

The Path of Land Use Control for Urban Development and Construction Projects in Germany

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Abstract

As global urban development transitions from quantitative expansion to qualitative enhancement, land use patterns grow increasingly intricate, necessitating sophisticated regulatory mechanisms. Germany, recognized for its mature development control system, has established an integrated framework combining public construction law, development guidance planning, and permit-based enforcement. Through systematic analysis of Germany's urban land governance evolution, this study examines the synergistic interplay between legislative mandates, planning instruments, and regulatory oversight. It further explores the transferable value of Germany's model through four critical dimensions: clear objectives, robust legal foundations, comprehensive control tools, and refined implementation methodologies, offering actionable insights for achieving sustainable and orderly urban growth worldwide.

Keywords Land use control; German planning system; Zoning; Urban Development

Introduction

As global urban development shifts to a refined phase, land use grows more diverse and complex, with stock development and urban regeneration becoming crucial strategies. Nations face the shared challenge of balancing functional integration with conflict avoidance in urban land use control, while ensuring land use flexibility over its entire life cycle.

Germany, the pioneer in development zoning control, has established a robust system by integrating public construction law, development guidance planning, and construction permits. This system effectively regulates urban construction and use, offering strong support for achieving spatial planning goals and maintaining urban development order.

1. The Evolution of German Land Use Control

1.1 The Origin of Zoning

In the second half of the 19th century, German cities rapidly developed and expanded due to the Industrial Revolution. Municipal authorities started to use spatial planning and legislation to regulate urban growth. The 1862 Berlin City Binding Land-Use Plan and the 1868 *Baden Grand Duchy's Road Red Line Law Fluchtliniengesetz* were landmark events in modern urban spatial control. The 1891 Frankfurt *Graded Building Ordinances (Staffelbauordnungen)* marked the birth of German "zoning." It divided cities into residential, industrial, and mixed - use zones, specifying the characteristics, uses, maximum building height, density, and distance between buildings in each zone. Subsequently, the *Graded Building Ordinances* spread rapidly in Germany, with many cities adopting zoning rules. For example, the 1935 *Local Construction Ordinance* divided urban land into six functional zones, such as mixed - function and residential areas, guiding the layout of manufacturing, housing, and service functions. It also established ten intensity zones with building density decreasing from 60% to 10% and linked them to functional zones. These regulations embodied the "functional zoning" concept, preventing industrial and residential mixing, controlling development intensity, and ensuring good lighting and ventilation for housing, thereby improving urban living conditions and enhancing public health.

1.2 The Establishment of Development Control Methods and Systems

After World War II, West Germany began national urban construction legislation. The 1960 *Federal Building Act (BBauG)* and the 1962 *Federal Land Utilization Ordinance (BauNVO)* standardized development plan preparation, marking the establishment of modern German development control. The two laws and the resulting development plans continued the zoning approach of the *Graded Building Ordinances*, forming a refined "land use + building

function" dual - layer mixed - use control system. Under the *Federal Land Utilization Ordinance*, urban development areas are divided into four types: residential (W), mixed (M), industrial (G), and special construction zones (S). Each is further subdivided into several development sites. For instance, industrial zones (G) are split into commercial and industrial zone (GE) and industrial zone (GI). The regulations specify the permissible building functions on each site, guiding their layout. To distinguish primary and supporting functions, permissible construction functions are categorized into "allowable" and "allowable under special circumstances." The restrictions can apply to building types like residential or commercial buildings, or to business types such as retail or catering. They can also limit facility scale, service targets, and external impacts, such as "local - serving" shops or "non - disturbing" handicrafts. Moreover, development plans can set special regulations for specific areas or building parts.

1.3 The Evolution of Development Control Requirements

Over the past five decades, German development control has been continuously optimized based on new planning concepts and has responded to emerging issues. Initially, influenced by the *Athens Charter's* functional zoning concept, it focused on separating residential and industrial uses to address environmental degradation caused by industrialization. As the service sector grew and vibrant urban life gained recognition, promoting job - housing integration and orderly functional mixing became significant. The *Land Utilization Ordinance's* evolution reflects this shift. In the 1962 version, only accessory residences like dormitories were allowed in core zone (MK) areas. The 1968 version added "residences above the floors specified in the development plan," and the 1990 version further permitted "other residences meeting the size requirements of the development plan." In 2017, the *Federal Land Utilization Ordinance* introduced the "Urban-Style Zone (MU)" as a new development category, facilitating higher-density, functionally flexible, and spatially coordinated integration of residential and non-residential uses.

