyards have the highest average floor space occupancy per company. However, given the proportionality in terms of average size, it can be assumed that this type features a richer mix of small, medium, and large tenants; this was confirmed by the material and the interviews (Interviews 2 and 4).

3.3. Functional Mixed-Use Development in Commercial Courtyards of Berlin

3.3.1. "Diversity of Use" in Commercial Courtyards

The criterion "diversity of use" evaluates the variety and range of different functional use categories within a commercial courtyard, reflecting the extent to which these spaces support a range of activities. This is measured using two sub-indicators: "number of use categories" and "diversity of sectors within those categories." The indicators were analysed based on the inventory compiled for each individual commercial courtyard. For the analysis, seven primary use-categories were considered: office, material production, retail, gastronomy, social infrastructure, residential, and other commercial uses. Within each of these categories, various industry sectors were identified. The categorisation has been designed to be straightforward, even if several fields of activity were conceivable, and is not based on the official classification of economic activities (e.g., WZ 2008 or NACE Rev. 2) but was carried out based on how the companies and institutions portrayed themselves. The "office" category, for example, includes a variety of (intangible) services from different sectors, such as media, engineering and architecture, finance, research and development, and IT and software, while "material production" includes tangible industries such as furniture and wood processing, light industry, textile manufacturing, and 3D printing (for similar official classifications, see Meyer & Schonlau, 2024). The criterion "diversity of use" was evaluated using a comparative analysis of the investigated commercial courtyards. Commercial courtyards accommodating five or more use categories were considered to have a heterogeneous structure, receiving high ratings for use diversity, while commercial courtyards with fewer than three use categories were regarded as homogeneous and obtained low ratings (Figure 5).

The results of the indicator analysis for the criterion "diversity of use" demonstrate considerable variations depending on the type and location of the commercial courtyards. Interestingly, Autonomous Courtyards typically show a higher diversity of use compared to the other courtyard typologies, especially those situated outside inner-city areas. That is surprising, as one would expect Berlin Mix Courtyards to have the highest values. A possible explanation could be that commercial activities that could not find spaces elsewhere or were displaced from inner-city estates by commercial gentrification and/or industrial displacement were thrown together, and because in rather peripheral, large, and younger Autonomous Courtyards, many available spaces in the past were just filled up. As a result, no specific profile emerged (Interview 4).

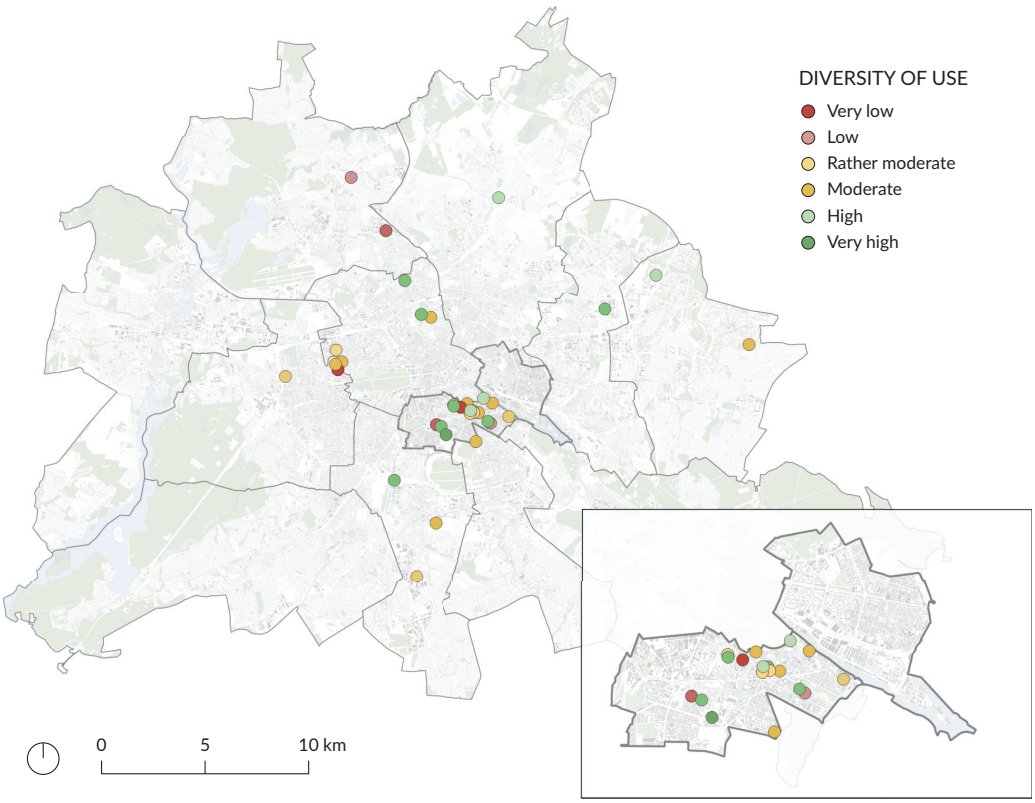

Figure 5. Diversity of use within commercial courtyards.

Notwithstanding, commercial courtyards located in the inner-city district of (Friedrichshain-)Kreuzberg (Figure 3), also dubbed the cradle of Berlin craftsmanship (mostly Berlin Mix and Adjacent Courtyards), tend to show a higher diversity of use than their counterparts in periphery districts and locations. For example, the GSG-Hof Flottenstraße and Dittmann-Höfe Adjacent Courtyards located in Reinickendorf display a notably lower diversity of use. These commercial courtyards tend to integrate fewer sectors but can be considered as established locations in former West Berlin with a more specialised focus, resulting in a low diversity rating (Interview 1). Although other commercial courtyards located in inner-city districts exhibit moderate to high levels of use diversity in general, there are exceptions to this trend. The Seifen-Höfe courtyards (see Figures 1 and 3) and Prinzessinnen-Höfe courtyards (Figure 3), both of which are classified as Extended Berlin Mix Courtyards, show a predominance of offices and other business sectors. In particular, the Prinzessinnen-Höfe courtyards are largely dominated by tenants from the IT, software, and consulting sectors, while the Seifen-Höfe courtyards primarily host businesses in the engineering and architecture fields. The following explanation can be provided: Their location profile(s) have developed organically (e.g., location cooperatives and cluster formation) or have been actively promoted by the owners. Rising (rent) prices are increasingly pushing manufacturing, craft, and cultural businesses out in favour of pure office spaces in these locations. (International) start-ups and high-tech companies are able to pay those rents and like to stay close to highly-skilled workers (Interviews 3 and 5). This is also demonstrated by the fact that the company names at Prinzessinnen-Höfe are predominantly in English.

As illustrated in Figure 6, the number of tenants (over 900 were identified in all courtyards) within the various use categories varies significantly depending on the type of commercial courtyard. In all courtyard types, except the Integrated Berlin Mix Courtyards, where the “residential” category is exclusively present

and exhibits the highest share of tenants, the office function dominates (as measured in number of tenants). The extent of domination is mostly pronounced in Adjacent and Extended Berlin Mix Courtyards, where almost 60% of the tenants surveyed fall into the "office" category. In the Autonomous Courtyards, the "material production" use category is almost as evenly distributed as the "office" category, with both accounting for roughly 30% of tenants. Overall, Autonomous Courtyards are characterised by a greater number of different use categories, which accounts for the generally higher diversity of use in these spaces. The "gastronomy" and "social infrastructure" categories, however, are underrepresented across all types of commercial courtyards, contributing marginally to overall use diversity.

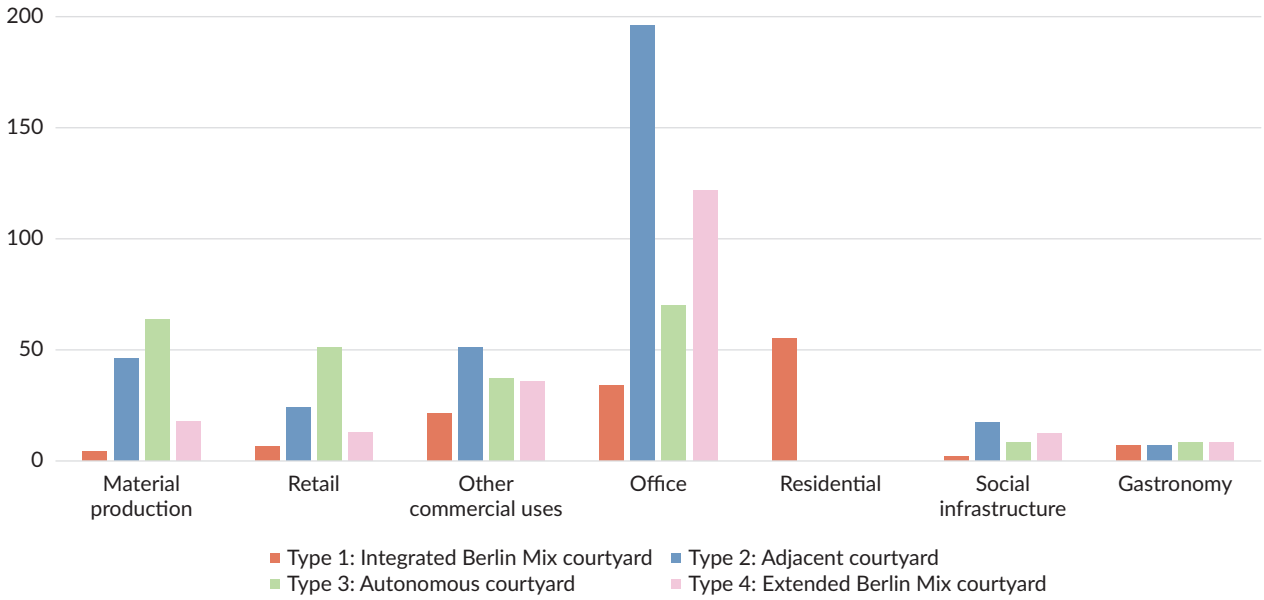

Figure 6. Distribution of use categories within types of commercial courtyards, in number of tenants, $n = 919$.

3.3.2. "Integration of the Productive Economy" in Commercial Courtyards

The criterion "integration of the productive economy" evaluates the presence of urban production/ industries within the different commercial courtyards. To measure the criterion, two sub-indicators were selected: "proportion of urban production" and "sectoral diversity within urban production." These indicators were also analysed based on the inventory compiled for each individual commercial courtyard. The proportion of urban production shows the number of tenants from the "material production" use category in relation to the total use categories (see Figure 8). Additionally, the presence of different production industries—such as crafts, workshops, light industry, pharmaceuticals, metal/woodworking, printing, car repair, and 3D/robotics, which can be subsumed under the label "urban manufacturing" or "urban industry"—is examined to evaluate the sectoral diversity within material production. The results of the indicator analysis reveal a correlation between the integration of productive industries and the location of commercial courtyards. Specifically, commercial courtyards located on the outskirts exhibit high to very high levels of integration (see Figure 7). These areas predominantly consist of both Autonomous Courtyards and Adjacent Courtyards, which accommodate both a high proportion and high sectoral diversity of urban production. For example, the econopark Plauener Straße Autonomous Courtyard in Lichtenberg (see Figures 1 and 2) receives a very high overall rating. A total of 30% of its tenants belong to the "material production" category, and the courtyard shows strong sectoral diversity within urban production. It hosts both urban manufacturing activities, such as

furniture workshops, textile processing companies, and printing presses, and urban industries involved in 3D printing and the production of light industrial products. In other autonomous econopark courtyards (Döbelnerstraße, Wolfenerstraße, Pankstraße, Wilhelm-von-Siemens-Straße), similar proportions (around 30%) and diversities (e.g., crafts, printing, textiles, light industry, and sometimes pharmaceuticals and food processing) can be observed.

In contrast, commercial courtyards in the district of (Friedrichshain-)Kreuzberg show very low levels of integration of the productive economy. Of the 18 courtyards in this district, six do not feature any form of urban production, while there was only one remaining business left in the others, which clearly cannot account for sectoral diversity. This trend is observed in both Integrated Berlin Mix Courtyards and Extended Berlin Mix Courtyards. Within the Extended Berlin Mix Courtyards, urban production is integrated to highly varying degrees. While 30% of tenants deal with material production in a large variety of sectors (light industry, pharmaceuticals, crafts, metal) in GSG-Hof-Reuchlinstraße, four out of nine commercial courtyards in this group do not host any urban production activities. In the districts of Mitte, Charlottenburg-Wilmersdorf, and Tempelhof-Schöneberg, the integration of production industries varies, with no clear pattern.

A much higher baseline of integration of the productive economy can be observed in Adjacent Courtyards, albeit also with significant variation. The GSG-Hof Flottenstrasse (67%) and Dittmann-Höfe (44%) courtyards, for instance, demonstrate a relatively high "proportion of urban production" and sectoral diversity (e.g., wood/metal, crafts, printing, car repair), whereas the GSG-Hof Franklinstraße courtyard does not engage in urban production at all. Only very few (Adjacent) Courtyards, such as Amperium am

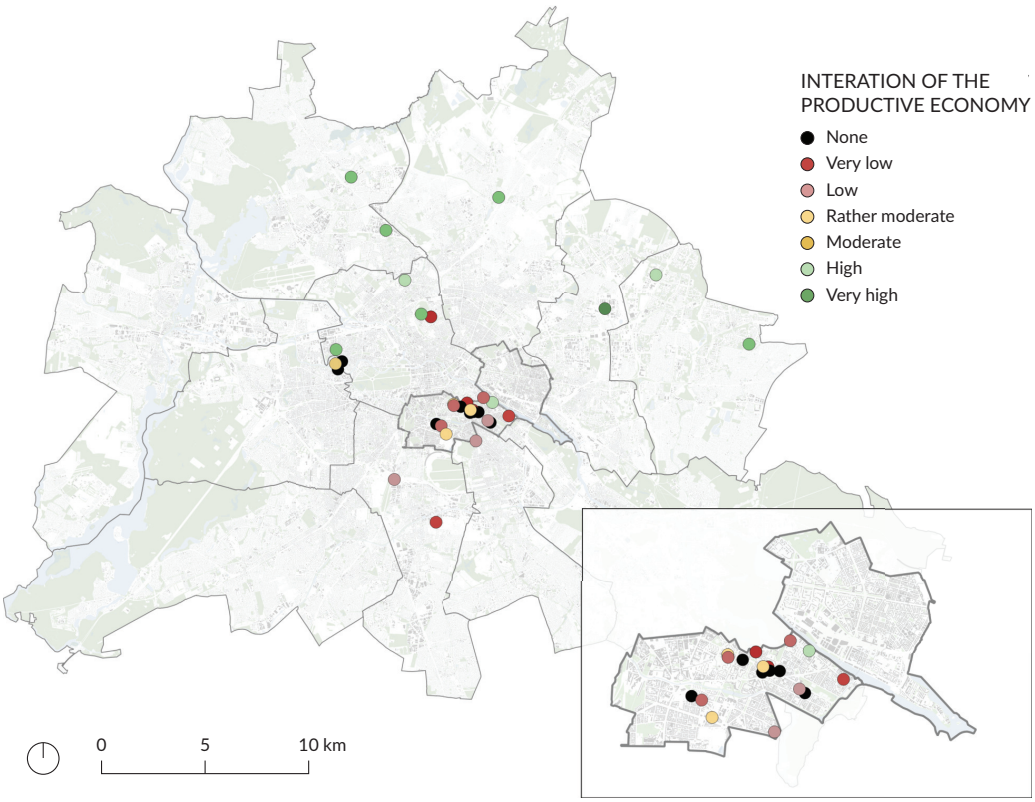

Figure 7. Integration of the productive economy in commercial courtyards.

Humboldthain, host the theoretically desired material production, such as 3D printing and robotics (see Erbstößer, 2016).

By taking a closer look at the average number of tenants, the average number number of tenants in urban production and type of commercial courtyards (see Figure 8), we can draw the following conclusion: The Integrated Berlin Mix Courtyards represent the typology with the lowest proportion of tenants in urban production (as measured by the ratio of the average number of tenants and the average number of tenants in urban production), comprising only 0.7 out of 13 tenants on average or 5% of total tenants (residential use excluded), followed by the Extended Berlin Mix Courtyards with only 1.6 out of 13 tenants on average (7%), Adjacent Courtyards with 4 out of 25 tenants on average (16%), and Autonomous Courtyards with 12 out of 40 tenants on average (31%). This distribution highlights the differences in the integration of productive industries based on the type and location of the commercial courtyards. Autonomous Courtyards tend to accommodate a more substantial proportion of tenants in urban production, whereas Adjacent Courtyards and those Courtyards in central urban districts show a much more limited proportion of urban production. It can be said that "urban production" plays almost no role in both the Integrated Berlin Mix Courtyards and in the novel Extended Berlin Mix type. This can be explained by the competition with residential uses, noise disturbance, and the strategic realignment of structural extensions, combined with higher rent prices (Interview 1).

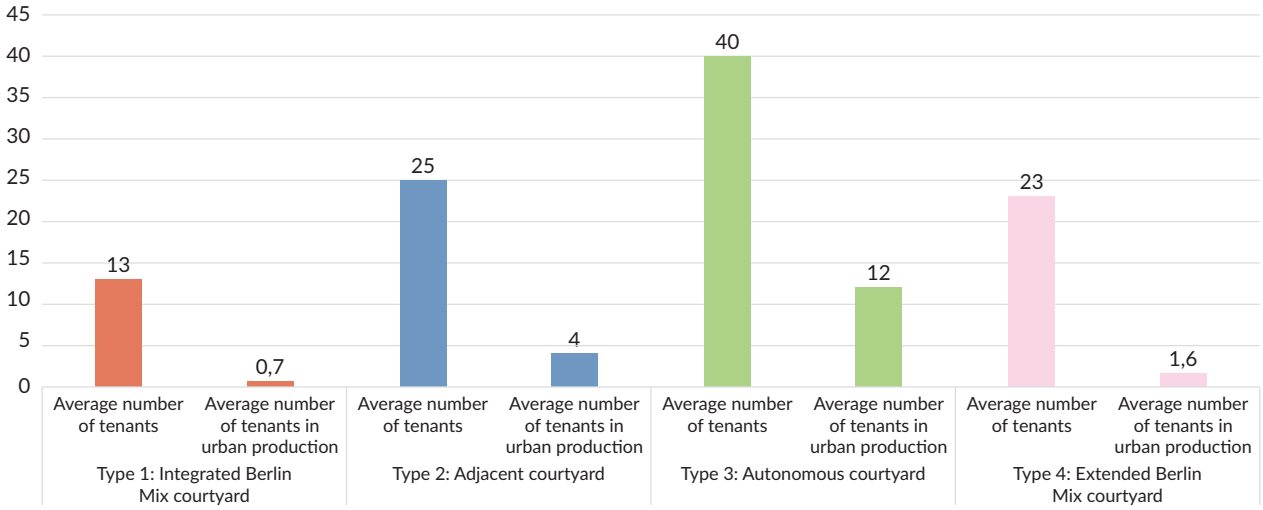

Figure 8. Average number of tenants and average number of tenants in urban production within different types commercial courtyards.

