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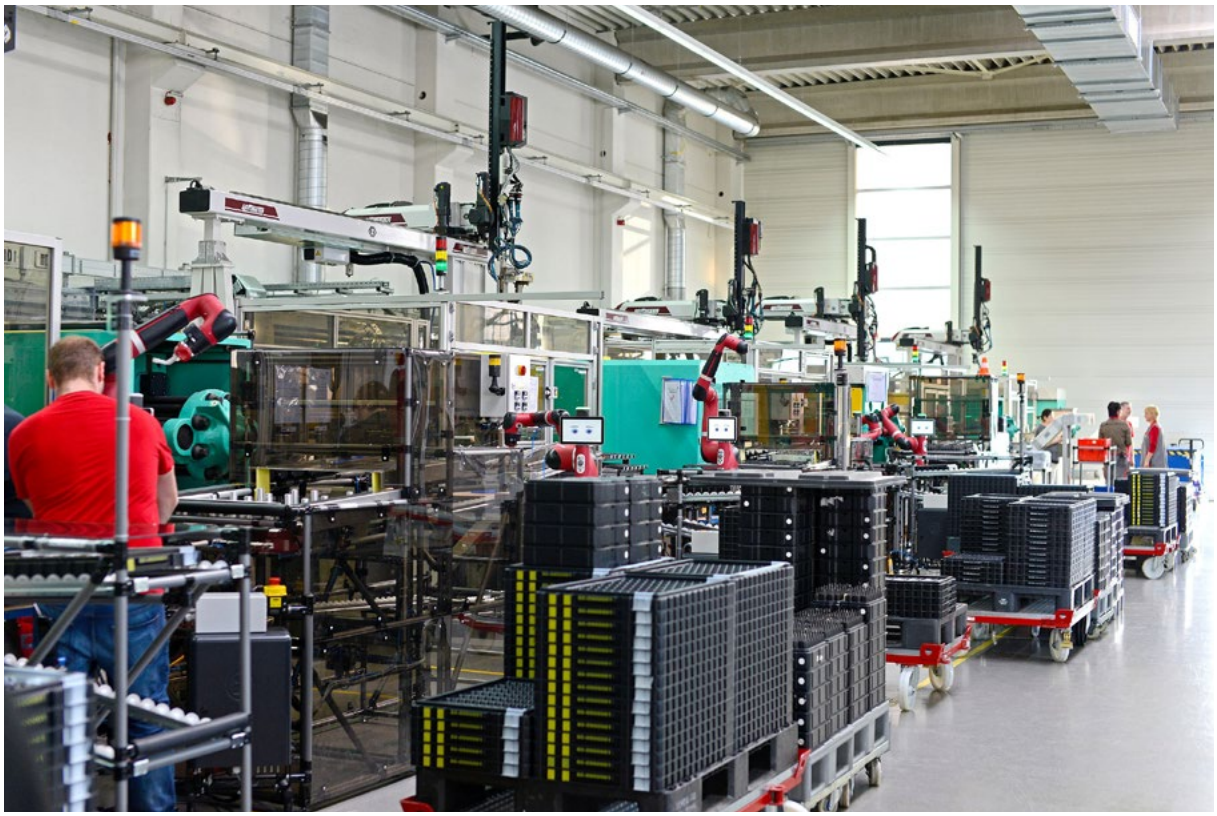

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Policies to Support Urban Manufacturing

A Case Study of Germany

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Keywords: Manufacturing, policy; cities; space; urban planning

Abstract

With recent technological advancements that bring about quieter and cleaner forms of production, cities are witnessing a surge in high-value manufacturing and shifts towards decentralized industrial production. However, policy-makers and cities are often unaware of the technological changes and the potential integration of new forms of manufacturing in inner-city areas. Consequently, they continue to rezone industrial land for residential and commercial developments underestimating the opportunities and services provided by manufacturing. We examine policy documents on urban manufacturing to understand how they address issues related to land use, economic development, labor and resources. While urban policy is centered around advanced manufacturing, results revealed that land use regulations lag behind as Germany continues to follow conventional approaches that separate industrial uses based on performance standards. Based on our review, we identify opportunities to support the integration of new forms of manufacturing in urban contexts and recommend changes to better respond to manufacturing challenges.