2. Development Control Tools and Their Roles

Germany's development control system operates through a coherent regulatory framework integrating public building regulations, development guidance planning, and construction permits Figure 1. This integrated approach ensures comprehensive implementation of development control objectives. Statutory building regulations establish foundational constraints, while development guidance planning translates these requirements into site-specific zoning schemes through adaptive refinement. Construction permits enforce regulatory compliance throughout both construction and operational phases, thus establishing a closed-loop management cycle that maintains system integrity.

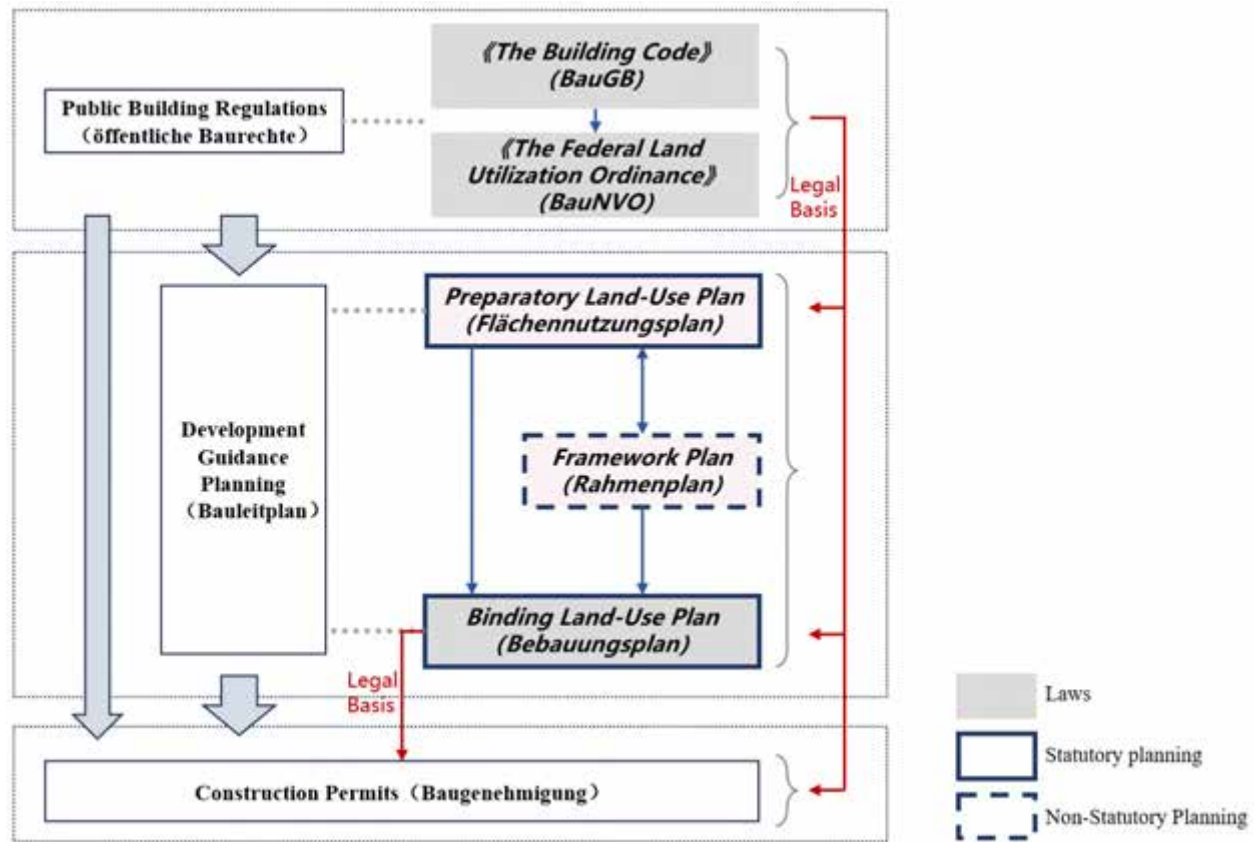


Figure 1: The System of Development Control Tools in Germany

2.1 Public Building Regulations

Public building regulations primarily encompass the *Building Code (Baugesetzbuch, BauGB)* and the *Federal Land Utilization Ordinance (Baunutzungsverordnung, BauNVO)*. These laws provide the overarching framework and general rules for the management of development, construction, and use. In addition to these key regulations, other rules at the federal, state, and municipal levels also play a role in this process.