3.3.3. "Vibrant and Integrated Urban Spaces" in Commercial Courtyards

The third criterion, "vibrant and integrated urban spaces," evaluates the quality and connectivity of the courtyard environments (Häußermann & Kapphan, 2002; Läpple, 2016). Sub-indicators for this criterion include "proximity to social infrastructure and local amenities," "quality of transport connectivity," and "proximity to green spaces" at the neighbourhood level. In this case, neighbourhood level is the equivalent of a one-kilometre radius around each commercial courtyard. This radius, approximately a 15-minute walking distance, serves as a parameter for pedestrian accessibility (Bartzokas-Tsiompras & Bakogiannis, 2023). The criterion evaluates the extent to which commercial courtyards are embedded within a well-connected

urban fabric that offers a variety of amenities and infrastructures. This integration is considered essential for enhancing the overall quality of life for both residents and employees.

The analysis revealed significant spatial disparities between different courtyard typologies and locations within Berlin. In the inner-city district of (Friedrichshain)-Kreuzberg, commercial courtyards predominantly achieved high to very high ratings for the "vibrant and integrated urban spaces" criterion (see Figure 9). This outcome is primarily due to the district's well-established mixed-use urban environment, which features a dense concentration of amenities, social infrastructure, and robust transportation networks. Notably, commercial courtyards located along Oranienstraße and near Kottbusser Tor benefit from dynamic surroundings. These areas offer access to multiple subway lines, main roads, and a wide range of amenities. Most of these courtyards belong to the Berlin Mix type. In contrast, Adjacent Courtyards in (Friedrichshain-) Kreuzberg are located in peripheral areas of the districts and exhibit only moderate to high ratings for this criterion, with variations primarily influenced by their immediate surroundings. For example, the Späth-Höfe and Schirmer Höfe courtyards are situated in predominantly commercial neighbourhoods that offer fewer amenities. While their central locations within the inner city contribute positively to transportation connectivity, these courtyards score lower on the indicator for "proximity to green spaces." This shortfall reflects the limited availability of accessible parks or recreational areas.

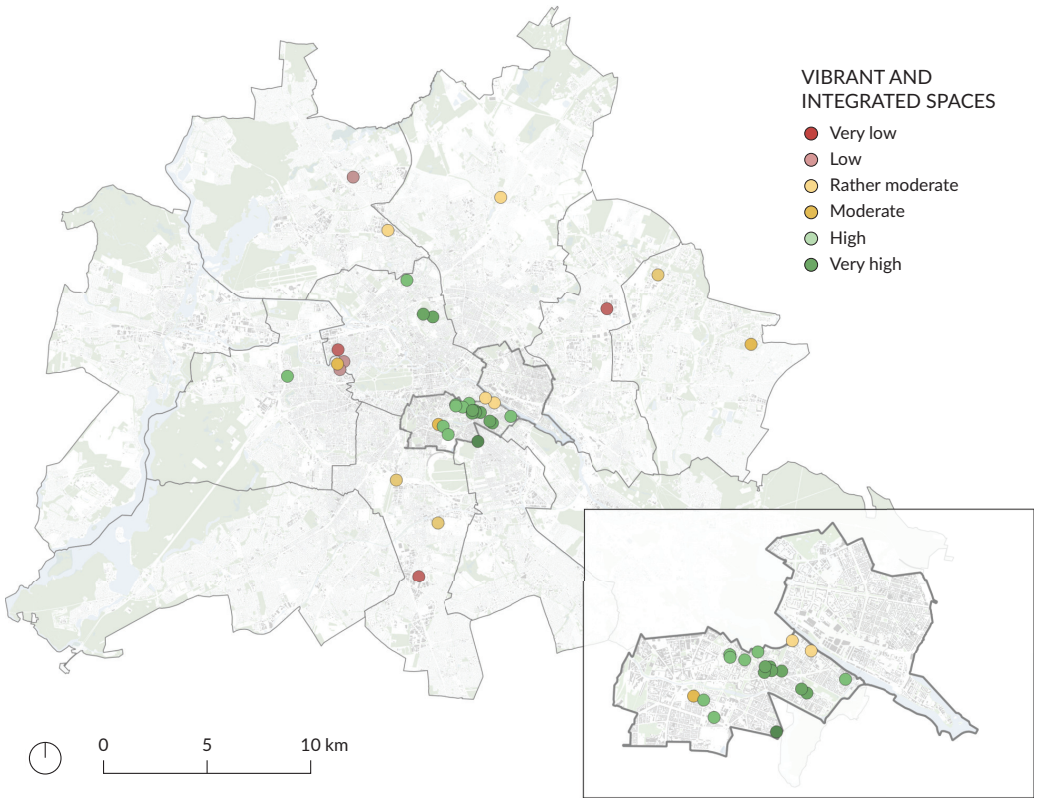

Figure 9. Vibrant and integrated urban spaces in commercial courtyards.

In peripheral districts, particularly in Berlin's northeast and southern outskirts, Autonomous Courtyards tend to receive moderate to low ratings for this criterion (see Figure 9). These courtyards are often poorly integrated into the broader urban structure, with limited access to essential social infrastructure and local

amenities. Additionally, many of these areas lack proximity to green spaces. However, exceptions exist within this typology. For instance, the GSG-Hof Sophie-Charlotten-Straße courtyard is located in a vibrant neighbourhood in the district of Charlottenburg. This Autonomous Courtyard was built on the abandoned estate of a local brewery in the late 1980s and benefits from strong transportation connectivity and a well-integrated neighbourhood characterised by diverse local services and social infrastructure. Its proximity to prominent green spaces, such as Lietzenseepark and Charlottenburg Palace Park, further enhances its overall rating.

Extended Berlin Mix courtyards present mixed results, reflecting variations based on their geographic location and surrounding infrastructure. In (Friedrichshain)-Kreuzberg, these courtyards benefit significantly from the district's diverse urban structure and robust transportation networks, achieving relatively high ratings. By comparison, courtyards such as the Gebauer-Höfe and GSG-Hof Reuchlinstraße achieve lower ratings. Positioned on the borders of the districts Mitte and Charlottenburg-Wilmersdorf, these courtyards are far away from public transportation networks and lack local ties. Despite their central geographic positions within the city, their integration into the surrounding urban fabric remains limited, contributing to lower overall ratings. It is worth pointing out that these courtyards are a remnant of extensive inner-city industrial areas along the sites of large companies such as Siemens or AEG, where transport was handled via waterways in the early days of industrialisation (these transport routes no longer play a role for handling cargo from and to courtyards today and were therefore not accounted for in the connectivity evaluation), which explains their locations along the Spree river being in inner-city locations yet peripheral.

In summary, commercial courtyards situated within centrally located, mixed-use districts—most notably (Friedrichshain)-Kreuzberg—achieve higher ratings for the criterion "vibrant and integrated urban spaces." This is largely due to their advantageous proximity to diverse amenities, robust transportation infrastructure, and accessible recreational spaces. In contrast, commercial courtyards located in more peripheral areas, particularly Autonomous Courtyards, generally lack these attributes and also have worse transport connectivity, leading to comparatively lower scores. These scores reflect limited integration into the surrounding urban structure, insufficient access to social infrastructure, and a lack of recreational spaces.

3.4. Overall Evaluation and Discussion

To obtain a larger picture and answer our first research question (How can a "New Berlin Mix" be defined?), we conducted an overall evaluation (see Table 1) and formed three main groups: top performers (Group 1), medium performers (Group 2), and low performers (Group 3), as well as specific subgroups categorised based on their structural types and location.

In general, it can be said that a stylised "New Berlin Mix" Courtyard can be characterised as follows:

- Mixed uses: at least five out of seven use categories integrated and an additional residential function within the block for the Integrated (and Extended) Berlin Mix type;
- Proportion of urban production: at least 10% for the Integrated (and Extended) Berlin Mix type, and at least 20–30% for the Adjacent and Autonomous types;
- Sectoral diversity within urban production: crafts and workshops, including light industry, pharmaceuticals, crafts, metal/woodworking, printing, car repair, and, to a limited extent, 3D/robotics;

- Embedded in a vibrant and mixed environment: courtyards located in mixed neighbourhoods, surrounded by a residential environment with numerous local amenities and social infrastructure.

If we look at the group of top performers, we have two Integrated Berlin Mix Courtyards (1a) that merely align with the "New Berlin Mix" as they score highly in the "variety of use categories" and "embeddedness in the environment" and moderately when it comes to "integration of the productive economy," which they managed despite residential functions on the same block. A second subgroup of top performers consists of Adjacent Courtyards (1b) that score highly in all categories, two of these Adjacent Courtyards also integrate novel and desired industry 4.0 applications such as 3D printing (Amperium am Humboldthain, GSG-Hof Schwedenstraße), but without a residential function. The third subgroup of top performers includes Autonomous Courtyards on the outskirts (1c) that score highly for the criteria "variety of use categories" and "integration of the productive economy," but there is room for improvement with regard to their local embeddedness. It is surprising that this type appears in the top-performing group despite its location and building structure. According to interviews, the econopark courtyards provide lower rent prices, flexible sectioning, and good standards in modern buildings and often function as a catchment area for displaced inner-city craftspeople and producers, as landlords have not set up specific branches or location profiles (Interviews 3, 4, and 5; Suwala, 2024).

The medium-performing courtyards include four subgroups: Integrated Berlin Mix Courtyards (2a) have the same characteristics as 1a, but with low scores for urban production. The Adjacent Courtyard subgroup (2b) differs from 1b in that they received low scores in "integration of the productive economy." Although the 2c subgroup includes diverse structural types (Adjacent, Autonomous, Extended Berlin Mix) and locations within Berlin, all of these courtyards received high scores in terms of integrating the productive economy and average scores in category uses and embeddedness. It mostly consists of well-established locations with a specific industry profile in West Berlin (Interview 1). The 2d subgroup consists of Extended Berlin Mix Courtyards that align with the characteristics of types 2a and 2b, but with low performance in terms of integrating the productive economy.

The entire low-performing group (3) shares a complete lack of urban production. While both subgroups are well embedded in their surroundings, subgroup 3a has average and subgroup 3b low values in diversity of use. The GSG-Hof Franklinstraße courtyard (3c) performs poorly in all three categories.

Our results can be summarised in the following threads. The "New Berlin Mix" is a modified type of mixed-use development that differs from the "original amd historical" Berlin Mix in the functional composition: It does not necessarily belong to the Integrated Berlin Mix Courtyard type nor is it located exclusively in inner-city locations. Besides, we see a much lower or even no proportion of urban production in many courtyards. Furthermore, the envisioned and desired mixed-use development with progressive low-emission technologies (e.g., 3D printing, robotics; Erbstößer, 2016) is still in its infancy. Moreover, it would be exaggerated to romanticise the original or Integrated Berlin Mix as this was also a non-altruistic community of purpose that evolved from past structural, social, economic, and demographic constraints (Hoffmann-Axthelm, 1993). Therefore, the functional mixed-use development integrating local economies and urban production (Bundesministerium des Innern, 2020) is and will continue to be a Herculean task for planning in future, including from an economic perspective.

Table 1. Overall assessment for the "New Berlin Mix."

Group	Name of Courtyard	Type	Location
(1) Top performers (> 12 out of 18 points)	(1a) Peters-Höfe, Heinrich-Höfe	Integrated Berlin Mix	Inner city
	(1b) Amperium am Humboldthain, GSG-Hof Schwedenstraße, Marzipan-Höfe, Bechstein-Höfe	Adjacent	Inner city
	(1c) econopark Plauener Straße, econopark Döbelner Straße, GSG-Hof Sophie-Charlotten-Straße, econopark Wolfener Straße, econopark Pankstraße	Autonomous	Outskirts (exception: Sophie-Charlotten-Straße)
(2) Medium performers (9 ≤ x < 12 out of 18 points)	(2a) SO26-Höfe, Zuse-Höfe	Integrated Berlin Mix	Inner city
	(2b) Glaser-Höfe, Zander und Palm-Höfe, Schellack-Höfe, Schirmer-Höfe, GSG-Hof Ullsteinstraße	Adjacent	Inner city
	(2c) Späth-Höfe, GSG-Hof Helmholtzstraße, Dittmann-Höfe, GSG-Hof Flottenstraße, econopark Wilhelm-von-Siemens-Straße, GSG-Hof Reuchlinstraße	Adjacent, Autonomous, Extended Berlin Mix	Inner city and outskirts
	(2d) AQUA-Höfe, Zermelo-Höfe GSG-Hof Wattstraße, GSG-Hof Geneststraße	Extended Berlin Mix	Inner city
(3) Low performers (< 9 out of 18 points)	(3a) Orangen-Höfe, Adalbert-Höfe, Gebauer Höfe	Integrated and Extended Berlin Mix	Inner city
	(3b) Prinzessinnen-Höfe, Seifen-Höfe, Sauerbier-Höfe	Integrated and Extended Berlin Mix	Inner city
	(3c) GSG-Hof Franklinstraße*	Adjacent	Inner city

Notes: Although the overall rating allowed for a range of 0 to 18 points (see also Section 3.1), roughly half of the courtyards scored between 9 and 12 points (which we consider medium performance), while the total average was 10.67 points; therefore, we obtained a slightly shifted Gaussian distribution to the right and pragmatically set the point ranges for top performers (> 12 out of 18 points) and low performers (< 9 out of 18 points); * GSG-Hof Franklinstraße cannot really be included in the analysis as it served as the headquarters of the GSG between 1975 and 2016 with administrative functions.

With regard to the location, the following can be said: Even if we have not considered the courtyards in a dynamic longitudinal perspective, we assume that residential gentrification and its spatial spiral patterns in Berlin, as modelled by Döring and Ulbricht (2018) and Holm (2014), have also been taking their toll on commercial activities in courtyards. Heider and Siedentop (2024) differentiate between two types of economic gentrification (see also Ferm, 2016; Glatter & Sturm, 2020; Ryckewaert et al., 2021), which are quite useful for explaining our overall assessment in Table 1. First, industrial displacement describes the replacement of manufacturing activities by more profitable uses such as housing or higher-value services. This process results in de-mixing and is particularly prevalent in Integrated Berlin Mix Courtyards, which have lost or are losing their production base, but also in Adjacent Courtyards in inner-city locations to a more limited extent. Second, commercial gentrification represents the successive displacement of traditional businesses (for example, in retail, gastronomy, or crafts) by property upgrading processes in changing neighbourhoods. This happens in Integrated Berlin Mix Courtyards and in Extended Berlin Mix Courtyards to

a large extent. By and large, two results of our analysis can be confirmed. First, the "New Berlin Mix" is no longer restricted to inner-city locations due to the lack of urban production. Second, displaced businesses have clearly moved to Autonomous Courtyard locations on the outskirts, which act as a catchment area with available spaces, a high variety of industries, and lower rents (see also Suwala, 2024).

4. Conclusion and Outlook

We have investigated functional mixed-use development in Berlin within a sample of 35 commercial courtyards based on the GSG company's website, on-site visits, georeferencing and GIS analysis, and a comprehensive inventory and survey of all (commercial) activities, as well as ex-post interviews. Our objective was to assess which characteristics a potential "New Berlin Mix" would include. Our results show that the "New Berlin Mix" aims to integrate a diverse range of use categories, including residential use, the productive economy, and a vibrant environment with local amenities and social infrastructure. Interestingly, this "New Berlin Mix" can also be found in Adjacent and even Autonomous Courtyards on the outskirts, while mixed-use developments seem to be losing ground in inner-city tenement housing quarters (i.e., Integrated Berlin Mix or Extended Berlin Mix Courtyards). A reason for this spatial movement towards the periphery could be industrial displacement and commercial gentrification (Ferm, 2016; Heider & Siedentop, 2024). Meanwhile, envisioned and desired mixed-use developments with progressive low-emission technologies (e.g., 3D printing, robotics; Erbstößer, 2016; Läpple, 2016) are still rare.

On the one hand, our study contributed to the literature on the economic nature of mixed-use development (Hoppenbrouwer & Louw, 2005; Rowley, 1996), urban production (M. Brandt et al., 2017; Grodach & Martin, 2021; Herrmann et al., 2020), commercial courtyards (Baumgart, 2001; Bodmann, 1984; Henckel, 1981), and to the very few studies about urban economic gentrification (Chapple & Loukaitou-Sideris, 2019; Ferm, 2016; Heider & Siedentop, 2024). Practically, our study provides a starting point for potential planning measures to be taken in order to secure such mixed-use development, safeguard urban production, or prevent industrial displacement (Baumgart et al., 2024; Meyer, 2023). Politically, it illustrates how much the calls for productive cities with the New Leipzig Charter (Bundesministerium des Innern, 2020; Gärtner et al., 2021) have developed in reality and shows that they are still in their infancy.

On the other hand, there are, of course, several limitations associated with our approach. First of all, qualitative follow-up studies taking into account, for example, several case studies on selected sites and types would be able to shed light on the assumed structural and functional characteristics and tell us about the intangible social and lived mixed-use development (*gelebte Mischung*; Roskamm, 2024). Second, even if the sample can be considered as fairly representative, a full survey of all Berlin courtyards (see Suwala & Franke, 2025) would show a larger picture by also paying attention to former Integrated Berlin Mix Courtyards that have already been transformed (for Friedrichshain-Kreuzberg, see Baba et al., 2017). Third, methodologically, there is room for variation. Should the block and/or neighbourhood level be considered, and how should the radius be set up? Should a residential function outside the block but in close proximity or vis-á-vis be included? Fourth, planning measures could have been formulated. Is the "New Berlin Mix" a desirable planning objective or rather a reference value?

In the future, we suggest taking a closer, longitudinal look at commercial courtyards in order to assess dynamic developments and possible implications for modification in the composition of mixed-use development, urban

production, commercial gentrification, and industrial displacement. Even if the results are not or only partly transferable to other cities in Germany and Europe, the findings can act as benchmarks or blueprints for functional mixed-use development, guide future urban planning towards a "New Berlin Mix" that is aligned with the New Leipzig Charter, and contribute to the desired economic and societal revival of inner-city areas by reintegrating tangible production into those areas.

Conflict of Interests

In this article, editorial decisions were undertaken by Robert Kitzmann (Humboldt University Berlin), Sebastian Henn (Friedrich Schiller University Jena), and Stefan Gärtner (Institute for Work and Technology).

LLMs Disclosure

To ensure responsible AI use and maintain publication integrity, we disclose using DeepL (version 25.1.4.15077). DeepL was used to translate selected parts of the article, which were then manually verified by researchers; this tool also enhanced our manuscript's grammar and style in those selected parts.