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Manufacturing and cities

Successive industrial revolutions have prompted the rise of new patterns of urbanization. As cities and industries evolved mutually, small-scale local manufacturers and artisan craft gave way to mechanized mass production. Taylorist tendencies of industrialism reflected across space emphasizing the separation of functions and incompatible land uses (Gleeson 2001). The zoning of industrial activities intensified as changes in production processes brought about large-scale manufacturing premises that later suburbanized and gradually relocated to peripheral areas (Hatuka and Ben-Joseph 2017). The industrial displacement and separation from other uses contributed to production's invisibility and exacerbated misunderstandings and negative perceptions around urban manufacturing. Following the exodus of industries from cities, the deindustrialization and outsourcing were later countered by the rise of services that heralded a transition to the post-industrial economy (Grodach and Gibson 2019; Ferm and Jones 2017). In recent years, technological advancements and the rise of small-scale decentralized firms that are quieter and cleaner has revived interest in manufacturing. In light of these paradigm changes, advanced economies have pursued reshoring and reindustrialization policies as part of their economic agenda (Barbieri et al. 2018; Backer et al. 2016; Levinson 2012). Consequently, many cities witnessed a surge in high-tech industries, where small-scale firms and new forms of production were reintroduced as makerspaces, vertical urban factories or innovation districts (Rappaport and Lane 2020; Gornig and Werwatz 2018).

In general, retaining and integrating a diverse range of industries is key for maintaining the city's economic and social resilience, vitality and vibrancy (Borret 2021; Balland and Rigby 2017; Jacobs 1961). Manufacturing enterprises and makerspaces can create employment opportunities, foster social equity, and promote an area's cultural distinctiveness (Dierwechter and Pendras 2020; Wolf-Powers et al. 2017). Retaining micro manufacturers and industrial premises can also contribute to a city's circular transition given manufacturing's role in reducing resource consumption and recycling resources at different life cycle stages (Acerbi and Taisch 2020; Herrmann et al. 2020). In addition, hosting industries in cities can reduce travel distances by bringing production closer to consumers while improving local supply chains (Tsui et al. 2021).

Notwithstanding the potential advantages of manufacturing (Wolf-Powers et al. 2017), cities continue to rezone industrial land, particularly in central areas, for mixed-use commercial and residential developments (Leigh and Hoelzel 2012). These land use transitions can erode the city's economic base, reduce the supply of jobs and debilitate potential inter-firm synergies (Curran 2010). By maintaining misconceptions that manufacturing activities are noxious, noisy and incompatible – requiring large-scale industrial parks in peripheral areas – cities and policymakers are missing out on the economic, social and environmental opportunities that changing forms of manufacturing bring about. By analyzing a set of 11 policy documents and city development plans on manufacturing, the article aims to document German planning and policy's approach to recent changes in urban manufacturing and identify the strength and challenges conceived, particularly in relation to economic development, land take, labor and resources.

Overall, the study shows a rift between advanced industrial policies and lagging land use strategies. It brings evidence that policy's focus is mostly on large-scale enterprises and activity within industrial-zoned sites. Indeed, while urban policy is centered around high-tech circular manufacturing, cities' development plans fall short in exploring the spatial requirements of new and advanced forms of manufacturing, their geographical manifestation and potential integration with other uses.

Industry 4.0 and responses in land use regulations

With recent technological advancements, the national initiative *Industrie 4.0* (I4.0) was launched as a new proposal to further German economic policy and manufacturing (Carvalho et al. 2018). I4.0 subsumes several industrial developments which integrate intelligent and digitally connected systems to production environments. It is characterized by modular and efficient production whereby cyber physical systems and the *Internet of Things* (IoT) are integrated to monitor physical processes (Lasi et al. 2014; Wang et al. 2018). Despite the rigorous digitalization of vertical and horizontal value chains (Lee et al. 2015), the spatial implications of the I4.0 narrative and its consequences on land use remain unclear.

From a planning perspective, the so called *Bauleitplanung* (land use planning) implements a two-tier planning process based on the *Baugesetzbuch* (BauGB; Building Code) as well as the *Baunutzungsverordnung* on the federal level (BauNVO; Federal Building Regulations). The latter delineates different land zones to every municipality (BGBl 2021). A zoning plan, defining the basic land uses, is first drawn for the entire municipality. Development plans are later prepared for territorial sub-areas of the municipality. The BauNVOs, which are slightly different for the 16 federal states, entail a degree of flexibility and enable municipalities to select the relevant category from a list of permissible uses. The BauNVO defines twelve categories of land use, ten of which allow mixed uses including mainly light non-disturbing industries. Multiple uses are not required and industries are allowed based on certain performance standards. Despite the occasional monotony, Hirt (2007) noted that small and medium-sized enterprises (SMEs) and light industries are in fact scattered within certain residential areas. However, large industries that remain incompatible with residential uses are usually situated in commercial and industrial-zoned sites.

Various scholars have argued for mixed-use developments to enhance social interaction and equity (Montgomery 1998; Leyden 2003), encourage pedestrian activity (Ewing and Cervero 2001; Moudon et al. 1997), and reduce land take (Grant 2002). Despite the consensus on the benefits of mixed-use development, many cities continue to separate uses and face pressures to rezone derelict central industrial areas to higher yielding commercial and residential uses (Leigh and Hoelzel 2012; Wolf-Powers 2005). Given the increasing competition for space in central areas, strategic policies tend to support the development of commercial and residential premises over industrial uses and thus accelerate the decline of industrial land and the relocation of urban manufacturers (Ferm and Jones 2017). The displacement of industries and the conversion of land escalates land values, reduces the availability of af-

fordable industrial spaces and weakens the economic base of cities (Davis and Renski 2020). These barriers, that hamper the integration of manufacturing in cities, are further exacerbated given the mismatch between current zoning statutes and the emerging forms of urban manufacturing, that potentially require smaller footprints and are within permissible emission levels. In addition, federal regulations to protect industrial land facing conversion pressures are lacking in Germany since municipalities retain land use authority. Such regulations would preserve industrial spaces from escalating land values in the urban core and increasing competition from higher yielding uses. Preservation policies would also support SMEs during their early stages to locate to inner-city areas and benefit from the skilled labor pool and fertile ecosystem of businesses (Curran 2010; Ferm and Jones 2017).

> In sum, mixed-use developments in productive cities could foster new and innovative forms of manufacturing that are relatively cleaner and quieter with smaller footprints and positive effects.

However, the integration would require an understanding of how these manufacturing premises are conceptualized in policy documents and their potential spatial requirements to bridge the schism between industrial and spatial policy and contribute to the efficient and sustainable use of space.

Conceptualization of urban manufacturing in policy

We conducted a qualitative document analysis to understand the ways in which urban manufacturing is interpreted in German policy. Industry policy documents and development plans at the municipal and national levels were analyzed (Table 1). Since municipalities in Germany retain land use authority, reports pertaining to local governments and cities were considered as they provided a better understanding of how cities conceptualize urban manufacturing and manage industrial spaces.

We drew from previous research that investigated policy and planning response to urban manufacturing to develop our methodological framework (Grodach and Gibson 2019). A total of 11 documents published between 2014 and 2022 were selected. Cities with the highest share of manufacturing employment (Table 2) were considered as case studies. The review and analysis of documents focused on identifying the formulated weaknesses, challenges and strengths of urban manufacturing in Germany as well as determining the main themes and issues in relation to production and manufacturing. Summaries were later derived and coded thematically. A limitation of our study is its focus on recent policy documents when numerous regulations were issued prior to 2014 and others stemmed before the latest national governmental election where different party alignments participated in drafting the documents.

However, future research can adopt a historical perspective to understand the development of German policy discourse in relation to manufacturing. Given the limited number of reviewed documents, our findings cannot be generalized but contribute to a better understanding of the ways in which urban manufacturing is depicted in policy.