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ARTICLE

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Mediating Policy to Mix Making Spaces

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Abstract

Cities have agency to reinterpret their building, zoning, and environmental code policies to adapt to the new economy and contemporary ways products are made in urban settings. The many vacant spaces in urban centers—from retail spaces to former factory buildings—can be rehabilitated for making things in the new urban economy of artisanal and light manufacturing and thus mix with other uses. New buildings can also be purpose-built with these mixes to meet current safety and environmental codes, and, if zoned proactively, these spaces can provide economic stability, nimble development alternatives, and dynamic urban symbiosis. Continuing the research I have conducted for my exhibitions, books, essays, and fieldwork in specific cities, this essay analyzes ways that production can be reinserted into cities in mixed-use buildings and districts that are now in the planning stages or have been recently realized. Some projects feature block-level mixes and vertical building configurations created by the volumetric separation of production from living as a new typology. The projects discussed here can inspire and guide city planning policies and economic development departments by integrating the new small, clean, and quiet production into cities and allowing for much more flexible and granular land-use and zoning regulations that will support small- and medium-sized enterprises and provide jobs for local residents. Key to these projects is the strength of mission-driven organizations that can work to bring manufacturing back through new zoning code overlays and social connectivity. Project locations include those where I have been working, or conducting in-person research in the U.S. cities of Berkeley, New York, Newark, Somerville, Trenton, and in Europe those of Brussels, Rome, and Turin.

Keywords

artisan; ecosystem; hybrid; mixed-use; mixity; productive cities; regeneration; small- and medium-sized enterprises; urban manufacturing; zoning overlays

1. Introduction

In the new economy of the Fourth Industrial Revolution, parameters for urban manufacturing have evolved spatially and environmentally. There is a shift from behemoth factories spewing harmful emissions found in export processing zones and isolated industrial districts toward smaller-scale, lighter, and nonpolluting industries and green, quiet, more pristine production integrated in urban settings. At a reduced scale, former industrial buildings and new multistoried hybrids (buildings that have a mix of uses) can offer small firms dynamic, embedded, and self-supporting ecosystems (Becker & Friedman, 2020; Croxford et al., 2020; Rappaport, 2017, 2023). Technological advances are transforming industrial organizations spatially and economically. The corresponding increase in local jobs on the factory floor as well as the business side have the potential to establish a new hybrid paradigm at the building, district, and citywide scales. Allowing variously scaled programs to be incorporated into regulatory plans, with mixity, provides opportunities for job creation near where people live. This proximity of working and living reduces an individual's carbon footprint while creating the 15-minute city where everything is in a walking radius that Clarence Perry in 1929 developed through his neighborhood concept (Perry, 1929/1989). In this realm, as former Baumeister Kristiaan Borret of Brussels has said, "production must be encouraged in the city and included as an integral part of the urban fabric. It must be able to reveal itself, in connection with daily life" (Borret, 2018, p. 6).

When land use zoning allows for mixed uses, especially in highly valued real estate markets such as New York City, the preferred new development proposals are those offering maximum profit and higher taxation of land use. Higher-end housing and expensive service and financial-oriented workspace dominate the market, not lower-rent industrial space. New policies thereby need to place affordability at the core of rezoning for mixed-use buildings and districts to counter commercial and industrial gentrification and not to encourage it (Becker & Friedman, 2020, p. 211; Grodach & Martin, 2025; Leigh & Hoelzel, 2012; Wolf-Powers, 2005, p. 390). This essay shows how cities in New York, California, New Jersey, and Italy—subjects of my recent research—are revising standard modernist land-use policies to respond to the artisanal and high-tech boom with layers of creative zoning codes in what is called "overlays," or new land-use districts, allowing new construction and adaptive reuse projects for small- and medium-sized enterprises to be integrated in cities with economic and environmental resilience. In order to substantiate these topics, I analyzed zoning policies and recent changes to city land use plans, met with economists and architects as well as local businesses who desire to remain in place.

To comprehend the evolution of the new mixed economy since the 1980s, it is essential to recognize a transformation in the urban economy in many cities of the Global North: the decline of large-scale industrial employers that once hired thousands of workers has coincided with the proliferation of micro-manufacturing enterprises, typically employing fewer than ten workers. For example, in 2019 over 10,000 micromanufacturing businesses in Turin employed up to nine employees, which comprises 80 percent of all manufacturing firms (Robiglio & Repellino, 2022, p. 146). In New York, currently, there are many smaller companies that employ fewer workers, but add to the total number of employees. While 90 percent of industrial businesses employ fewer than 100 people, 50 percent employ just five people (Manufacturing and Industrial Innovation Council New York, 2025). Because these companies are small, they can be integrated into geographically disperse workspaces increasing local production and jobs if cities rezone at a district scale proactively (Croxford et al., 2018, p. 68). The examples in this essay can serve as mixed-use models of good practices for former industrial spaces and new affordable mixes as communal

sites of interaction and economic ecosystems at the neighborhood level and demonstrate how methods to mix production can be made possible by:

1) Making manufacturing visible;
2) Organizing hybrid building massing volumes according to programs;
3) Creating zoning use overlays;
4) And linking the industrial community with the neighborhood residents.

This essay is organized by first describing the historical context of land use separation and its evolution. It then demonstrates the interest of integrating light industry in cities through the consumer's interest in watching the production process and the need for jobs. It then focuses on how some cities as diverse as Brussels; Somerville, Massachusetts; Berkeley, California; and Rome are working towards forming mixed-use districts in innovative ways. The result is that additional layers of building codes specific to light industry can allow for the new mix. The section following is a more in-depth discussion of specific mixed-use projects in New Jersey and New York that are potential models both programmatically and volumetrically. It concludes with how local organizations that support these mixes can bolster economic development with an equitable goal and create dynamic cities.

2. Urban Land Use From Separation to Integration

As we reevaluate the past segregation of uses that were developed by Modern architects in La Sarraz, Switzerland (1928) with the *Congrès international d'architecture moderne* or CIAM (Barnett, 1986, pp. 13–15) these distinctions now seem obsolete. Modernists focused on separating uses—residential, transportation, work, play—shifting those functions that were not cross-compatible beyond the urban core, cordoned off through highway networks, or, in the case of industry, moved to specially zoned districts in hinterlands. The intent of the nuisance-focused land-use zoning code in most urban areas is to protect the public from the negative sensory impacts of noise, odors, dust, and general activity that are incompatible with human well-being. Those nuisances and their public perception have changed. If industries no longer emit repulsive smells, which are subjective in any case, then the "nuisance" does not need to be regulated so tightly, and alternative zoning codes can guide urban development (Croxford et al., 2020, p. 73). Additionally, because small and light industrial enterprises that are now occupying spaces in cities do not pollute in the same way as heavy industry, the integration of making things in these dispersed urban spaces is made possible via three organizational paths: (1) smaller industries integrated in former "vertical urban factories" through adaptive reuse of factories; (2) newly built projects; and (3) at the block scale, dispersed in retail spaces or commercial buildings (Rappaport, 2017). The integration of these industrial entrepreneurs into neighborhoods can provide jobs to boost equity and stability for both higher and lesser skilled workers, with additional jobs related to administrative and services (Grodach & Guerra-Tao, 2023). On the one hand, established zoning regulations limit the imaginative potential of urban districts to a singular and monofunctional place that is only used at one time: offices by day/no activities at night; factory by day/no one living there (Kelly, 2016, p. 125). On the other hand, often industries still prefer monofunctional zones as they do not want to interact with what are quality of life issues, can have louder noise levels, and can have deliveries unimpeded by residents and pedestrians 24/7 (Conway, 2020, pp. 81–82). So the question remains, how do we create new mixed-use districts and buildings that allow working and living and/or production and retail to cohabit?

2.1. Making Production Visible

One current urban improvement idea is that of making light local production enterprises visible in streetscapes to help revitalize economies, even as we acknowledge that it might lead to higher-end products and some industrial gentrification (Grodach & Martin, 2018). Younger entrepreneurs and tech start-ups are gravitating towards the small-batch craft and artisanal work often produced by "neo-cottage" industries and micromanufacturing (Croxford et al., 2018, p. 35; Rappaport, 2015, p. 200). These economically stable urban industries, which cater to urban dwellers, fall most often into "F" categories: fashion, food, furniture, fabrication, and film (Micelli, 2011). Many of these companies can adapt to diverse spaces where the workers use prototyping, high-tech fabrication, and more hands-on work in an ecosystem where tools and methods can be shared (Anderson, 2013, p. 67). Some of these businesses grow organically across generations, embedded in a culture that is unrelated to land use, and become crucial to a city's economy. These "intangible" cultural traditions often represent dying art forms that need safeguarding and are place-dependent (Figure 1).

Figure 1. Craft manufacturer in New York City. Photograph by Nina Rappaport, 2022.

When craft and maker entrepreneurs (those who make things and form businesses) expanded with urban workshops and storefronts as well as through on-line platform sales, their authenticity became popular with consumers (Anderson, 2013, p. 182). Understanding the maker or fabricator's production process adds value to the product because customized production is distinctive (Meyer, 2023). Their increased visibility has led to what I call the "consumption of production," where consumers have access to learn methods and also enjoy watching the production process, whether via the factory tour or through a shop window (Rappaport, 2003, pp. 58–65). Even some larger factories became showcases for workers, as in Dresden, where Henn Architect's 2009 design of the VW Transparent factory added a dynamism to the city with views from glass facades into the production floor. This openness connects the consumer to the product they are about to buy in contrast to the distant factories of fast fashion and global production (Ruby, 1999). The factory-museum has also become a renewed urban typology as seen in the 2023 Lindt & Sprungli factory-museum in Zurich designed by Christ & Gantenbein. The history of chocolate is on display in didactic exhibitions and a chocolate tasting experience connects the consumer to the product. This concept of watching and learning about production

can help to bring activities back to city centers as a place of meditating local production in terms of jobs while simultaneously enlivens the streetscape as an urban design goal.

3. The Hybrid Through Zoning Overlays; Dispersed Light Industry Block by Block

Although city governments have agency to change building, zoning, and environmental codes, the bureaucratic process to enact a new law is filled with conflicts and demands from many different city departments, preventing them from responding nimbly to immediate economic and social issues. This adversely affects entrepreneurs who need to bring products to market quickly. Few city planning agencies know how to create new building and land-use codes to intermingle production, even though these adjacencies exist historically and organically in cities such as Seoul, Tokyo, and Hanoi in shophouses: shops and workshops on the ground floor, residences above. When industries fail or move, often their lands are designated as polluted brownfields and sit dormant until developers realize their potential decades later and propose to convert the land to more valuable market-rate residential uses. This can be seen in the high-rise luxury towers that continue to proliferate in New York's previously industrial waterfront districts: Long Island City, Queens, and Williamsburg, Brooklyn (Capuano, 2003). Usually, the zoning changes allow for taller buildings, thereby increasing height and site bulk; these development projects do not include industry, so most have become residential, thereby removing industrial lands from potential regeneration plans or making them unaffordable (Podemski, 2013, p. 16; Wolf-Powers, 2005, p. 328).

One way that cities have started to loosen their Euclidian zoning regulations is through not-often-used, hard-to-regulate performance zoning where, instead of a blanket code, pollution and nuisances are evaluated on a case-by-case basis where each site must be analyzed in person and monitored by understaffed city agencies (Elliott, 2008, pp. 24–26). Performance zoning gained popularity in the U.S. in the 1980s but has since faltered as a trend. In other cases, cities such as those in Germany have a framework for the Urbanes Gebiet ("urban area") established in 2017 to encourage mixed uses on former industrial sites and as ways to reinvigorate downtowns. However, it does not include industrial use (Brandt et al., 2017; Schoppengerd, 2023). Of interest is the evolution of regulatory changes as cities such as Turin are evaluating sites more organically without changing the city-wide zoning codes. There, a chocolate company integrated a small production facility into the city block adjacent to residential buildings (Robiglio, 2022, p. 149). Workshops or little garages—as in the industrial revolution—have repurposed the interior courtyards of residential blocks that now house custom bicycle fabricators, food producers, glass artists, ceramists, and young fashion companies, among others. It is yet to be seen how regulations will have to change in order to maintain the small enterprises in place (Robiglio, 2022, p. 155).

With some success other cities, including those that I have been studying or involved in—Berkeley, Newark, Trenton, Somerville, Brussels, and Rome—are undertaking more granular methods for innovative mixed-use zoning regulations as added layers of land use and zoning codes on top of existing regulations, called overlays, that are inspiring building owners to reweave light manufacturing into the urban fabric. Influential to this discussion is the innovative 2016 "Production Distribution Repair Zones" initiative in San Francisco (Grodach & Martin, 2018; Pendras et al., 2023, p. 229; San Francisco City, 2025) as well as the importance of Brussels' "Enterprise Zones in an Urban Environment" (De Boeck & Ryckewaert, 2020). I will use examples of Brussels; Somerville's new "Fabrication Zone"; West Berkeley's "Light Manufacturing Plan"; Rome's "Artisan Craft Districts"; and the city of Newark, New Jersey, which uses a more normative nomenclature such as MX

(for Mixed) and "Light Industrial District" to indicate the mix of uses. In this moment, the cities allowing for lighter nonpolluting production with other uses represent a kind of avant-garde of land use planners. They are experimenting with ways to maintain industry and increase jobs in synergy with mixed-use building activity and are seen in the examples below.

3.1. Brussels

A pioneering industrial regeneration model to rebuild disused sites, introduced seven years ago in Brussels, is the concept of Enterprise Zones in an Urban Environment or ZEMU (Borret, 2018). Brussels is better known than other cities so I will limit my discussion here (see also Ryckewaert et al., 2021). There, an equilibrium between industry and new developments was created by integrating industries into new urban amalgamations in the city's Canal Area. The 2014 linear Canal Plan reimagined the integration of residential into heavy-industrial uses along the canal's shores where goods are still transported by barge to the broader Belgian regions (Canal Plan, 2017). The desire for revitalization of the city's brownfields and abandoned post-industrial development sites helped to expand urban development areas and instigate mixed-use zoning (Borret, 2023). Brussels' success is evident in the new projects built with the city development arm and innovative zoning codes that require new housing projects in these areas to provide space for new industrial tenants. This is working because of the light industrial and non-polluting uses and the fact that people who move into the buildings know that these uses are adjacent (Borret, 2018).

3.2. Somerville

While Brussels is an exemplar, other cities are experimenting with new smaller light industrial districts in their own contexts with the addition of zoning overlays. For example, in 2017 in Somerville, Massachusetts, where a former factory building is filled with smaller local producers, the city designated the area as a Fabrication District to support "activities common to the arts & creative economy…and a variety of employment opportunities in the arts & creative enterprises" (Dwan, 2023). The code requires that five percent of the floor area of new buildings be set aside for productive space with large floor plates and storefronts to revitalize urban districts through window displays visible to pedestrians. This Fabrication District zoning overlay could be a model for small and light industries (chocolate and hot sauce), and encouraged local light industries to stay in the neighborhood. However, the free-market process continues, and now a developer has proposed to demolish the main industrial building and add adjacent sites for a residential project. A community engagement process in the summer of 2025 tried to negotiate with the developer to keep affordable spaces for light industry and housing in the area but now a 1.5 million-square-foot (93,000-square-meter) complex will be built in between the less profitable arts and industrial uses to maintain affordable production spaces.

3.3. Berkeley

The city of Berkeley, California, created the West Berkeley Plan Light Manufacturing District to allow companies to have spaces for production *if* they include retail. The new rules as according to the Zoning Regulations intended to "encourage development of an area where light manufacturers can operate free from the economic, physical, and social constraints caused by incompatible uses" and by requiring that companies have adequate space to do so; the codes also support the establishment of companies that

"encourage the creation and continuation of well-paid jobs that do not require advanced degrees" (Berkeley City, n.d.). The city's intention is to have on-site retail space so that businesses can sell their goods and to maintain and enhance the economic viability of manufacturers in the district (Berkeley City, n.d.). The Inside Line bag company, which has a factory space in conjunction with their retail space, has been successful with this model. Inside Line workers cut and assemble thick canvas fabric using heavy-duty sewing machines to make fashionable and functional backpacks and handbags. The sewers sit in the front of the space with their backs to the cashier and consumers so that they can concentrate. This production and display space creates the street-level dynamism described earlier, and the workers creating the products are visible to the consumer (Figure 2).

Figure 2. Inside Line bag company with worker in store, Berkeley, California. Photograph by Nina Rappaport, 2024.

3.4. Rome

In cities such as Rome, where it is essential to provide space for local artisans who help conserve the historic urban fabric, the city planning office institutionalized light fabrication and artisanal workspaces by implementing new zoning with preservation safeguards. In 2020, the city created an Artisan Craft District a block from the tourist pedestrian area along the Tiber River in the Tor Nona Area that was nearly destroyed by Mussolini's planners in the 1930s. It has also changed its General Regulatory Plan to protect and promote artisanal activities for specific craft-related trades; the concept is to protect "the intangible, cultural and economic heritage of the city, in consideration of the knowledge and traditions that distinguish it" ("Roma Capitale, nasce il distretto dell'artigianato artistico," 2020, p. 6). In order to reinvigorate their craft heritage, in collaboration with the Schools of Art and Crafts of Rome Capital, there will be training and educational programs to transfer knowledge between master craftspeople and students, similar to medieval craft guilds. The artisans can sell their work in the designated buildings that will support their economic sustainability but also maintain the historic atmosphere. The city is tying the program into the redevelopment of the local economy to promote creative entrepreneurs. Many of the businesses are also related to the building

construction, craft, and conservation industries such as mosaic, plaster work, stone carving, and fresco painting whose skilled workers will, in turn, renovate the city's architectural heritage in a renewed ecosystem. The program also incentivizes the city to renovate and manage the buildings in these districts. One woodworker, for example, operates from a workshop with a large shopfront window that he often leaves open so that passersby can see the activity inside, in a consumption of production interchange, and from which he can easily deliver his cabinetry, stage sets, and furniture locally (personal communication with woodworker, February 2025). The area is zoned for commercial uses that include production, not only consumption. This type of land-use regulation encourages a synergistic ecosystem that helps the city promote and sustain artisans as well as the economy as it attracts consumers and fosters vital networks. The city is thus "strengthening the local productive fabric and the coordinated management of initiatives for the promotion and development of artisan, commercial, industrial, service, and freelance businesses" (Rome City, 2019). The mastery of craft is one example of an intangible cultural heritage tied to the city being valued on a level with protecting physical structures and monuments.

4. Linking Industrial Community to the Neighborhood

The mix of uses can help to revitalize declining former industrial neighborhoods as long as they have connections to the community and local entrepreneurs are engaged. At the building scale, adding new layers of building code regulations that allow the mix of industry also protects enterprises while providing housing or commercial uses. For solely manufacturing uses, one volume that is efficient is the "vertical urban factory" (Rappaport, 2015, p. 36), which utilizes existing multistoried buildings or is built anew. One company can occupy the entire building, or smaller companies can occupy layered or stacked spaces (Figure 3). Within these multi-tenanted buildings, productive communities grow and a self-supporting ecosystem evolves symbiotically through skill and equipment sharing. Examples that I have been researching, visiting, and discussing with the building managers are the Greenpoint Manufacturing and Design Center's (GMDC) series of six buildings, the Pfizer building in Brooklyn, and Keilepand in Rotterdam. Keilepand is particularly community-oriented as there the workers in the building eat lunch at on-site cafeterias; woodworkers combine efforts with metal workers to build furniture; vegetable gardens supply in-house cafés; and ground-floor exhibition spaces accommodate art shows, events, and other gatherings and presentations.

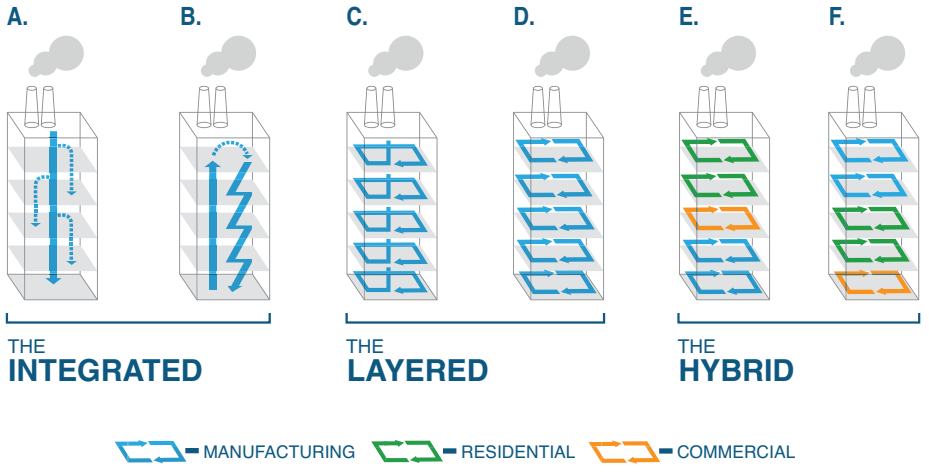

Figure 3. Vertical urban factory showing different configurations for light manufacturing, and mixed use in the Integrated (A&B), Layered (C&D), and Hybrid (E&F). Illustration by Sarah Gephart with Alex Lange.

While no data about the synergy has been collected yet, we know that it occurs through observation and discussions with the building owners who oversee the facilities of these mission-driven organizations (personal communications with M. Adams, 2024, B. Coleman, 2025, and J. Rosenblum, 2025).

While the mix of diverse types of light manufacturing is more normative, the mix with residential is complex and thus requires new layered zoning or building codes. Four typologies of residential uses mixed with light industrial uses that I am highlighting were organized through new land-use and building codes. Some of these ideas of volumetric massing of mixes have been studied in the analysis of Hoppenbrouwer and Louw (2005) in Amsterdam and continued in later studies (Ryckewaert et al., 2021). The analysis below is based on projects that I have been involved in, or researched in the U.S., along with my earlier work on the Vertical Urban Factory historic case studies in my eponymous traveling exhibition (Vertical Urban Factory, 2011) and include current projects with the Center for Urban Industry in New Jersey.

The first massing concept that is gaining traction is a simple diagram of lower floors containing the light-manufacturing space with commercial and residential spaces above. Often, the architects design a separate podium space with horizontal divisions to protect residents from vibration and nuisances. Some examples I often cite include the Strathcona project in Vancouver, which combines residential and light-industrial spaces (Rappaport, 2017, p. 74); the project Making a(nd) Living by Plusoffice; and NovaCity by DDS + Architects, both in Brussels (Borret, 2018, p. 27; Ryckewaert et al., 2021, pp. 340–342; Verbakel, 2022, p. 70; Figure 4). A second configuration of building volumes includes vertical volumes linked by common spaces on the ground floor in, at times, a separate volume. This is seen in the project of The Bridge, for light industry and assisted living, as described below. And the third configuration is a more scattered site with individual buildings hosting different functions but often with light manufacturing and artisanal production on the ground floors. The potential for shared spaces then requires design systemization, as the more complex mechanical systems for industrial waste, logistics, and services must be separated from the residential uses to protect residents, which is the point of the building code (Grodach & Martin, 2018;

Figure 4. Novacity, Brussels. Rendering by DDS + Architects, 2022, showing the manufacturing podium and the residential tower; building now completed.

Shapiro & Bingham, 2020, p. 202). Elevators may be allocated for residential or industrial use and the delivery and heavy-truck logistics can be separated from entrances; courtyards can also be used to allow trucks to come in off the street and not interfere with pedestrians. A fourth configuration is not the physical building volume per se but programmatic including hybrid scattered activities such as cultural spaces, day care, and recreation areas that can serve as the new industrial commons where people can interact in a district or neighborhood (Rappaport, 2022; Suwala et al., 2025).

These new typologies of the hybrid urban factory serve as innovative models and inspire ways to increase the inclusion of light manufacturing and smaller workshops throughout the urban fabric with newly established building and zoning regulations in each city. Four projects that I have been providing support and outreach for were realized in 2024 and 2025 in the New York–New Jersey region: The Bridge, Makerhoods, Willow Works, and Productive Community Connections.

4.1. The Bridge—Podium

In Brownsville, Brooklyn, two mission-driven organizations—a social service organization called The Bridge and the non-profit manufacturing real estate company, the GMDC—developed a new building for lower-income residences and light manufacturing spaces. Think + Architects designed a mix of uses in a 180,000-square-foot complex that opened in 2024. The Bridge features two, eight-story volumes on a podium base for light manufacturing, similar to the Brussels projects, and offers 174 affordable apartments for low-income residents and homeless veterans, including 87 units with supportive services in offices that surround an interior courtyard (Figure 5).

Figure 5. The Bridge, Brooklyn. Courtyard view with garden and two parallel residential volumes, Think + Architects, 2024.

Unusual for a new project is the inclusion of light manufacturing in 39,000 square feet (3,600 square meters) of working spaces below the landscape courtyard. These workshops are leased by GMDC to local start-ups including a furniture company, woodworkers, cabinet makers, and plaster workers. A light-filled entrance leads

up to a second floor where the community rooms, offices, and laundry spaces are situated as buffers above the light manufacturing spaces. Vaporproof barriers create a protective membrane for the safety of tenants and insulation limits noise and vibration.

As an untested scenario, the regulations were difficult for the architects, the nonprofit developers, and the city agencies who basically invented the hybrid combinations as they went. Numerous environmental and building code specifications addressed pollution, fire, safety, and program issues and requirements as the land use was designated residential. The nonprofits requested to change the zoning assigned to this site, creating a great deal of risk and unknowns (Coleman, 2023). After numerous public meetings, they were able to convince the planning agencies to change the zoning from R6 (residential up to six stories) to M1–4 (light manufacturing with other uses R6A and R7A) as a new special mixed-use district (MX-19) in what is known as a mandatory inclusionary housing area for affordable housing, underscoring that clean and lean production makes mixing with residential feasible.

On the ground-floor industrial space, the architects designed a faceted facade that permits light to penetrate the factory space through translucent L-shaped windows. Preventing the blocking of foot traffic and other sidewalk access by loading dock activity was also solved. Now that the spaces are occupied, new ways of thinking in New York about mixed-use inclusive of light manufacturing have accelerated; this project's success and its use mix awaits replication to be established as a new urban paradigm.

4.2. Makerhoods—Vertical With Courtyard

In New Jersey—a state that is the most densely populated in the U.S. with a mix of uses that form a visual hodgepodge of decay along the freeways and train corridors—entrepreneurs and public agencies are reframing ways to repurpose numerous vacant industrial buildings.

In Newark, a project called Makerhoods, which launched its planning phase in 2020, was inspired by my hybrid factory concept (Rappaport, 2015, p. 446). It involved saving the abandoned 20,000-square-foot (1,880 square-meter) hilltop 1888 Krueger Mansion, built by a brewery entrepreneur, to create a work-live complex. The developer Avi Telyas restored the building and added an L-shaped mixed-use space to the site in 2023. Using historic preservation tax credits and local grants and loans, he transformed the mansion into a community hub with workshops, rental offices, a café, and event spaces. On the adjacent site, Garrison Architects designed the six-story, 65,000-square-foot (6,038-square-meter), L-shaped building with 66 affordable apartments, and ten lower-level, double-height studio spaces with retail space facing either the courtyard or the street. These spaces come with the apartment lease, in a way similar to the Asian shophouse, so that makers can live above their workplaces. A common rear courtyard where community events can take place features an 8,000-square-foot (743-square-meter) commercial kitchen, a greenhouse, and open spaces for trucks to turn around (Figure 6).

The mix was possible because the city of Newark already allowed different programs through their MX-1 and MX-2 zoning codes for residential, commercial, and industrial to be combined on one site (Rich, 2015; personal communication with Rich in 2025). They also started a Light Industrial District zoning regulation to support low-impact manufacturing, artisanal production, and tech-oriented businesses in designated areas, particularly on transitional sites and former brownfields where a great deal of social injustice occurred because

Figure 6. Makerhoods, Newark, showing the historic mansion and the new affordable housing. Photograph by Nina Rappaport, 2024.

of public housing built adjacent to the polluted sites from the 1980s through the 1990s (Chien & Knoble, 2024, pp. 7–14). As noted in the city's zoning code, "the Light Industrial District allows the development of manufacturing and warehousing facilities, research and development labs, and other light industrial uses that do not produce significant noise or pollution" (Newark City, 2015). However, although the zoning allows for this mix, few have taken advantage of it in the same way as Makerhoods, with production spaces as part of a new development project. One reason for its success is that it is mission-driven to support local business and entrepreneurs who now produce candles, cosmetics, clothes, photography, film sets, and furniture in a new urban symbiotic ecosystem.

4.3. Trenton and the Center for Urban Industry (CUI), New Jersey—Scattered Hybrid Programs

In New Jersey, I initiated a Center for Urban Industry (CUI) with Kean University's Watson Institute (www.urbanindustryNJ.org) to encourage light industrial uses mixed with others, and to influence change in urban zoning policies to embrace new forms of light, clean, and quiet industries such as high-tech and biotech, as well as artisanal food-related producers. These initiatives can be models for the renovation of historic industrial building projects with manufacturing enterprises that offer unskilled jobs and could pay higher than the minimum wage. A few projects to repurpose abandoned factory buildings and support new enterprises are underway, some initiated by private property developers, and others on city-owned sites redeveloped through city-sponsored requests for proposals. The goal is to help local entrepreneurs grow with assistance from city departments of planning and economic development and inject new life and new opportunity into New Jersey cities. Throughout the state, the CUI is initiating partnerships with public and private entities to identify industrial regeneration areas for redevelopment and critical urban sites

for future rebirth. The idea of mixed use has potential for economic flexibility and the renewal of community connections.

With the CUI, the first in-depth work has been with the city of Trenton, a shrinking state capital suffering from declining employment and quality of life, which has its origins in the white flight and rampant crime that occurred in the 1960s (Cumbler, 1989). Historically, the city was renowned for its pottery production, such as porcelain dishware, and electrical and sanitary supplies manufactured by over 20 companies. Trenton was also a major production center for steel wire rope factories, established in the nineteenth century by John A. Roebling for the construction of the Brooklyn Bridge and by Peter Cooper (inventor of the I-beam) used in the transatlantic telegraph cable. But when the companies making steel wire rope failed in the 1970s, they left polluted areas and abandoned sites, including a 20-acre Roebling manufacturing complex and blocks of factories now in city ownership (Figure 7). The post-industrial ruins have left dilapidated conditions adjacent to what are now poorer residential communities built on lands that are designated for environmental clean-up, placing a negative stigma on these neighborhoods and illustrating environmental injustice (Chien & Knoble, 2024, pp. 7–14). The city now owns some of these properties and has engaged the CUI to assist with visions for the future to assist local entrepreneurs and help with access to funding and redevelopment methods.

Figure 7. Historic Roebling Complex, part of a new development site, Trenton, New Jersey. Photograph by Nina Rappaport, 2022.

On one former 1.5-acre (6,000-square-meter) industrial site in Trenton, an entrepreneur of a new prefabricated wall panel company called Willow Works is creating a mix of light industry, residential, and community use. He is planning a 20,000-square-foot (1,860 square-meter) complex in an adaptive reuse of a brick complex. His products will be used to rehabilitate houses in the area. The design scheme integrates a series of smaller volumes with new insertions to provide space for the factory, community area, a maker

space, and housing units. Sited on a corner close to the city center, the mix can increase the owner's opportunity for financial investment through grants and loans in an area designated in need of revitalization. By combining different uses, he can be awarded public funding for different aspects of the project in an incremental development project. The CUI is assisting with predevelopment guidance, design, and connections to appropriate public and business support agencies to bolster the community and its economy (Figure 8).

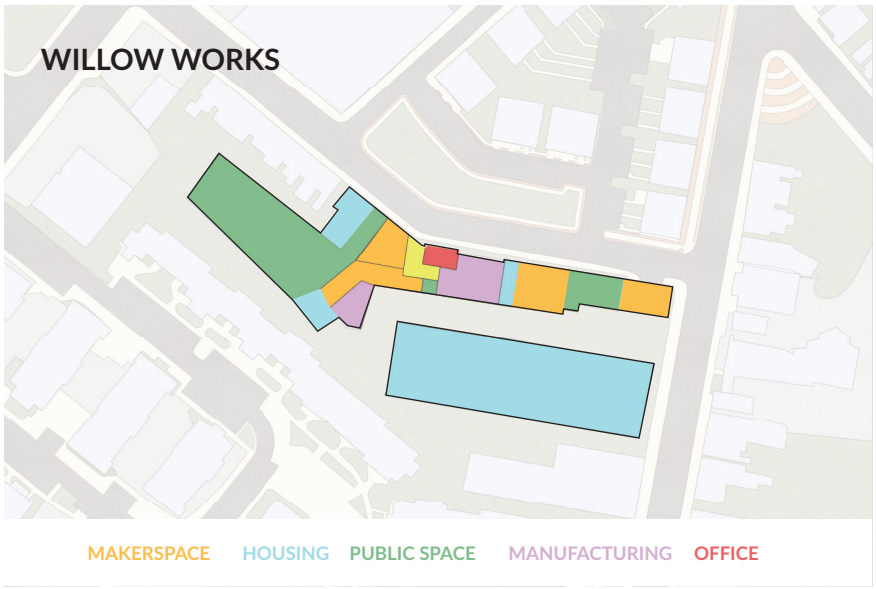

Figure 8. Willow Works, Trenton plan for site. Image by Center for Urban Industry, Alex Lange, 2024.

4.4. Connecting Production to Community

The CUI is also proposing catalysts to link city blocks between the industries and the residential uses through shared activities and common spaces. One collaborative potential is to reconsider ways to reshape a 1970s mini-industrial district in the neglected East Trenton neighborhood, a 20-minute walk from the train station, on a street once filled with former pottery producers. There, a developer built six standard shed factories that he leases to a variety of businesses, including a production artist, a linen distributor, a fish producer, a safety flashlight manufacturer, a building supply firm, a recycling industrial shelving company, and a cleaning service. The original plan has a surprisingly careful landscape design along North Clinton Avenue with rows of trees, green lawns, and large delivery areas at the rear of the buildings with access from a short industrial road where heavier industries border the railway tracks that once brought coal to the pottery companies. Across North Clinton Avenue is a residential area that has no relationship to the industrial enterprises—most of the businesses do not know the community (personal communication with factory owner, November 2025). The CUI is working to form links, literally, between the two sides of the street through shared community spaces and activities such as a shared recreational space and walking tours, called "productive walks." With these social initiatives, the residents can learn how local entrepreneurs organize their companies and production process and, vice versa, the companies can meet the residents and mentor them for future jobs (Figure 9).

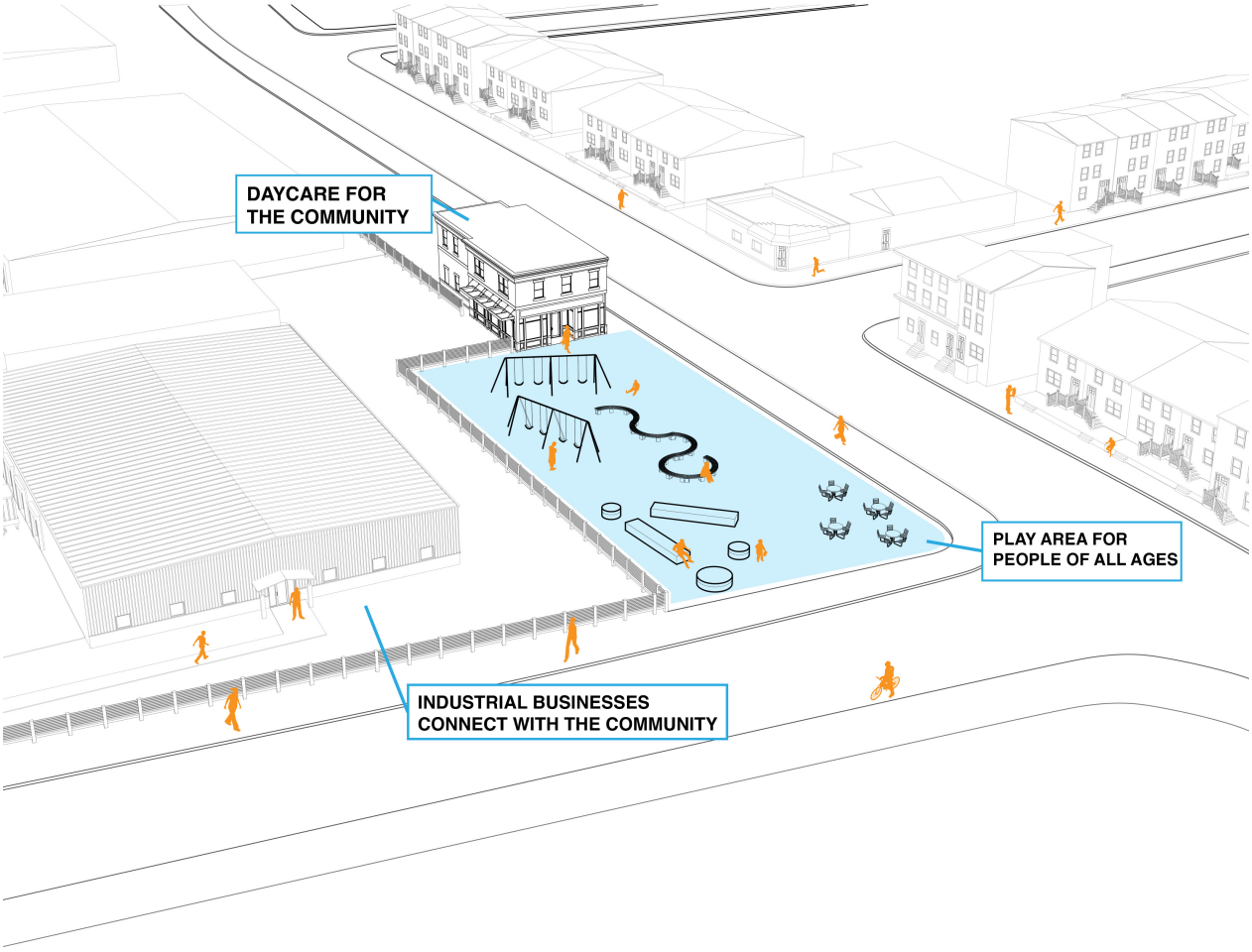

Figure 9. N. Clinton Community Connections concept, Trenton. Image by Center for Urban Industry and Vertical Urban Factory.