Author or issuing authority / Year	Title of document
Bundesverband Der Deutschen Industrie (BDI 2014)	Die Zukunft der Industrie [The future of industry]
Bundesverband Der Deutschen Industrie (BDI 2019)	Deutsche Industriepolitik: Zum Entwurf der Nationalen Industriestrategie 2030 [German industrial policy: On the draft of the National Industrial Strategy 2030]
Bundesministerium für Wirtschaft und Energie (BMWi 2019)	Industriestrategie 2030: Leitlinien für eine deutsche und europäische Industriepolitik [Industrial strategy 2030: Guidelines for a German and European Industrial Policy]
Bundesministerium für Wirtschaft und Klimaschutz (BMWK 2022)	Industrie 4.0 gestalten. Resilient, nachhaltig, wettbewerbsstark [Shaping Industry 4.0. Resilient, sustainable, competitive]
Behörde für Wirtschaft, Verkehr und Innovation - Hamburg (BWVI 2017)	Masterplan Industrie [Industrial Masterplan]
Die Senatorin für Wirtschaft, Arbeit und Europa – Freie Hansestadt Bremen (DSWAE 2021a)	Schlüssel zu Innovationen 2030 - Strategie für innovation, dienstleistungen und industrie land bremen Land Bremen 2030 [Key to Innovation 2030 - Strategy for Innovation, Services and Industry State of Bremen State of Bremen 2030].
Die Senatorin für Wirtschaft, Arbeit und Europa – Freie Hansestadt Bremen (DSWAE 2021b)	ZUKUNFTSWEISENDE WIRTSCHAFTSSTANDORTE: Klimaschutz, Klimaanpassung und Biodiversität im Rahmen des GEP 2030 der Stadt Bremen [FORWARD-LOOKING BUSINESS LOCATIONS: Climate protection, climate adaptation and biodiversity as part of the GEP 2030 of the city of Bremen]
Landeshauptstadt Dresden (2021)	Tomorrow's Home Dresden als Wissenschafts- und Wirtschaftsstandort [Tomorrow's Home Dresden as a science and business location]
Landeshauptstadt München (2021)	Stadtentwicklungskonzeption „Perspektive München“ [Urban development concept "Perspective Munich" Report for update 2021].
Landeshauptstadt München (2022)	Der Wirtschaftsstandort. Fakten und Zahlen [Munich. The business location. facts and figures].
Landeshauptstadt Stuttgart (2019)	Entwicklungskonzeption Wirtschaftsflächen für Stuttgart (EWS): Entwicklungslinien, Handlungsfelder und Strategieansätze für eine nachhaltige Gewerbeentwicklung in Stuttgart bis 2030 [Development concept for economic areas for Stuttgart (EWS): Development lines, fields of action and strategic approaches for sustainable commercial development in Stuttgart by 2030]

Table 1: A list of reviewed policy documents. Source: Authors.

City	Manufacturing employment*	Population*
Bremen	55,000 (62,900 including Bremerhaven)	563,290
Dresden	40,800	555,351
Hamburg	120,900	1,853,935
Munich	41,200	1,487,708
Stuttgart	83,600	626,275

Table 2: Number of employed persons in the manufacturing sector (excluding construction) in 2020 across different case studies based on employment data from the Federal and State Statistical Offices (Statistische Ämter des Bundes und der Länder 2022).

Urban manufacturing agendas across case studies

Manufacturing is regarded as a major contributor to the success and prosperity of the German economy. With 120,900 employees in manufacturing in 2020, industry is a stronghold for Hamburg's economy (BWVI 2017; Statistische Ämter des Bundes und der Länder 2022). Munich considers manufacturing as one of the city's strengths where manufacturing value added constituted 21.8% (Landeshauptstadt München 2022). Bremen boasts about the diversity of industrial sectors it hosts and promotes itself as the "Home of Innovation" with a prominent international profile and a mix of large companies, research institutions and innovative SMEs (DSWAE 2021a). In addition, Stuttgart is celebrated as a "Productive City" that builds on a culture of innovation and trade as well as high-tech industrial production (Landeshauptstadt Stuttgart 2019).