Productive walks have proven a valuable way to introduce communities to local manufacturing spaces, as seen in a project in Long Island City called Connecting the Arts, where light manufacturers and artists learn about each other's practices and works and then began collaborations (Design Trust for Public Space, 2006). Making work visible to the public involves removing barriers and creating new relationships. For example, in Long Island City, a company that makes high-tech electrical and metal work is providing machines and space for a recycling center to make metal containers, and they invite artists into the workshops to do metal welding for their own projects, like an artist-in-factory residency. On the business side, the CUI has also organized business-to-business-to community tours with Developer Days to bring potential building owners to see the abandoned industrial sites and meet public officials in charge of them. The CUI has held entrepreneurs' roundtables to discuss together ways to assist start-up businesses in mentorship programs that will lead to larger Entrepreneur Days. These examples demonstrate how essential it is to be engaged in communities, as company owners and local residents can create a symbiosis not only between the physical production environments but also through social spaces and community engagement for an economically sustainable urban mix (Table 1).

Table 1. Chart showing the three main hybrid projects and their variations for an affordable mix.

	Project name	Massing of project	Square ft	Reuse or new	Mix	Management type	Zoning type	Rent type	Common space
	The Bridge, Brooklyn	two volumes on podium vertical	180,000	new	housing community space light industry	mission-driven non-profit housing nonprofit production storefront commercial	R6 (residential of up to 6 stories) to a M1-4 (R6A and R7A) as a new Special Mixed-Use District (MX-19) in a Mandatory Inclusionary Housing area	affordable supportive some market	four shared common rooms lobby and entry garden courtyard
	Makerhoods, Newark	l-shaped volumes around courtyard vertical	65,000	new and reuse	housing community space artisanal	mission-driven housing company private artisanal for-profit office spaces	early use of existing zoning code MX2	affordable subsidized some market	courtyard logistics-events lobby cafe
	Willow Street, Trenton	scattered volumes low-rise vertical	20,000	reuse	house community space light industry	private but mission-driven private house private shared space possible non-profit common	RH1- High-Density Residential change to mixed use	market some grants	shared workspace future common workspace

5. Conclusion

As city agencies recognize new needs for flexibility in building and zoning codes that allow for a mix of local artisanal and small-scale producers with commercial, residential, and community uses in hybrid spaces there is an innovative opportunity to restitch the urban fabric and build more vibrant communities as seen in case studies around the world (Becker & Friedman, 2020; Grodach & Martin, 2025; Ryckewaert et al., 2021; Wolf-Powers, 2005). The mixes provide a dynamic intermingling of people with different skill levels and interests during times of economic uncertainty (Grodach & Guerra-Tao, 2023). With the aforementioned potentials for establishing new layers of zoning codes on top of the existing ones, a mix of artisan and maker uses can contribute to increased light industry in cities. Key components that allow this to occur are both social—interest in production visibility and linking the community with residents—and physical—hybrid massing through programs at the building and site scale.

Perhaps it will be seen, as from these examples, that the overlays for land use, while not the building-by-building evaluations of earlier performance zoning, will be the method to reestablish these production uses into the city, combining the ideas of the Brussels planners with those of the Brooklyn and New Jersey projects described here. While physical and financial analysis is still needed, and more dialogue between business owners, city planning, and economic development agencies is required, it is evident that connecting communities becomes essential. Through my re-evaluation of the regulatory land-use and building standards affecting organic change on the ground, I am optimistic about the potential for new codes to measure and determine where light manufacturing can safely and compatibly be located in mixed-use buildings and urban blocks. As discovered through this on-going analysis, local agencies require increased support and creative visioning of potential solutions. If new combinations of uses can occupy the finer grain of cities in hybrid paradigms, the multiplicities of programs and spaces will inspire urban policies to support social and economic equity with resiliency for more dynamic cities.

Conflict of Interests

The author declares no conflict of interests.

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ARTICLE

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Planning for and Designing a Publicly Owned Commercial Courtyard Infrastructure—The Case of Berlin

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Abstract

The attempt by the Berlin Government to develop a publicly owned commercial courtyard infrastructure is anchored in various district and city-wide planning frameworks. The main rationale is to support small and medium-sized enterprises from manifold branches (light manufacturing, crafts, start-ups, cultural industries) with appropriate and affordable spaces for future industrial and commercial-based services of general interest (*gewerbliche Daseinsvorsorge*). The general urban and architectural design concept for what has been dubbed commercial courtyards 2.0 (*Gewerbehof 2.0*) is derived from the traditional Berlin Mix (*Berliner Mischung*) based on mixed-use development, short distances, local sourcing, and a vertical commercial building structure adapted to contemporary framework conditions. Seven different state-owned properties have been taken into consideration for further development whereof three of these properties (located in the districts of Mitte, Lichtenberg, Marzahn-Hellersdorf) will be showcased here. Methodologically, we carried out location analyses, created urban and architectural designs, utilization concepts and conducted expert interviews, based on a research-to-practice approach and an inside-outside perspective. Our results show that—despite great future ideas such as innovation-oriented, mixed-use, crafts, cultural-creative, manufacturing-based, and socially anchored commercial courtyards with childcare facilities—competing and conflicting uses, economic profitability considerations, the fiscal situation of public authorities, urban development policies, property laws and building regulations impose a tight straitjacket concerning its realization. Pertinent commercial courtyard planning programs and experience with publicly owned operating companies from Berlin itself in the past and in other large German cities indicate that if long-term planning horizons for such endeavors are envisioned these ventures can be successful.

Keywords
Berlin Mix; commercial courtyards; industrial and commercial planning; local economies; mixed-use development; productive city; urban and architectural design; urban production

1. Introduction

Publicly owned land is a critical resource for spatial economic planning and policies. A key component therein is an active property policy assuring current and future industrial and commercial-based services of general interest (*gewerbliche Daseinsvorsorge*) in times of industrial displacement and commercial gentrification (Heider & Siedentop, 2024; Lingenhöle et al., 2025). Against this backdrop, the Berlin Government aims to reestablish a publicly owned commercial courtyard infrastructure anchored in various district (e.g., *bezirkliche Wirtschaftsflächenkonzepte*) and city-wide planning frameworks that are binding for territorial authorities (e.g., *Stadtentwicklungsplan Wirtschaft* 2040; Suwala et al., 2021). The main rationale is to support small and medium-sized enterprises (SMEs) from manifold branches (light manufacturing, crafts, start-ups, service sector) with appropriate and affordable spaces (Suwala, 2024), to supply surrounding communities with craft-based products and services (Suwala & Franke, 2025), and to provide spaces for social and cultural activities where possible (Lesem, 2023). For these reasons, we have analyzed Berlin's current planning efforts to set up such a publicly owned commercial courtyard infrastructure using three case study designs that exemplify approaches to innovation-oriented, mixed-use craft, cultural-creative, manufacturing-based, and socially anchored commercial courtyards.

This article contributes to the often neglected debates about planning (e.g., Baumgart, 2001; Hennings & Dobberstein, 2012) and designing commercial courtyards (Lane & Rappaport, 2020; Rappaport, 2016, 2017), proposing creative architectural and urban designs including utilization concepts (Moughtin et al., 2003; von Bittenfeld & Holz, 1997; WISTA, 2024) adapted to competing and conflicting uses, desires of public authorities, societal demands, logistical, economic, and built environment factors, urban development policies, property laws, and building regulations (Abt et al., 2020; Lesem, 2023; Schwabe, 2022; Schwappach et al., 2023). It asks how a publicly owned commercial courtyard infrastructure should be planned and designed from an integrative mixed-use development perspective. We use a multi-methods approach that consists of location analyses, expert interviews, and architectural and urban designs including utilization concepts based on a research-to-practice approach and an inside-outside perspective combining hands-on and academic expertise. Section 2 of this article outlines planning concepts and frameworks for commercial courtyards in German cities in general, and in Berlin with its novel imperative for the Berlin Mix 2.0 in particular. Section 3 describes the methodology and provides an overview of the location surveyed before analyzing and discussing the three case studies based on urban design and accompanying utilization concepts. Section 4 concludes, summarizes, and reflects on the theoretical, methodological, and practical contribution of this article, including an outlook for future research.

2. Planning and Design Concepts and Frameworks for Commercial Courtyards

2.1. Developing and Designing Industrial and Commercial Spaces in Urban Areas

The ongoing interest in industrial and commercial spaces in urban areas originated from the image of the mixed-used, compact "European city" with short distances (see Breheny, 1992; Häußermann & Siebel, 1997; Wegener, 1994) together with the rediscovery of local economies (Birkhölzer, 2000; Henn et al., 2020) and the recently reformulated imperative of the productive city as a fundamental pillar within the framework of the New Leipzig Charter (Bundesministerium des Innern, 2020; Gärtner et al., 2021; Suwala et al., 2025). There are various reasons in favor of mixed-use development, such as the "desire to limit sprawl, preserve open space, reduce automobile dependence, limit the expense of providing and maintaining infrastructure in low density environments, achieve housing, and increase sustainability" (Rabianski et al., 2009, p. 206), as well as economic reasons such as increasing employment rates, encouraging local value chains and sourcing, promoting family businesses and SMEs, and providing neighborhoods with commercial services of general interest (*gewerbliche Daseinsvorsorge*; Basco et al., 2021; Liepe et al., 2022; Roost et al., 2021). There are several planning measures designed to safeguard industrial and commercial spaces for this general interest and protect them against commercial gentrification and industrial displacement (Heider & Siedentop, 2024). Some studies differentiate between retention strategies and modernization/investment measures (Hennings & Dobberstein, 2012). Retention strategies aim to preserve, reactivate, and stabilize industrial and commercial areas using a combination of area-based management approaches and formal or informal planning instruments—such as urban development frameworks, binding land-use plans, and strategic land management. These strategies may include the provision of new commercial spaces for business relocations on existing plots or brownfield sites, the targeted development and thematic profiling of commercial areas for specific economic sectors or business types via tailored commercial area concepts, active site marketing, and the implementation of networking initiatives designed to foster collaboration among existing firms in both manufacturing and service sectors (Berens, 2010; Fitzgerald & Leigh, 2002). In contrast, modernization and investment measures aim to plan, initiate, and develop industrial and commercial spaces through the provision and structuring of dedicated business infrastructure—such as commercial courtyards, business parks, and knowledge or technology hubs—alongside the establishment of supportive institutional frameworks, including networks, incubators, start-up ecosystems, and targeted economic development policies (Brinkhoff et al., 2015; Henckel, 1981).

Mixed-use development, however, does not stop with designs at the urban level but is traditionally also anchored at the level of the building itself (Baumgart, 2001; Fiebig et al., 1984; Lingenhöle et al., 2025). Approaches to urban industrial and commercial design, particularly in the context of manufacturing, have historically included spaces for architectural and engineering experimentation. Yet, despite the complexity of these designs, form remains largely driven by function, aligning with production flows in a system of mutual synergies (Rappaport, 2017, pp. 105–107). While this still holds true for contemporary vertical urban factories, these buildings must now also respond to new and more complex conditions (such as low-emission, highly customized manufacturing enabled by advanced technologies), as well as to the expectations and demands of surrounding neighborhoods (e.g., assuring current and future commercial-based services of general interest; Gärtner et al., 2021; Roost et al., 2021). Therefore, designs in this realm should serve a twofold purpose: as urban design that helps overcome the challenge of accommodating manufacturing in cities (e.g., connecting and integrating production, protecting against commercial gentrification) and as architectural design that helps overcome the challenge of accommodating

manufacturing in buildings (e.g., facilitating loading, lifting, and storage, providing interesting design opportunities, inviting entryways). Overall, these designs should promote interaction among manufacturers (high-tech, low-tech, and high-touch) and the surrounding environment (e.g., built structures, neighborhoods) to create spatial identities in a compact, mixed-use city with short distances and local value chains (Lane & Rappaport, 2020; Rappaport, 2016).

2.2. Publicly Owned Commercial Courtyard Initiatives in Germany

Most large cities in Germany or even their districts (e.g., in the case of Berlin) run various (in)formal planning frameworks to identify, develop, safeguard, monitor, and integrate urban/regional commercial and industrial spaces under various denominations (*Gewerbeentwicklungsprogramm*, *Wirtschaftsflächen-* oder *Gewerbeflächenkonzept*, *Gewerbesicherungskonzept*; e.g., Liepe et al., 2022; Meyer, 2023; Metropolregion Hamburg, 2020, 2025; Senatsverwaltung für Stadtentwicklung, Bauen und Wohnen, 2024; Stadtplanungsamt Frankfurt am Main, 2021). In this context, or as subprograms of these planning frameworks, publicly owned commercial courtyards play a crucial building block. They can be understood as multi-story inner-city housing (tenement buildings) and working estates with one or more commercial courtyards from the early days of industrialization in their original version, which are also referred to as Berlin Mix (*Berliner Mischung*; Bascón-Borgelt et al., 1983; Lingenhöle et al., 2025). While commercial courtyards—and similar formats such as commercial parks—can have diverse structural types, they are commonly characterized by a compact, high-density block configuration within buildings or between building complexes. These sites typically accommodate a mix of sectors and businesses, integrating retail, craft-based enterprises, and light manufacturing alongside facilities for storage, production, and workshops (Baumgart, 2001; Bodmann & Rieger, 1988; Fiebig et al., 1984; Lingenhöle et al., 2025; Rappaport, 2016). In addition, commercial courtyards can be defined as facilities offered for rent for the joint accommodation of several legally and financially independent small and medium-sized industrial, commercial, and craft businesses and without any retail outlets and major foot traffic. Usually, uniform planning, construction, marketing, and operational management is carried out by an organization that can be public, private, or a mix thereof. In the case of a public organization, the pricing is often below market office rents thanks to subsidizations. The main rationale for public involvement is the lack of commercial spaces for small businesses in urban areas, growing demand for craft products and services from surrounding neighborhoods, all of which is to be accomplished in the realm of the compact city along the lines of inner development and densification (*Innenentwicklung und Nachverdichtung*; Baumgart, 2001; Habermann, 1990; Henckel, 1981).

With regard to publicly-owned or administered commercial courtyards, certain large cities in Germany run dedicated programs (e.g., Munich, *Münchner Gewerbehofprogramm*; Hamburg, *Hamburger Gerwerbehofkonzept*), are planning on starting a program (e.g., Frankfurt am Main), and/or cooperate with public, city-owned, or mixed operating companies (*Trägergesellschaft(en)*; e.g., *Leipziger Gewerbehof GmbH & Co. KG*; *Dresden—Dresdner Gewerbehofgesellschaft mbH*) to monitor, maintain, safeguard, or develop a publicly owned commercial courtyard infrastructure (see Table 1).

Table 1. Publicly owned courtyard infrastructure and programs in selected cities in Germany (created by the authors).

City	Program	Year(s) of foundation, operating company, and shareholders (in brackets)	Portfolio of commercial courtyards (number, total area in m², and locations)	Future plans (number, total area in m², and locations)
Hamburg	*Hamburger Gerwerbehof-konzept*	1935/2014 *Sprinkenhof GmbH* (among others: *Hamburger Gesellschaft für Gewerbebauförderung mbH)* (part of the city-owned conglomerate *HGV Hamburger Gesellschaft für Vermögens–und Beteiligungsmanagement mbH* (HGV))	13, 96,000 m², various locations	3 publicly owned, 5.800 m² courtyards + 11 in the planning stage
Munich	*Münchner Gewerbehof-programm*	1981/1993 MGH—*Münchner Gewerbehof–und Technologiezentrumsgesellschaft mbH* (City of Munich)	9, 106,000 m²; inner city, brownfields, and 1 technology center	3, 45,000 m²; extension on the outskirts
Dresden	—	1996 *Dresdner Gewerbehofgesellschaft mbH* (City of Dresden, the regional savings bank *Ostsächsische Sparkasse Dresden*, and the co-operative bank *Volksbank Dresden-Bautzen eG*)	4, 25,850 m²; inner city, outskirts, and former brownfields	
Leipzig	—	1994, *Leipziger Gewerbehof GmbH & Co. KG* (City of Leipzig, Leipzig Chamber of Industry and Commerce, Leipzig Chamber of Crafts)	12, 130,000 m²; inner city, outskirts, and former brownfields	1, currently building an innovation center
Düsseldorf	—	1898/1951 *Industrieterrains Düsseldorf—Reisholz AG* (City of Düsseldorf)	6, 11,000 m²; various locations	

2.3. The Turbulent History of Former Publicly Owned Commercial Courtyards in Berlin

Berlin was a pioneer in Germany with regard to a publicly owned commercial courtyard infrastructure. The city-owned *Gewerbesiedlungs-Gesellschaft mbH* (GSG) was founded by the city of West Berlin, the Berlin Chamber of Crafts, and the Berlin Chamber of Industry and Commerce in 1965 (later, two city-owned banks and one co-operative bank also joined as shareholders). Despite a great exodus of many large industrial and service companies in the aftermath of the Second World War from divided Berlin, affordable premises for the remaining production and crafts-oriented SMEs were scarce (GSG, 1999a, 1999b, 2015; Habermann, 1990). GSG aimed to offer businesses reliable economic prospects by creating affordable and well-equipped commercial space and by acting as a redevelopment agency for (a) acquisition, clearance, land readjustment, development, and resale for private commercial use particularly in redevelopment areas, (b) modernization, construction, construction management, administration, and letting of commercial buildings, and (c) building leases (Abgeordnetenhaus Berlin, 2005). This included the refurbishment, maintenance of existing, and development of new commercial courtyards (Habermann, 1990).