In alignment with the I4.0 narrative, strategies at the federal and local level focus on advanced manufacturing and the shift to the knowledge economy, where innovation plays an integral role in maintaining the competitive advantage of the sector (BMWK 2022; BMWi 2019; BDI 2019). Certain cities built on their extensive research activity to emphasize their strong position and expand on the interlinkage between research and manufacturing. Indeed, Dresden capitalized on the presence of major research institutions such as the Fraunhofer, Max Planck and Leibniz institutes to brand itself as an innovation hotspot (Landeshauptstadt Dresden 2021). Bremen's Innovation Strategy 2030 claimed that the city is well positioned as a research location, particularly for maritime, aerospace and renewable energy industries and expanded its vision to include craft production (DSWAE 2021a).

> While the case studies exhibited a diverse ecosystem of urban manufacturers, makers, and entrepreneurs, a clear definition of urban manufacturing was lacking in almost all reports.

Prominent sectors that recurred across policy documents include the automotive industry; steel, copper and aluminum; chemical and pharmaceutical; machinery and factory engineering; electro-technical and IT; energy technology industry; as well as aerospace and maritime industry. A common sector that prevailed across different case studies is the automotive industry. Most policy documents focused on the economy, labor, technologies and innovation, as well as resources and climate change in relation to manufacturing. Land use and spatial requirements were only addressed at the municipal level. Other themes, such as infrastructure, mobility and regional cooperation, also emerged. We build on four main recurring themes – economy, labor, resources and space – to better understand how manufacturing is envisioned across planning and policy documents. An overview of the results is presented in Table 3.

Themes	Case Studies				
	Bremen	**Dresden**	**Hamburg**	**Munich**	**Stuttgart**
Overview	Considered "Home of Innovation"	Part of the 'Silicon Saxony'	Boasted as a port city with a strong manufacturing sector	Boasted about its innovation labs	Considered a 'Productive City'
	Defined urban manufacturing in relation to high-tech production				
	Major industries identified include aviation; maritime; automotive; renewable energy; and food and beverages	-	Major clusters include maritime, logistics, aviation and renewable energy industries	The automotive industry is identified as one of the significant sectors in the city	Automotive and electrical engineering are considered anchor industries
Economy	Emphasized the integration of manufacturing and knowledge intensive services			Acknowledged manufacturing as a stronghold with a high revenue	Emphasized the integration of manufacturing and knowledge intensive services
	Focused on specialization strategies	-	Focused on specialization strategies	-	Acknowledged manufacturing as a stronghold
Labor	Identified the shortage of skilled labor and the aging labor force as challenges	Boasted about education institutions and the provision of a skilled workforce	Identified fields of actions to secure a supple of skilled labor	-	Identified the shortage of skilled labor and the need to equip labor with the necessary skills
	Identified the need to equip labor with the necessary skills	-	Aligned curriculums to secure skills for the future	-	-
Resources and Climate Protection	Emphasized the recycling of resources and building materials and the transition to a circular economy	Manage and preserve resources	Emphasized recycling and the efficient use of resources	Emphasized the efficient use of resources and the transition to the circular economy	Emphasized the recycling of resources and building materials and the transition to a circular economy
	Focused on hydrogen technologies	Emphasized sustainable, low-cost production of green hydrogen, synthesis gas and e-fuel	Focused on hydrogen technologies	-	-
Land Use	Limited availability of space	-	Limited availability of space	-	Limited availability of space
	Densification of existing areas and activation of derelict spaces	-	Densification of existing areas and activation of derelict spaces	-	Protection of inner-city industrial areas and densification of existing areas and activation of derelict spaces

Table 3: Overview of the analysis results across the case studies. Source: Authors

Economy

Policies seek to support large-scale manufacturing firms, start-ups, as well as SMEs and focus on inter-firm synergies, clustering and networks. Most federal documents addressed the location choices of firms and the need to maintain and expand Germany's economic and technological competence and industrial leadership (BMWi 2019). They acknowledged that increased bureaucracy, rigid institutional structures and the location tax in Germany are one of the major challenges affecting the location decision for multinational companies (BMWi 2019; BDI 2014).

Most cities and federal documents portrayed an advanced high-tech image of manufacturing that focuses on cutting-edge technologies and aligns with the I4.0 vision. Various cities aimed to strengthen innovation and the role of SMEs to create strategic clusters that reinforce agglomeration economies. In this regard, Dresden built on its location within the "Silicon Saxony" and boasted itself as the center of the European semiconductor industry, where large chip factories are supported by a network of component suppliers and software experts (Landeshauptstadt Dresden 2021). Synergies between large companies and innovative research-based SMEs were widely encouraged to strengthen existing value creation networks (BMWK 2022; BMWi 2019).

In sum, SMEs and start-up companies received concrete emphasis as important players in the industrial ecosystem; nonetheless, policy's main focus remains on large-scale companies and advanced technologies. Planning documents highlighted industries and urban manufacturing's role in maintaining the economic health of cities and creating employment opportunities.

Labor

The digitalization of economic activity has brought about structural changes to the labor market. The perceived shortage of skilled workers, particularly in the areas of IT hampers the growth and competitiveness of Germany. Providing cross-cutting support, by equipping workers with the necessary capabilities and digital skills, is of high priority to the federal government and various cities (BMWi 2019; BDI 2019). Apart from the high labor costs that present a major challenge to the location policy debate in Germany, Bremen highlighted regulatory bottlenecks, low employment rates in large-scale industries and an aging workforce as challenges (DSWAE 2021a). Many cities, particularly Hamburg, emphasized the alignment of curriculums and pedagogy as an imperative for securing the necessary skills for the future (BWVI 2017).

Overall, policymakers and cities called for offering attractive working conditions, promoting science, technology, engineering and mathematics (STEM) fields, addressing the shortage of skilled labor, attracting foreign workers, and shifting thinking towards lifelong and inclusive learning. These measures are integral for sustaining production and skilled labor pools in urban environments.

Resources and climate protection

A sustainable production requires the decoupling of economic growth from negative environmental impacts such as greenhouse gas (GHG) emissions. Policymakers recognize that climate change and the scarcity of resources, including space, should have profound implications on German industrial policy (BMWK 2022; BMWi 2019). The reduction of GHG emissions as well as other climate protection targets affect different sectors and necessitate private and public investments in climate-friendly technologies, production processes and infrastructure (BDI 2019). Planning policy emphasized that climate protection measures should be an innovation driver to the competitiveness of German industries and sustainable value creation (Bardt and Lichtblau 2020; BMWi 2019; BDI 2019). In this regard, Bremen seeks to become "a role model for German industrial cities into the post fossil fuel age" and intends to develop as a prominent business location for harnessing renewable energy (DSWAE 2021b: 17).

Securing access to raw materials is another challenge for sustaining value creation and maintaining Germany's position as an industrial nation. Innovative products and new technologies are shaping the demand for raw materials and increasing Germany's reliance on countries rich in natural resources (BDI 2019). Other widely reported challenges are associated with the high energy costs and state levies, particularly for electricity.

Since production processes and products are affected by strict climate regulations, policymakers consider that climate policy is equivalent to industrial policy (Bardt and Lichtblau 2020). Overall, most cities focused on the transition from a linear to a circular economy and the need to develop sustainable supply chains as well as enhance resource efficiency.

Land use

Given their need to attract more industries and maintain their competitive advantage, cities mainly emphasized the limited availability of space and the short supply of industrial land. In this regard, Stuttgart acknowledged that the available industrial and commercial land is just "below 12% of the city's total built up area" (Landeshauptstadt Stuttgart 2019: 11). Presumably, this is one of the factors that drove numerous firms to relocate to the broader Stuttgart region while start-ups and firms with a small manufacturing production capacity (pilot production) remain in central areas (Landeshauptstadt Stuttgart 2019). Hamburg, Bremen and Stuttgart recognized that the stock of commercial and industrial property is in short supply and emphasized the need to activate derelict spaces, restore brownfield sites and develop existing spaces more efficiently through densification (Landeshauptstadt Stuttgart 2019; DSWAE 2021b; BWVI 2017). Various cities are committed to retaining industrially-zoned land while taking housing, infrastructure and transport requirements into consideration. Despite aligning their strategies to the I4.0 narrative, cities' land use approach to manufacturing remains a conventional one. Overall, cities emphasized the efficient use of space to reduce the development of new greenfield sites yet failed to consider the spatial requirements and geographical manifestations of various industries.