Initially, GSG renovated and partially extended many of Berlin's old commercial courtyards and refurbished them for contemporary commercial use in former West Berlin (after the German reunification, in inner-city districts of East Berlin as well). In the 1980s, this task was supplemented by the conversion of old inner-city industrial sites. The sites once occupied by leading industrial companies (e.g., from Berlin's great past as an "Electropolis," such as Osram, Siemens, AEG (*Allgemeine Elektricitäts-Gesellschaft*), and SEL (*Standard Elektrizitätsgesellschaft*), Kitzmann and Suwala, 2018) were transformed into attractive new commercial courtyards in the heart of the city (Habermann, 1990). In East Berlin, new, modern commercial courtyards were built on derelict urban land and industrial sites pending demolition. After the fall of the Berlin Wall, GSG has increasingly concentrated on new construction. Since districts on the north-eastern edge of the city had previously lacked space for SMEs, this was the geographical focus of new construction activities. Hence, in Marzahn, Pankow, Hellersdorf, and Hohenschönhausen, GSG built commercial courtyards (or centers) in line with traditional industrial estates (GSG, 1999a, 1999b). In the late 1990s, GSG developed, maintained, and administered a stock of 50 commercial courtyards with a total area of over 670,000 m². In 2007, 42 commercial courtyards with a total area of over 750,000 m² were part of the GSG's real-estate portfolio before the company was sold (GSG, 1999b, 2015; Sethmann, 2007; own calculations).

A severe banking crisis in Berlin in 2001—commonly referred to as the Berlin banking scandal—coincided with the bursting of the dot-com bubble, intensifying pressure on the Berlin Senate to sell off publicly owned land and real estate in the subsequent years. During this period of economic downturn, the city-owned company GSG attracted particular scrutiny: Around one-third of commercial courtyard spaces stood vacant, revenues were declining, profits were minimal, and no capital reserves were available (Tagesspiegel, 2007a, 2007b). In 2007, GSG was sold to the ORCO Group (a real-estate company with stocks in Germany, Central, and Southeast Europe) with the help of a large US-based investment bank using a share deal (Abgeordnetenhaus Berlin, 2007) before it was renamed GSG Group and acquired by a Luxembourg-based property and real-estate group in 2014, also merely owned by the same person (a Czech multi-billionaire). The transaction was made under special conditions: the company had to establish and maintain its headquarters in Berlin until 2027 and guaranteed real-estate contracts for Berlin-based universities on those premises until 2037/2044 (Abgeordnetenhaus Berlin, 2007). In 2018, GSG Group owned 48 commercial yards in Berlin with a total area of around 918,000 m². All of these courtyards, with the exception of one, were used identically as before privatization. Therefore, during the first 10 years, a moderate expansion took place (Abgeordnetenhaus Berlin, 2018). At the same time, the company—often in cooperation with partners—invested in a high-speed Internet infrastructure, e-mobility charging stations, and rooftop photovoltaic systems. These upgrades were largely financed through refinancing schemes, frequently supported by regional and national banks, to ensure compliance with contemporary technological and sustainability standards (GSG, 2025). Following the expiration of the property speculation period in 2018, the company undertook several portfolio restructuring measures, including the divestment of smaller inner-city properties. Currently, GSG administers 35 commercial courtyards in Berlin with a total area of 845,000 m² (calculated by authors; GSG, 2025; Lingenhöle et al., 2025).

2.4. The Idea of a Novel Publicly Owned Commercial Courtyard Infrastructure in Berlin and a New Berlin Mix 2.0

Despite these developments within the privatized GSG, Berlin plans to (re-)establish a city-owned commercial courtyard infrastructure (Abgeordnetenhaus Berlin, 2020). Currently, four commercial

courtyards remain under the direct or indirect ownership of the City of Berlin: *Künstlerhof Kreuzberg* (through the district of Friedrichshain-Kreuzberg), *Comeniushof* (through Berlinovo, a city-owned housing company), *Gewerbehof Köpenicker Str. 21–27* (through BEHALA, a city-owned company that runs Berlin's ports), and *Heynhöfe* (through BIM, a city-owned real-estate management company), which were not part of GSG's former portfolio (Abgeordnetenhaus Berlin, 2018). In addition, seven empty and underused city-owned premises mostly in the eastern part and on the outskirts of the city have been selected as the most suitable for future consideration (Abgeordnetenhaus Berlin, 2020, 2023). The main rationale is to preserve, steer, and influence Berlin's commercial diversity within the inner city and enhance the city's economic resilience by providing affordable, flexible, and future-oriented workspaces and workshops. This can be achieved by leveraging municipal ownership and management to ensure long-term accessibility for SMEs in the craft, production, and service sectors (CDU Berlin & SPD Berlin, 2023). This is also intended to counter financial speculation in real estate and commercial gentrification, which have displaced many traditional and craft businesses in Berlin (Suwala, 2024). Additionally, municipal ownership facilitates sustainable and socially equitable urban development, taking both ecological and social needs into account (Berliner Senat, 2021).

The city-owned company WISTA GmbH—an experienced business promoter, location developer, and service provider that has run Europe's biggest science and technology park in Berlin-Adlershof for 35 years, as well as other flagship technology and commercial urban quarters (called *Zukunftsorte*, see Figure 1) in Berlin (Suwala & Dannenberg, 2009; Suwala et al., 2021)—has been commissioned as the operating company to deal with the planning, development, operation, maintenance, and commercial management of these future publicly-owned commercial courtyards. This will safeguard public interests as the land and property will remain under public ownership and will be made available exclusively through leasehold arrangements (*Erbbaurecht*), which can span up to 99 years (for community land trusts in the US as a similar model where residents, local businesses, and their neighborhoods act as self-governing and operating bodies; see Davis, 2010). Interested companies will be bound as commercial tenants through public-private contracts (Abgeordnetenhaus Berlin, 2020). The City of Berlin has promised sufficient financial funds as a backup but has also called for innovative solutions with regard to cross-financing (e.g., promotion programs), urban designs (e.g., energy-efficient solutions), and mixed-use development, setting benchmarks for sustainable urban development. In this context, taking matters into own hands appears promising to generate synergies by leveraging learning and experience curves, while also reducing costs through the development of standardized building modules for all commercial courtyards. At the same time, maximum flexibility is maintained through modular spatial concepts, shared workshops, and coworking spaces that allow for adaptable use and promote interaction among diverse stakeholders. This setup can foster innovation and community building, especially when integrated into social and educational institutions (Abt et al., 2020; Lesem, 2023; Ludwig, 2019; Schwabe, 2022; WISTA, 2024).

WISTA and its partners have developed the concept of a hybrid commercial courtyard (also dubbed *Gewerbehof 2.0*; WISTA, 2024). This concept combines traditional and modern elements of the Berlin Mix courtyard (Lingenhöle et al., 2025) with a future-oriented building design. It seeks to enhance economic resilience through innovative mixed-use development, to boost competitiveness by combining craft businesses, SME with urban production—including exhibition spaces—start-ups in urban settings, and social institutions with integrated social and educational facilities. Hence, the hybrid commercial courtyard creates a productive and collaborative work environment that fosters exchange and innovation. This is supported by specialized coworking spaces, prototyping labs, and communal and networking areas. The idea is that the

spatial proximity of commercial enterprises and start-ups will allow for interdisciplinary collaboration and create synergies that support the further business development and maturation of both groups. As such, the hybrid commercial courtyard aims to unite both small-scale high-tech, advanced manufacturing with low-tech, high-touch manufacturing, with both depending on the benefits of close proximity to the city. As a result, the Gewerbehof 2.0 commercial courtyard is expected to make an essential contribution to urban development and strengthen the local economy (Abgeordnetenhaus Berlin, 2023; Senatsverwaltung für Wirtschaft, Energie und Betriebe, 2024; Tagesspiegel, 2022; WISTA, 2024). Next to these and privately-run efforts, the city of Berlin also wants to test cooperatively organized commercial courtyards as a third way in the near future (Suwala & Franke, 2025). Against this backdrop, our team has been asked to provide urban and architectural designs for several potential premises. We have provided three cases and desired variants with different manifestations of this envisioned commercial courtyard 2.0 (*Gewerbehof 2.0*). These three cases exemplify urban designs and utilization concepts for an innovation-oriented commercial courtyard (see Section 3.3), for a mixed-used commercial courtyard with urban production, crafts, and cultural and creative enterprises (see Section 3.4), and a commercial courtyard with childcare facilities (see Section 3.5), all of which are also based on relevant local, political, administrative, and social demands.

3. Analysis and Results

3.1. Methodology

The entire methodology is based on architectural and urban designs that have been conducted as (commissioned) research work to further develop the concept of newly built commercial courtyards by showing several socially and politically demanded variants for the respective premises in the last five years (Abt et al., 2020; Lesem, 2023; Schwabe, 2022). This commissioned work was based on a research-to-practice approach and an inside-outside perspective (Thierbach & Petschick, 2019) in a team consisting of members from the Berlin-owned location developer and business promoter WISTA (inside view: Becker; both views: Lesem, Schwabe, and Weber, all formerly associated with Technical University Berlin, now WISTA) and Technical University Berlin (outside view: Suwala, Starre). This perspective allows for the integration of internal insights, practical experiences, and planning, as well as political practice to some extent, on the one hand, and their systematic classification within current academic discourse on the other hand. Regular meetings (ex ante, in situ, and ex post) between the two sides also provided for systematic validation and verification of the interpretations of the data, knowledge stock, and designs, as well as reflection on the results.

We apply a multi-methods and multi-scalar approach guided by a mixed-use imperative and experimental design based on standardized modules derived from the vertical, hybrid urban factory, urban manufacturing concept (Lane & Rappaport, 2020; Rappaport, 2016, 2017) as the overall operational framework for all three locations. We envision a development measure that combines an urban design concept (Moughtin et al., 2003; von Bittenfeld & Holz, 1997) and an architectural design, including a utilization concept (Brückner, 2010; Hennings & Dobberstein, 2012) to showcase the idea of the commercial courtyard 2.0 (WISTA, 2024). The development of both concepts required several preparatory steps: on-site visits and SWOT-analyses for the location and the surrounding environment based on publicly available and internal site-specific data. In addition, access and operational concepts were initially considered. However, due to the rapidly fluctuating construction cost indices and high inflation rates over the past five years, operational concepts

were ultimately excluded from the analysis. The urban and architectural design concepts (Moughtin et al., 2003) are based on both the preparatory planning phases and pre-existing construction modules developed within the framework of an architectural concept study conducted by KOP GmbH. These modules were predefined as standard elements to reduce overall construction costs (Abgeordnetenhaus Berlin, 2020, 2023; KOP GmbH, 2020). Module sizes have fixed dimensions and act as defaults, but their number and orientation can be flexibly adapted to different space conditions and usable areas on the plots. The commercial and workshop modules can be rented out individually. The connecting module contains the access and technical areas. Therefore, modules were adopted and individually arranged according to various development and access variants (*Erschließungs–und Bebauungsvarianten*), which were then tested. This article presents only the best of the preferred options (*Vorzugsvarianten*) for those modules combined in a spatial arrangement to create a commercial courtyard. It does so within the context of the overarching question: How should a publicly owned commercial courtyard infrastructure be planned and designed from an integrative mixed-use development perspective? The preferred options for both architectural and urban designs and utilization concepts have been evaluated working with the following (a) general criteria for built structures (maximum space utilization, surface sealing rate (in %), green area (in m^2), delivery area (in m^2), efficiency of routes on the site (accessibility of entrances, car parks, delivery areas)), (b) criteria for integration into the neighborhood level (desired economic/social activities, emission/noise issues, design of entryways, zoning regulations), and (c) criteria for integration into the building level (mixed-uses and their arrangement on specific floors, economic consideration for financing). All these criteria are theoretically informed, express partly politically and socially desired outcomes, and have been carefully assessed and relativized by specialist planning authorities and building law experts during interviews (Interviews: S1–2 for Spandau; M-H1–4 for Marzahn-Hellersdorf; M1–3 for Mitte).

3.2. Location of Surveyed Areas

The analyzed locations are part of the seven publicly owned sites in Berlin that were selected for this initiative by the Berlin Senate (Abgeordnetenhaus Berlin, 2020, 2023). Our subsequent selection was based on the different utilization concepts that we applied using theory-based and practice-based urban (production) imperatives, available plots, the specific priorities of district administrations, and social concerns after consultations and interviews with relevant stakeholders and experts to represent the full range of possibilities. The surveyed areas are scattered across Berlin and include both former West (Spandau) and East (Marzahn-Hellersdorf) Berlin premises, as well as an inner-city area close to the former border (Mitte).

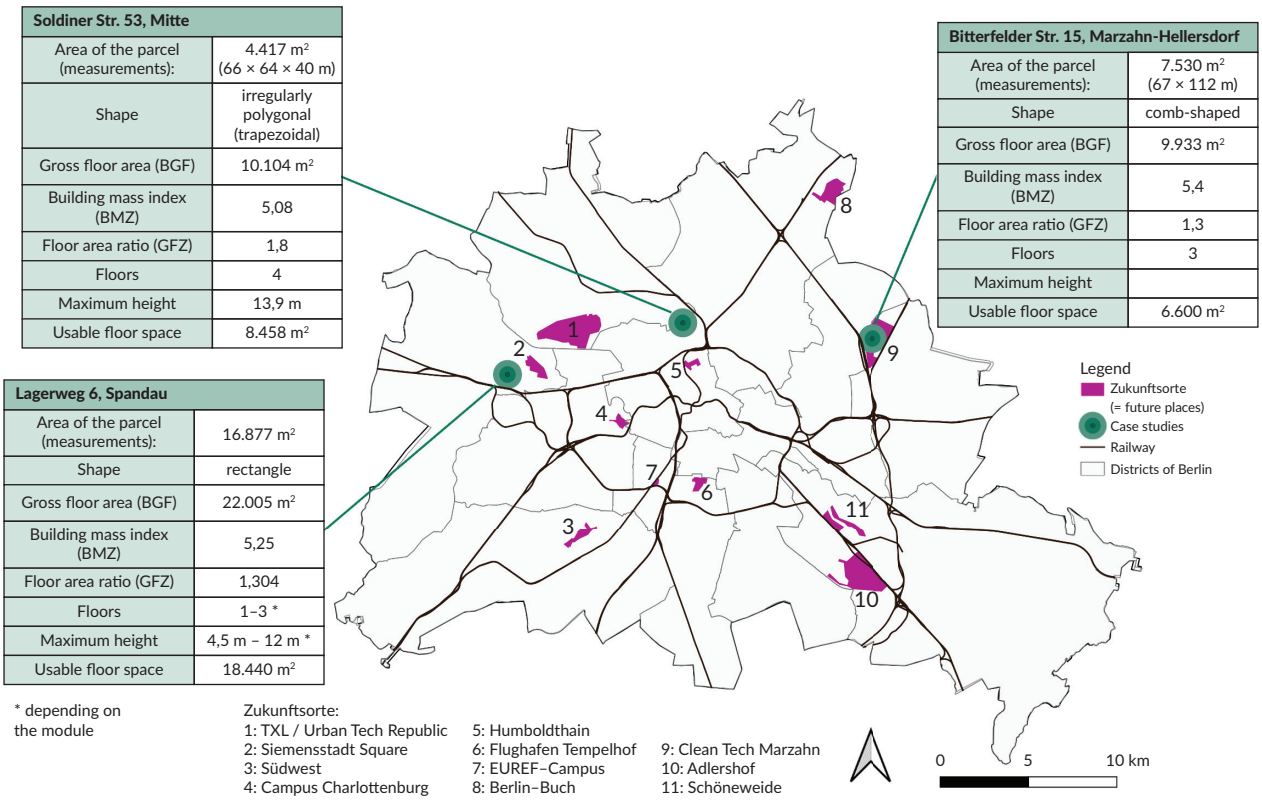

Figure 1. Locations of surveyed areas within Berlin and *Zukunftsorte* (existent or envisioned future commercial quarters; figure created by authors).

3.3. The Innovation-Oriented Commercial Courtyard in Spandau

3.3.1. Site Profile

The Berlin-owned potential site at Lagerweg 6 is located in the Spandau district's Haselhorst neighborhood in northwest Berlin. The premises are currently underutilized (e.g., used for storage) and are located within a mixed-use area on the city's outskirts, positioned between small-scale commercial zones and larger commercial and industrial areas, with the Spree river forming the southern boundary. The site is 3km west of Siemensstadt Square, the newest of the 11 *Zukunftsorte* (envisioned future commercial quarters; Figure 1; Suwala et al., 2021). Although the site currently lacks the necessary conditions for a commercial yard—such as adequate land development and access to local infrastructure—it is still well connected to Berlin's main road network. The property lies within an area designated by two binding land-use plans and is safeguarded as an industrial area. Given that this poses challenges to the development of a commercial courtyard, it is recommended that the preparatory land-use plan be revised to designate the area for commercial use (Geotechnik und Dynamik Consult GmbH, 2021; Hoffmann-Leichter Ingenieurgesellschaft mbH, 2021).

3.3.2. Urban Design Concept

We are illustrating the desired case of the urban design concept, which has been derived from two preferred options (*Vorzugsvarianten*) and selected from nine development variants (*Erschließungs—und Bebauungsvarianten*; see Abt et al., 2020, Interviews S1–2). The urban design concept presented here

combines a compact design with the maximum possible utilization of the plot. This results in both a high degree of sealing and a large amount of space for commercial use. The commercial courtyard consists of two buildings (see Figures 2a and 2b). The first building in the north of the plot consists of five three-story commercial modules arranged parallel to one another, which are linked to each other via a connecting module. A workshop module is provided between each commercial module. Small courtyards are created between the modules to reinforce the character of the commercial courtyard. The second building in the south is constructed in a similar way. It consists of a communal module and three three-story commercial modules, which are arranged parallel to one another and connected to each other via a shorter workshop module, creating courtyards. To enhance the quality of the open spaces, the rear courtyard areas have been greened, as has the zone directly adjacent to the Spree river (see Abt et al., 2020, p. 174).