Implications for urban planning and recommendations

Industry is witnessing radical shifts driven by globalization, scarcity of resources, climate variations and demographic change. We reviewed various policy documents to understand the ways in which cities and policymakers in Germany address urban manufacturing. Overall, planning and policy response to manufacturing remains ambiguous with no clear implications for production and spatial processes in cities. Main challenges identified throughout the review included the escalating energy prices; lagging legislative adjustments; shortage of skilled workers and limited availability of industrial areas. In alignment with the I4.0 initiative, urban policy mainly focused on advanced or high-tech manufacturing while overlooking low-tech, creative industries and craft manufacturers. It called for synergies and collaboration between industry and services and the reduction of tax burdens and energy costs to internationally comparable levels.

Urban policies emphasized the integration of industry and knowledge-intensive services to strengthen the competitiveness of Germany. The I4.0 initiative succeeded in reframing the importance of manufacturing for the future of German society and economy. These findings align with previous studies across different geographic contexts, that observed a rebranding of manufacturing to promote the sector and eliminate negative perceptions (Grodach and Gibson 2019; Christ 2014). While considering the role of SMEs, German policy, particularly at the national level, substantially focused on large-scale companies.

In a similar vein, most cities considered large-scale manufacturing within zoned industrial areas or commercial spaces (business parks) yet few acknowledged the compatibility of small-scale industrial premises with residential or commercial uses. While regulations for the protection of industrial land were lacking across most documents, many cities recognized mixed use developments, densification of industrial areas, redevelopment of brownfield sites and revitalization of derelict spaces as potential solutions to emphasize the efficient use of space and reduce the development of new greenfield sites.

In addition, city center depictions of manufacturing were mostly restricted to the creative class and small batch manufacturing production activities due to compatibility issues. While this can weaken industries' contribution to economic development (Wolf-Powers et al. 2017; Curran 2010), retaining urban manufacturing in the urban core should be rigorously pursued by policymakers, planners and involved stakeholders. The mixing of firms and the ensuing inter-firm networks are integral to the adoption of innovation, sustainability of supply chains and creation of employment opportunities (Huggins and Johnston 2010; Luzzini et al. 2015). In addition, geographic proximity can also play a role in promoting industrial symbiosis and supporting circular economy practices (Walker et al. 2021). While policy documents superficially engaged in closing material cycles and increasing resource efficiencies, the spatial manifestations of inter-firm synergies conducive to a circular economy and their implications on urban production in cities are not addressed. Buzzwords such as circular economy, cradle to cradle, recycling, and sustainability are emphasized but the scale at which they are implemented remains vague.

> Thus, urban manufacturing strategies, particularly in the context of the circular economy, should not only focus on the micro and meso levels but should also address the macro level.

Generally, policy aimed to provide generalized solutions that promote sustainable value creation, manufacturing and knowledge-intensive services while merely addressing local specificities, spatial requirements or context specific industry relations. Few cities drew on their historical legacy of craft and their interrelationship with other industries. However, each city elaborated on its local capabilities and emphasized their long-standing large-scale industrial premises, such as the automotive industries in Munich and the aerospace and maritime industries in Bremen, to leverage their competitive advantage (DSWAE 2021a; Landeshauptstadt München 2021, 2022). Hence, a thorough understanding of the context's specificities, production processes and inter-firm industrial networks remains necessary.

While the reviewed planning policies are a step towards the sustainable development of cities, more strategies are needed to support the integration of urban manufacturing in urban areas. A flexible regulatory framework, that adapts to the spatial requirements of production and supports the retention of urban manufacturing in central areas, is a prerequisite to keep up with the changes in industry. Additionally, a modernization of the German land use and building regulations is required to support the integration of new forms of urban manufacturing in cities. Future research could explore new land use regulations, policy instruments, assess the potential of integrating new forms of manufacturing in densely populated areas and explore the interrelationships between manufacturers, suppliers, consumers and skilled labor pools to support agglomeration economies and the transition to circular models.

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