The property can be accessed via a road on the western plot boundary. This road is accessible in both directions. There are turning options in the southern area and between the two buildings. Short-term parking facilities are located along the road in front of the commercial modules and workshops. Above-ground parking is available to the north and south of the site. There is also an underground parking garage accessible from the northern area of the site. Loading zones are located between the two structures. The commercial modules are accessible both from the access road and via the connecting module. The workshops can also be accessed via separate entrances and via the commercial modules (Abt et al., 2020). The proposed urban design concept does not currently comply with existing planning regulations for

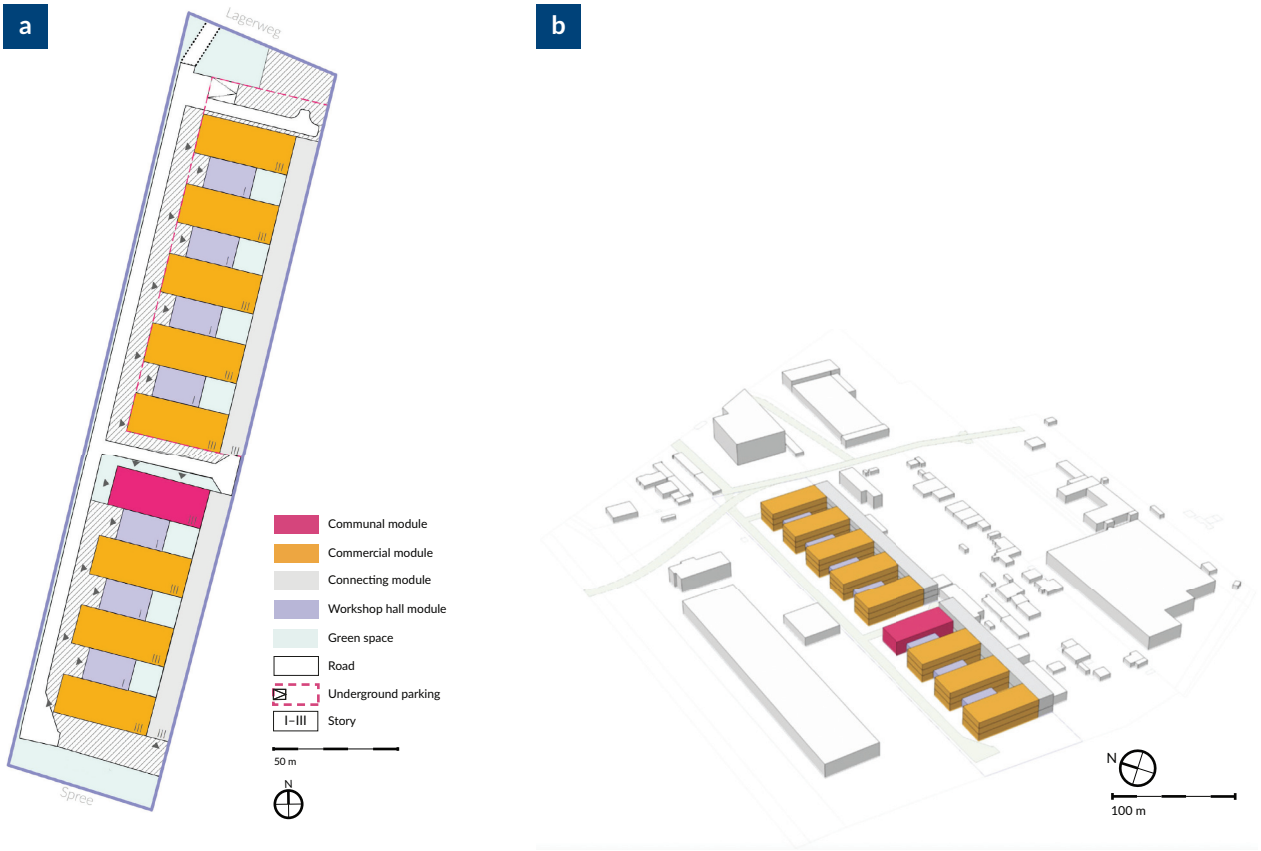

Figure 2. (a) Plan view of potential commercial courtyard in Spandau; (b) surroundings of potential commercial courtyard in Spandau (figures created by authors).

the site, making an amendment to the applicable preparatory and binding land-use plans necessary. It is also likely that the planned development will exceed the urban development ratios for commercial areas stipulated in the Federal Land Utilization Ordinance. This means it would be necessary for the responsible urban planning office to request an exemption and provide valid argumentation. The high degree of sealing in combination with an underground garage also suggests a conflict with the drainage on the property. This is because diverting rainwater into the sewage system is only permitted in exceptional cases in Berlin. Instead, rainwater must be managed directly on the property.

3.3.3. Utilization Concept

The urban design concept described above will create a total of more than 18,000 m² of usable floor space (see Figure 3). More than half of this is accounted for by the three-story commercial modules. A total of 1,400 m² of usable space is in the single-story workshops, around 1,300 m² of usable space is assigned to communal areas, and the remaining space (4,900 m²) is taken up by the three-story connecting modules. The site offers the possibility of an innovation-oriented profile. This approach both capitalizes on the site's proximity to Siemensstadt Square—a designated *Zukunftsort*—and responds to the local demand in the Spandau district for the development of similar spaces (Abt et al., 2020, p. 198). It uses the space very efficiently in line with Berlin's enclosed perimeter block development (*Blockrandbebauung*).

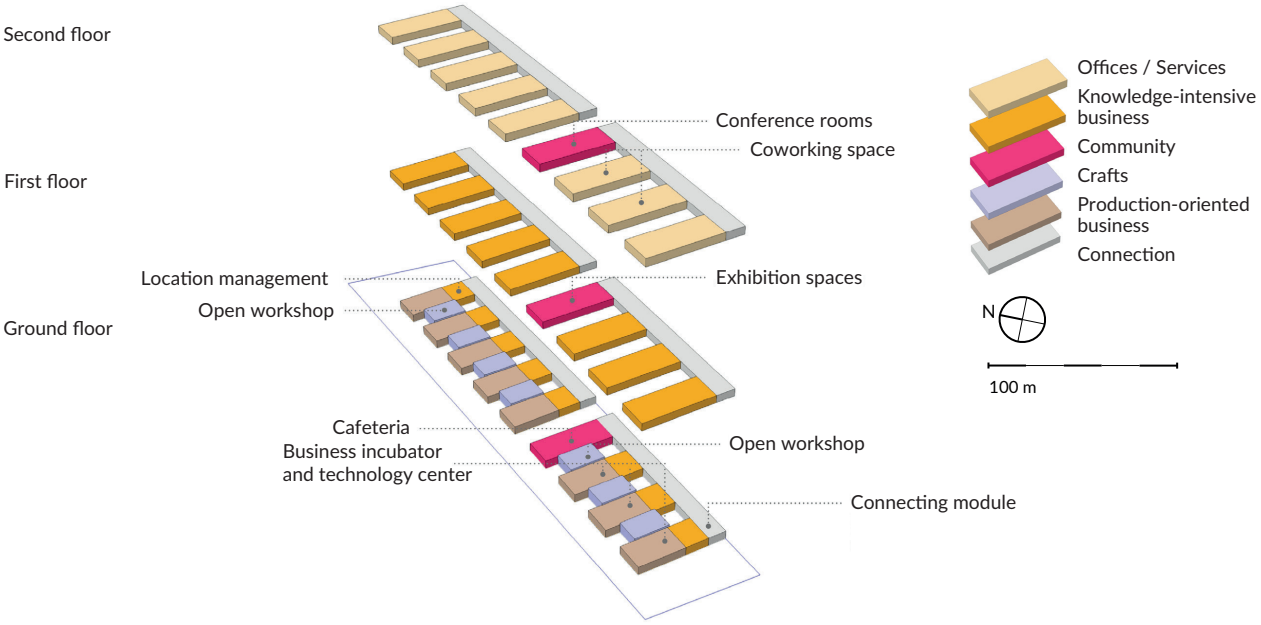

Figure 3. Utilization concept for a potential innovation-oriented commercial courtyard in Spandau (figure created by authors).

Given the anticipated innovation-oriented profile of the commercial courtyard, the commercial modules will primarily accommodate innovation-oriented and knowledge-intensive businesses on the first floor (in orange). They are beneficial not only for the profile but also for cross-financing the entire building complex as generous funding conditions are available via national (e.g., Joint Task for the Improvement of Regional Economic Structures, *Gemeinschaftsaufgabe zur Verbesserung der regionalen Wirtschaftsstruktur*) and European funds (e.g., European Regional Development Fund) for innovation and start-up activities.

Production-oriented businesses (brown) and crafts (light blue) can be found in the workshop modules and on the ground floor of the commercial modules. These businesses prefer to be close to the access roads. This also means that ceiling loads and freight elevators on the upper floors can be reduced, which in turn has a positive effect on construction costs. Knowledge-intensive uses are primarily planned for the first floor, but some will also be located on the ground floor to ensure proximity to the production facilities (see brown-orange modules). The mutual linkage is also expressed via the business incubator and technology center in the southernmost ground floor workshop module that could create synergies between production and innovation-oriented start-ups. Conventional office uses and services (yellow) are only of secondary importance and can be located on the second floor together with a coworking space, as they have no logistical requirements.

The utilization concept proposes several communal modules: a cafeteria positioned centrally within the complex on the ground floor, exhibition spaces on the first floor, and joint conference rooms on the second floor. The riverside area along the Spree river offers space for further communal areas. The two workshops will serve as open workshops. Three commercial modules in the southern structure are planned for a start-up and technology center to complement the innovative approach and knowledge-intensive industry. Two commercial modules in the southern structure are to be used as coworking spaces on the second floor. The site management will be housed in the northernmost commercial module on Lagerweg, providing a good drop-in center and control point directly at the entrance to the commercial courtyard. The innovation-oriented commercial courtyard in Spandau marks a distinct conceptual shift away from the traditional Integrated Berlin Mix model that combines working functions with residential uses, as well as from Adjacent Commercial Courtyards that primarily focus on crafts and urban production (Baumgart, 2001; Fiebig et al., 1984; Lingenhöle et al., 2025). At the same time, it rethinks the commercial courtyard concept in a modern way and combines the areas of crafts, production, knowledge, and innovation to create synergies along the hybrid commercial courtyard 2.0 concept (WISTA, 2024). The setup adds to the imperative of dense mixed-use development (Rowley, 1996; Wiegand, 1973) and is also reasonable in terms of cross-financing between uses and resilience in economic expansion and recession phases.

3.4. The Mixed-Use Commercial Courtyard With Urban Production, Crafts, and Cultural and Creative Enterprises in Marzahn-Hellersdorf

3.4.1. Site Profile

The potential Berlin-owned site at Bitterfelder Str. is located in the Marzahn-Hellersdorf district's Marzahn-Nord neighborhood in northeast Berlin. The premises are currently only partly used (e.g., office for commercial and social enterprises) and are located in an area that is designated as commercial building land in the preparatory land-use plan. As the designated plot is not covered by a legally binding land-use plan, permission for development is determined in accordance with Section 34 (1) of the Federal Building Code (BauGB), which applies to unplanned inner areas. In line with planning requirements, the proposed use must correspond to the prevailing character of the immediate context, a criterion that is met as the adjacent areas are predominantly designated and used for commercial purposes. The evaluation standard for permission approval is therefore the surrounding character of the built environment. The site is not far from CleanTech Business Park Marzahn (CTM), one of Berlin's *Zukunftsorte*, which, however, is in its infancy (see Figure 1; Liepe et al., 2022; Suwala, 2024; Suwala et al., 2021).

3.4.2. Urban Design Concept

Here we illustrate the desired urban design concept, which is identical to the preferred option (*Vorzugsvariante*) and selected from six development variants (*Erschließungs–und Bebauungsvarianten*; Schwabe, 2022, p. 96; Interviews M-H 1–4). The urban design concept presented offers a compromise between the optimum use of the existing space potential and open space, in addition to a large delivery area and efficient routing through an underground car park (see Figures 4a and 4b). It includes a three-story setting consisting of four commercial modules, a communal module, an access axis, and three single-story workshop hall modules. The communal module, which can be used as a cafeteria, is located on the eastern part of the site and is clearly visible from Bitterfelder Straße. The communal module could also be shared with companies at the *Zukunftsort* CTM (Figure 1) on the opposite side of the street. Since only eligible companies are permitted at CTM, and communal uses are excluded, a synergy is created through this shared infrastructure. The urban design concept also respects the adjacent noise-sensitive public uses by keeping the eastern area free of commercial and craft modules as a kind of buffer area.

The commercial courtyard includes a two-lane access road with a minimum turning curve and only one intersection at the feeder road. The access road is designed for larger vehicles, such as heavy-goods vehicles, to pass each other and complies with the relevant guidelines for the construction of urban roads. Furthermore, a sidewalk leading up to the minimum turning curve is provided. This form of development is suitable for areas without high development requirements and with a limited plot depth, such as this area (see Reicher, 2017). Due to the planned underground parking, this preferred option only requires a delivery area but no outdoor parking spaces, thus creating a large usable area. Although underground parking leads to higher costs than outdoor parking spaces or parking decks (see Wüstenrot Stiftung, 2012), an amortization is expected in the long run, thanks to the enhanced usable area generating higher revenues.

The urban design concept presented here is in line with the development law within the BauGB. As the designated plot is not covered by a legally binding land-use plan, the building authority must assess whether

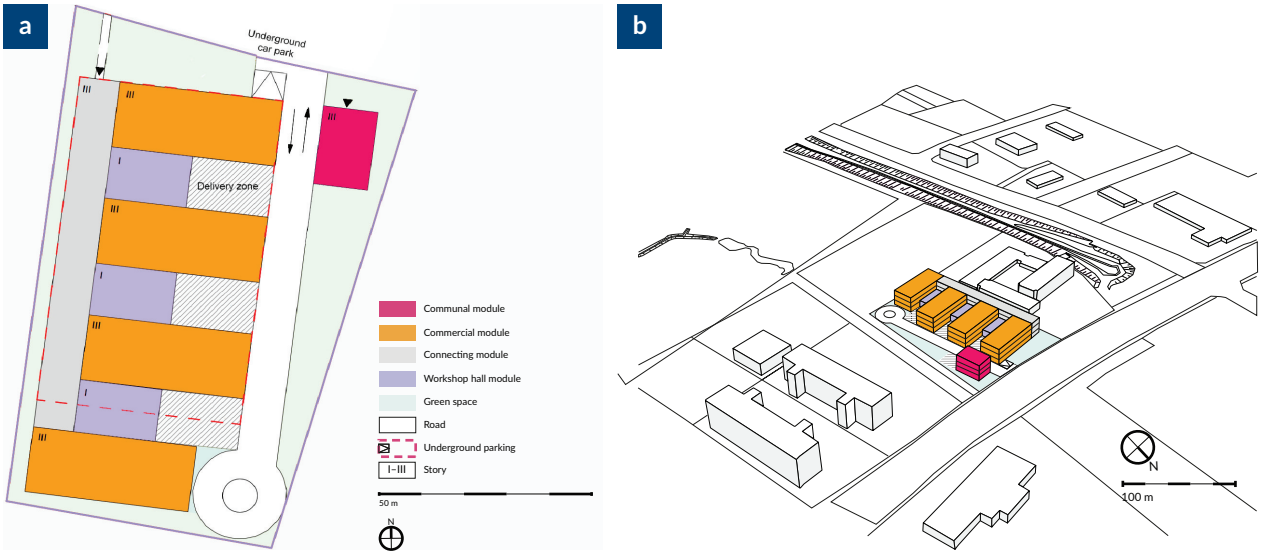

Figure 4. (a) Plan view of potential commercial courtyard in Marzahn-Hellersdorf; (b) surroundings of potential commercial courtyard in Marzahn-Hellersdorf (figures created by authors).

a proposed development project complies with Section 34 of the BauGB. In this context, the key parameters—including type and scale of use, building method, and buildable area (§34 (1) BauGB)—must follow the prevailing character of the immediate surroundings (§34 (2) BauGB; Figure 4b). As the immediate surroundings are used for commercial purposes and there are no residential buildings on the site to date, the envisioned commercial area (Section 8 of the Federal Land Utilization Ordinance) can be built. Although ecological considerations may support the renovation of the existing building, the flexibility required for modern commercial courtyards—particularly in terms of adaptable floor plans typically provided by skeleton construction—argues against its preservation.

3.4.3. Utilization Concept

The urban design concept will create a total of 6,600 m² of usable space. Craft businesses (in violet, in Figure 5) are prioritized in the utilization concept and should preferably be located on the ground and first floors (2,850 m² of usable space). At least two freight elevators are considered mandatory for supplying the craft producers on the first floor. The second-largest proportion of space is allocated to two modules that are planned for manufacturing production (brown) on the ground and first floor and for artists (green, cultural and creative industries) on the second floor (900 m² of usable space each, totaling 1,800 m²). In addition, we envision knowledge-intensive businesses (orange), which can occupy the higher floors (first and second floor) as part of office use (1,350 m² of usable space). The rest is planned for a communal module (red) with a small canteen, meeting spaces, and an exercise room (gym). This concept would result in a broad mix of uses, including crafts, manufacturing, and knowledge-oriented businesses. This aligns with the district's economic space concept (*bezirkliches Wirtschaftsflächenkonzept*), which emphasizes the creation of suitable and affordable commercial spaces, particularly for local businesses, including small-scale production companies, craft enterprises, and cultural/creative endeavors (Liepe et al., 2022). Craft businesses play an important role as local hubs for supplying the direct economic environment (*Zukunftsort*, CTM), the neighborhood of Marzahn-Hellersdorf, with various goods, services, and materials (Suwala, 2024). The utilization concept also promotes the spatial proximity and hub of both high-tech and low-tech (manufacturing) companies in the vicinity of the site, as well as accompanying crafts from the commercial courtyard. The idea is to create synergies with (local) hidden champions, ordinary manufacturers, craftspeople, and social stakeholders through existing artists in vicinity (Suwala et al., 2024).

The special location in the *Zukunftsort* CTM (Figure 1) and the resulting opportunities for cooperation with CTM are considered a great strength. Hence, companies that benefit from technologies and products for a clean and resource-friendly economy should move into the commercial courtyard (see Suwala, 2024; Suwala et al., 2021). The relationship with CTM could be established both as a customer-supplier link—for example, in areas such as facility management or catering—and as a manufacturer-supplier link, where products developed at CTM are maintained for clients within the commercial courtyard. Within this context, the commercial courtyard is intended to serve as a hub for district-oriented synergies, fostering collaboration both internally and with its urban surroundings. This mixed-use crafts-based, artist-friendly, and manufacturing-oriented commercial courtyard in Marzahn-Hellersdorf fits the traditional concept of the Integrated Berlin Mix Courtyard or Adjacent Commercial Courtyards in principle—only the residential function is missing (Baumgart, 2001; Fiebig et al., 1984; Lingenhöle et al., 2025). At the same time, it rethinks the commercial courtyard concept in a modern way and combines the areas of crafts, production, knowledge, and innovation to create synergies. The setup adds to the imperative of dense mixed-use

development (Rowley, 1996; Wiegand, 1973) and also makes sense by creating synergies through complementary activities with surrounding premises, companies, and stakeholders.

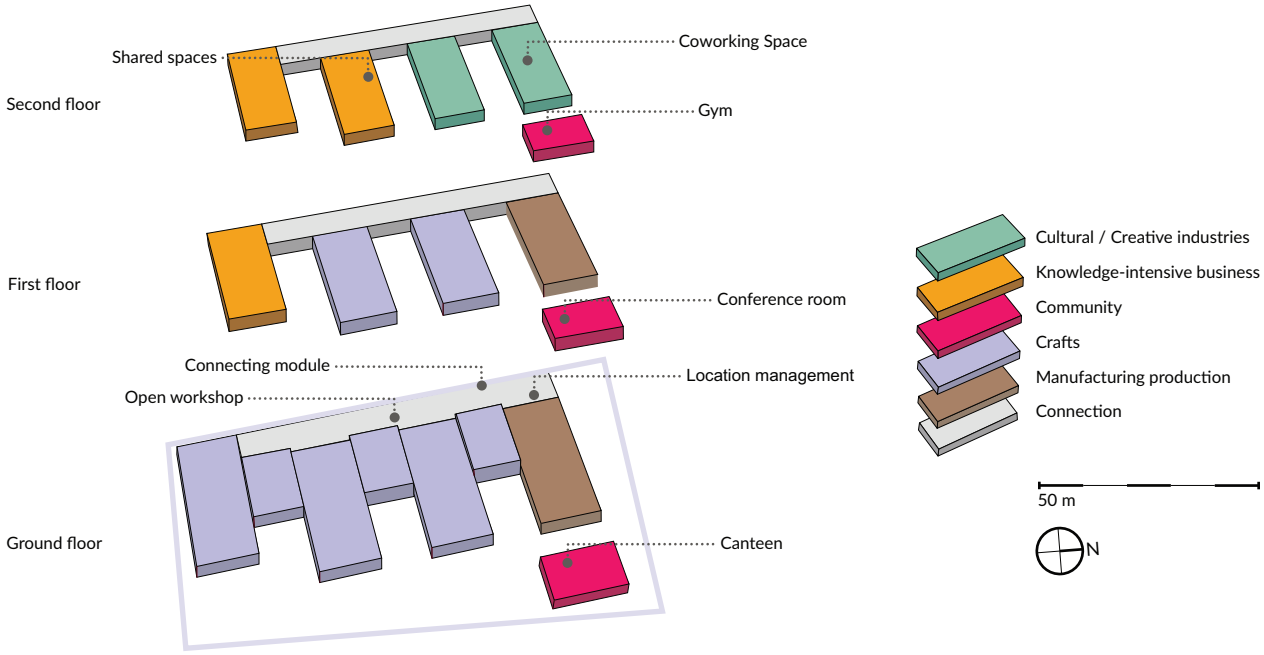

Figure 5. Utilization concept for a potential mixed-use commercial courtyard with urban production, crafts, and cultural and creative enterprises in Marzahn-Hellersdorf (figure created by authors).

3.5. The Commercial Courtyard With Childcare Facilities in Mitte

3.5.1. Site Profile

The site at Soldiner Strasse 53/Holzstrasse 1 is located in Berlin Mitte's Gesundbrunnen neighborhood, north of the city center, but still in an area adjacent to the inner city (Figure 1). The double plot is situated in a transitional area between residential and commercial establishments, at the southern edge of a small-scale inner-city commercial area. Both plots are owned by the City of Berlin. The southern plot at Soldiner Strasse 53 is currently leased to a landscaping company. The adjacent northern plot at Holzstrasse lies vacant with an abandoned building that has been empty for years. The public transportation connection is quite well established (two rail and tram lines in the vicinity), with two highways nearby—although the direct access could be improved (Bezirksamt Mitte, 2005; Hoffmann-Leichter Ingenieurgesellschaft mbH, 2024).

3.5.2. Urban Design Concept

Here we illustrate the desired urban design concept derived from two preferred options (*Vorzugsvariante*) and selected from seven development variants (*Erschließungs–und Bebauungsvarianten*; Lesem, 2023, pp. 121, 129; Interviews M1–3). The urban design concept presented offers a compromise between maximum site utilization and a high degree of surface sealing but also clearly separates the commercial courtyard and the childcare facility (see Figures 6a and 6b). From the connecting module, which is positioned along Holzstrasse, three four-story commercial modules and two single-story workshop hall modules extend outward. A four-story-mobility hub/car park completes the ensemble to the north. In the southern area, the

compact structure is broken up by a courtyard passage for cars through the connecting module. Combined with the inner courtyard area, this passage is somewhat similar to the design of traditional commercial courtyards. However, the building's setbacks and projections are not significant enough to create small-scale and diverse courtyard structures.

Nevertheless, the positioning of the building components ensures clear communication to the outside in terms of urban planning and ideally reduces noise emissions from inside the block. Access is provided via Holzstrasse with a four-story car park (mobility hub: in grey) adjacent to the northern part of the property. It connects to the connecting module (in orange) and allows for delivery access to the upper floors of the commercial modules without elevators. Given the relatively small size of the car park, it should be reserved exclusively for commercial courtyard users and their logistical efforts. For internal traffic, a half two-lane circular road is planned from the car park, which runs along the rear of the commercial courtyard and through the courtyard entrance at the southern end of the connecting module to meet Holzstrasse at the southeast of the property. This road is also intended to serve as an emergency and rescue route.

A notable advantage of this location is that the necessary planning regulations are already in place, allowing for legally secure development. The site falls within an area designated by a binding land-use plan, which permits high-density development and utilization by production-oriented businesses, making it particularly suitable for establishing a commercial courtyard (Bezirksamt Mitte, 2005). The site is being considered for both a commercial courtyard and a childcare facility. Due to Berlin's severe land scarcity, there are discussions about implementing a commercial courtyard with an integrated childcare facility (Bezirksamt Mitte, 2024). However, combining both uses in a single building presents certain risks, particularly regarding traffic safety and mutual noise exposure. These risks can be significantly minimized by clearly separating both functions. Therefore, the childcare facility (in blue) is located on Provinzstraße and Soldiner Straße in areas that are out of scope for the commercial courtyard (see Figures 6a and 6b). This idea of spatial separation was confirmed by district specialist planners during interviews (Interviews M2–3).

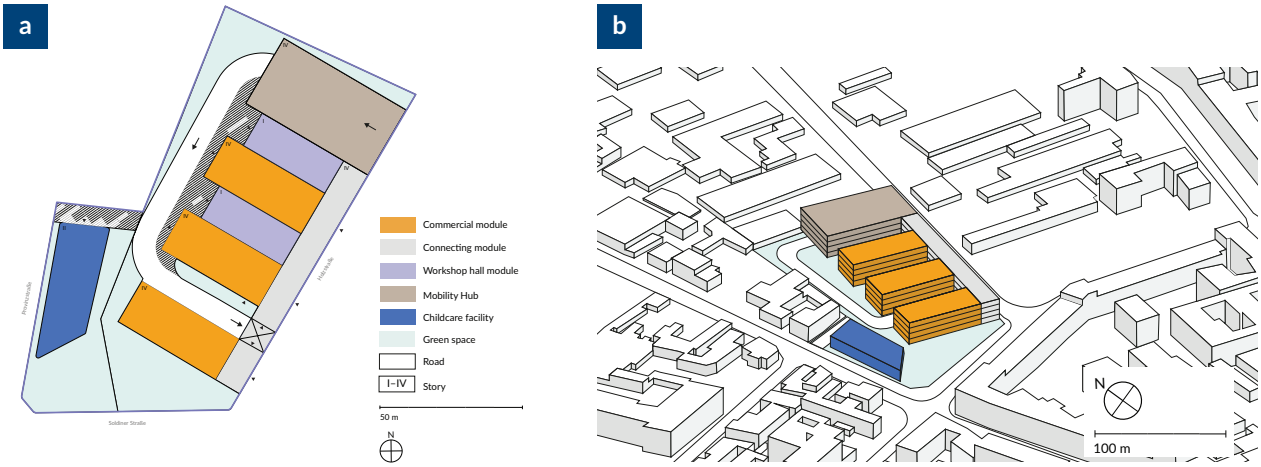

Figure 6. (a) Plan view of potential commercial courtyard in Mitte; (b) surroundings of potential commercial courtyard in Mitte (figures created by authors).

3.5.3. Utilization Concept

The utilization concept offers roughly 9,300 m² of usable floor space, about 826 m² for the childcare facility and approximately 8,500 m² within the commercial courtyard, allocating about 60 % to the commercial modules divided into various functions with spaces for production-oriented businesses such as manufacturing (brown), crafts (violet), and cultural and creative businesses (green; Figure 7). This setup should be understood as an illustrative example of possible uses and their distribution as the buildings are designed to be flexible enough to adapt to changing economic conditions and resulting needs. Various usage scenarios were also developed for the mobility hub/car park, particularly regarding the distribution of parking spaces for different modes of transport (cars, bicycles, cargo bikes).

The childcare facility, designed for approximately 100 children, requires about 826 m² (in order to comply with the specific regulations for such facilities, 1,200 m² of indoor space is needed, thus the modified module in Figures 6a, 6b, and 7; for details, see Lesem, 2023, pp. 100–103) split across two floors. The building itself would occupy about 413 m² (600 m²) of the 1,600 m² of land required for the childcare facility. The total share (building and outdoor areas) of available space (both plots) is roughly one fifth. This is necessary due to the legally required outdoor spaces. To use land resources more efficiently (through higher building density), architectural and legal assessments should examine whether outdoor spaces for the childcare facility could be (partially) established in the commercial courtyard's roof areas. The utilisation concept (Figure 7) strictly reserves ground floors for manufacturing businesses (in brown). The first floor is designated for manufacturing businesses using lighter machinery. Other uses are positioned as high up as possible. Test beds for media and creative industries (artists, in green), as well as spaces for knowledge-intensive businesses (in orange) are to be located away from the commercial area. This proposed mix of uses focuses strongly on manufacturing businesses and crafts to prevent the site from developing into a purely office and service location. Simultaneously, the mix should accommodate commercial uses that create substantial

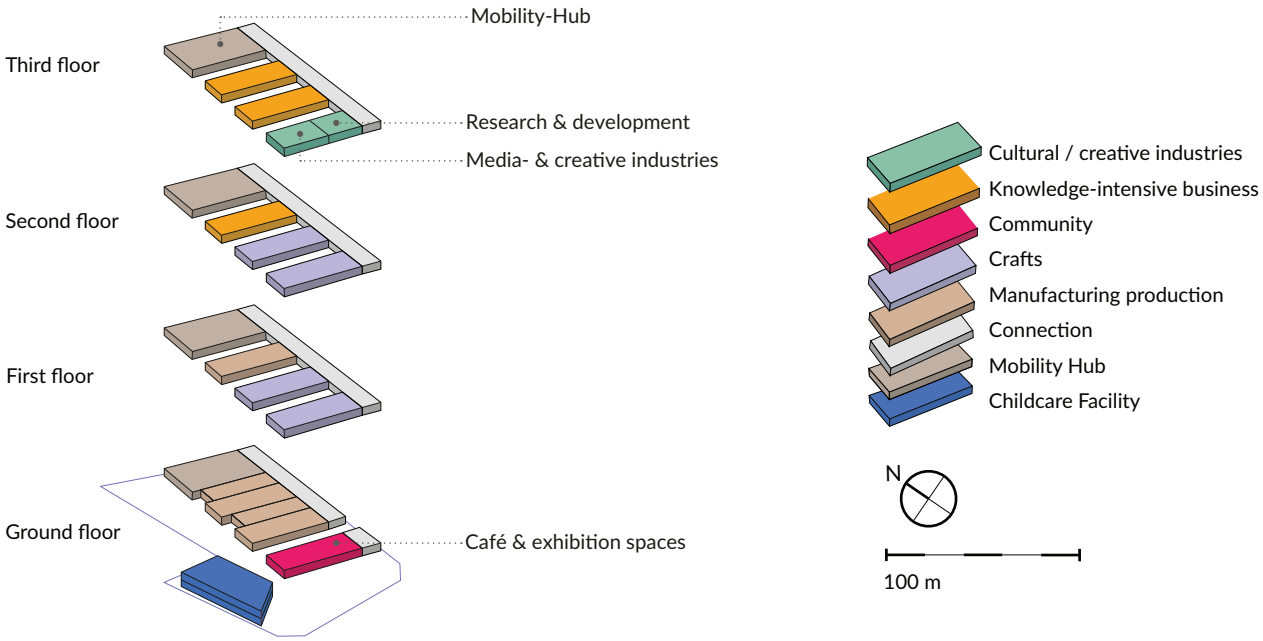

Figure 7. Utilization concept for a potential commercial courtyard with childcare facilities in Mitte (figure created by authors).

employment opportunities, are integrated into local value chains and provide the surrounding neighborhood with craft products and services (Suwala & Franke, 2025). This manufacturing and crafts-based commercial courtyard in Mitte reflects the traditional concept of the Integrated Berlin Mix Courtyard or Adjacent Commercial Courtyards in its original sense (Baumgart, 2001; Fiebig et al., 1984; Lingenhöle et al., 2025). The childcare facility that was planned in a separate building is a special feature requested by the district of Mitte. This feature enlarges the commercial courtyard to include a social function to serve the surrounding residential neighborhood. The utilization is in line with the imperative of dense mixed-use development (Rowley, 1996; Wiegand, 1973) but needs to remain flexible to allow for other uses.

3.6. Discussion of Results

All three case studies reflect different aspects of the *Gewerbehof 2.0* concept, as envisioned by the city-owned commercial courtyard development initiative—shaped by input from local administrations, social dynamics, and market-driven requirements. These stylized yet practice-oriented designs have been taken seriously by the city-owned developer WISTA and have been the subject of discussion both at the district level (Spandau, Marzahn-Hellersdorf, Mitte) and at the city-wide level (Berlin Senate). In addition, before developing the urban and architectural designs including the concepts, we consulted experts in specialist planning, urban development, and building codes. It should be noted that considerable effort was invested in developing the many variants (*Erschließungs–und Bebauungsvarianten*). These were evaluated based on theory-based criteria (general, neighborhood, and building level; see Section 3.1) around the compact city mixed-use development paradigm (Rowley, 1996) and the vertical/hybrid factory concept (Lane & Rappaport, 2020). Only the most desired variants (*Vorzugsvarianten*) have been presented. In particular, the commercial courtyard with the childcare facility was challenged and disputed; therefore, we opted to locate the childcare facility in a separate building. At the same time, there are similar urban and architectural designs that have been created for certain premises by other parties (e.g., a commercial courtyard with the childcare facility and a communal sports hall in addition to the location in Mitte; see Bezirksamt Mitte, 2024). A first site in Lichtenberg is currently being developed based on a concept similar to the innovation-oriented commercial courtyard proposed for the Spandau location (see Section 3.3). Preliminary assessments and planning steps have already been completed; a Berlin-based architecture firm won the competition for the urban design. The financing arrangement opts for a mixed calculation that consists of WISTA's own funds, supplemented by equity contributions from the Berlin Senatsverwaltung für Wirtschaft, Energie und Betriebe, as well as borrowed capital and planned assets from the Joint for the Improvement of Regional Economic Structures (*Gemeinschaftsaufgabe zur Verbesserung der regionalen Wirtschaftsstruktur*) to fund the upper floors with innovation-oriented activities (start-ups, incubators). Even if the idea sounds new, the *Dresdner Gewerbehofgesellschaft* has also developed such an innovation-oriented model where good practices could be transferred. Here, Berlin should be open to negotiations and exchange ideas with other cities (Munich, Hamburg; see Table 1). A program that clearly outlines the roadmap for the coming years might also help. Although we partly discuss operating concepts elsewhere (Abt et al., 2020; Lesem, 2023; Schwabe, 2022), construction costs, a smooth planning process, availability of specialized workers, and the city's fiscal situation will ultimately impact the actual implementation. Two of the presented locations (Mitte and Marzahn-Hellersdorf) are currently being considered for short to medium-term development (Abgeordnetenhaus Berlin, 2023; Senatsverwaltung für Wirtschaft, Energie und Betriebe, 2024).

4. Conclusion and Outlook

We have showcased three forward-looking concepts for innovation-oriented, mixed-use, cultural, creative, manufacturing-based, and the socially anchored commercial courtyards with childcare facilities by urban and architectural designs and utilization concepts. Theoretically, we have revitalized the mostly outdated discussion on planning, design, and utilization for new (urban) commercial courtyards (Baumgart, 2001; Hennings & Dobberstein, 2012; Lane & Rappaport, 2020; Moughtin et al., 2003; von Bittenfeld & Holz, 1997). There are definitive lessons to be learned for local contexts in Continental Europe, the UK, and North America (see Ferm et al., 2021; Rappaport, 2025) on how to plan, create, design, and use novel and mixed-use commercial areas in productive cities. Methodologically, our research-to-practice approach and an inside-outside perspective have proven to be effective as such an endeavor can not only promote much closer cooperation between practical urban design, economic operators, and academia but also envision theory-based, methodologically sound, and practically recognized commercial courtyard designs at both the neighborhood and building level. Empirically, innovative paths were explored when putting the designs and utilization concepts on paper in an effort to integrate a range of economic, administrative, logistical, and built environment requirements and stakeholder perspectives. Our approach breaks new ground in the field of commercial planning where, so far, such specifications were decided by administrators, specialist planners, entrepreneurs, and investors behind closed doors.

Of course, there are several limitations to our study that we would like to bring to the fore. From a theoretical perspective, there are only a few studies and guidance books on the urban and architectural design of commercial areas in general and commercial courtyards in particular (see von Bittenfeld & Holz, 1997; Lane & Rappaport, 2020; Moughtin et al., 2003; Rappaport, 2016). They often resemble synopses or encyclopedic collections of exemplary cases or practical guidelines, offering limited analytical depth and contributing little to theory development and discourse. Therefore, we have partly based our practical designs and utilization concepts on the hands-on experience of specialists (e.g., logistics managers, architects, planners, and administrators) from interviews (Interviews S1–2, M-H1–4, M1–3), as well as pragmatic considerations aimed at increasing the proportion of low-tech and craft-based businesses that otherwise struggle to find suitable premises. However, we described the construction of new premises and did not consider the refurbishment of existing buildings and their potential (for the UK, see Ferm et al., 2021; for the US, Lane & Rappaport, 2020). In addition, it was not possible to calculate the construction costs properly—despite city-owned premises—as current political and economic conditions in Western Europe are being reshaped by the new realities following the energy transition (*Energiewende*), in addition to the Russia-Ukraine conflict and the shortage of skilled workers, which has caused material prices and the cost of labor/energy to skyrocket in Germany. Therefore, although the design and use concepts might be transferable to other post-industrial cities in Europe and the US, planning regulations and construction costs are not (for the US, see Lane & Rappaport, 2020). Nevertheless, we consider the guiding principles of the productive city (Bundesministerium des Innern, 2020) to be highly compelling—particularly the emphasis on mixed-use development, short distances, local sourcing, and consumer-oriented provision, as well as the safeguarding of space for both high-tech and low-tech production adapted to current regulatory and environmental conditions. The commercial courtyard 2.0 (*Gewerbehof 2.0*) will contribute to creating and maintaining a livable, sustainable, and organic city. As demonstrated by experiences with publicly owned operating companies from Berlin in the past and other large German cities, however, long-term planning horizons need to be taken into account for such endeavors. Definitive declarations of intent have already

been made in planning documents (*Standentwicklungsplan Wirtschaft 2040*) and policies (political coalition treaty, *Koalitionsvertrag*).

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Conflict of Interests

In this article, editorial decisions were undertaken by Robert Kitzmann (Humboldt University Berlin), Sebastian Henn (Friedrich Schiller University Jena), and Stefan Gärtner (Institute for Work and Technology).

LLMs Disclosure

To ensure responsible AI use and maintain publication integrity, we disclose using DeepL (version 25.8.2). DeepL was used to translate selected parts of the article, which were then manually verified by researchers; this tool also enhanced our manuscript's grammar and style in those selected parts.

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