2.1.1 The Building Code

The *Building Code (Baugesetzbuch, BauGB)* was established in 1987 through the codification of the *Federal Construction Act (Bundesbaugesetz, BBauG)* and the 1971 *Urban Development Promotion Act (Städtebauförderungsgesetz)*. Comprising nearly 300 articles, it provides a comprehensive legal framework for urban development in areas such as spatial planning, land management, planning permission, and renewal measures. The Code defines *Preparatory Land-Use Planning (Flächennutzungsplan)* and *Binding Land-Use Planning (Bebauungsplan)* as “development guidance planning” (*Bauleitplanung*) and specifies their tasks, definitions, purposes, contents, and preparation methods. It serves as the legislative basis for the *Federal Land Utilization Ordinance (Baunutzungsverordnung, BauNVO)* and municipal-level *Binding Land-Use Plans*. Additionally, the Code clarifies the types of development and construction projects, stating that functional conversion, new construction, and reconstruction all fall under this category. Generally, *Binding Land-Use Plans* form the fundamental basis for granting construction permits for development and construction projects.

2.1.2 The Federal Land Utilization Ordinance

The *Federal Land Utilization Ordinance (Baunutzungsverordnung, BauNVO)* is a core legal tool for development control in Germany. The regulations consist of four main chapters, which cover the types of development sites, the scale of construction uses, construction methods and scope, as well as the management transition and

connection before and after regulation revisions. The provisions on development - and - construction - use control are mainly concentrated in the first chapter and include the following three aspects. First, the regulations define the types of development zones and sites. According to these four types of development areas, the *Federal Land Utilization Ordinance* revised in 2021 stipulate 12 types of land zoning Figure 2 . Second, they set out the main uses and permissible buildings for most development sites and clarify these as part of Binding Land-Use Plans Figure 3 . Third, they authorize Binding Land-Use Plans to adaptively adjust the general regulations in the *Federal Land Utilization Ordinance* for specific sites. According to Article 1, Paragraph 7 of these regulations, Binding Land-Use Plans can make special provisions for the use of specific parts of buildings on development sites. For example, they can specify that permissible buildings are only allowed under special circumstances or not allowed at all, and they can restrict the use of specific building facilities to certain locations, all based on special urban - construction reasons.

Main Category	Subcategory	Overview
Residential Area (W)	Small Residential Zone (WS)	Includes residential buildings, private gardens, and small-scale agricultural or horticultural establishments
	Pure Residential Land (WR)	Residential use without disturbance
	General Residential Zone (WA)	Mainly for residential use and regionally oriented local supply
	Special Residential Zone (WB)	Mainly for residential use; in areas of excessive development; may set minimum housing quotas
Mixed Construction Area (M)	Village Zone (MD)	Allows agricultural and forestry enterprises as well as non-intrusive commercial activities
	Village Residential Zone (MDW)	Allows residential and non-intrusive agricultural, forestry, and industrial activities
	Mixed-Use Zone (MI)	Allows residential and non-intrusive commercial activities
	Urban-Type Zone (MU)	Allows residential functions as well as non-intrusive commercial, social, cultural, and other facilities
	Core Zone (MK)	Allows commercial activities and economic, administrative, and cultural center facilities
Industrial Area (G)	Commercial and Industrial Zone (GE)	Allows non-intrusive industrial activities
	Manufacturing Zone (GI)	Allows industrial activities not permitted in other construction areas
Special Construction Area (S)	Special Development Zone (SO)	Areas with special regulations according to Articles 2-10 of the Building Code

Figure 2: The 12 types of land zoning stipulated in the German Building Use Regulations

Development and Construction Areas	Land Zones	Permitted Building Types	Building Types Permitted under Special Conditions
Mixed Area (M)	Mixed-Use Zone (MI)	1. Residential buildings 2. Commercial and office buildings 3. Retail, catering, and hospitality services 4. Other commercial and industrial activities 5. Office, religious, cultural, social, health, and sports facilities 6. Horticulture 7. Gas stations 8. In areas primarily designated for commercial and industrial use, the purpose and scope can extend beyond the core area's entertainment industry	In areas primarily designated for commercial and industrial use, the purpose and scope can extend beyond the core area's entertainment industry
	Urban-Type Zone (MU)	1. Residential buildings 2. Commercial and office buildings 3. Retail, catering, and hospitality services 4. Other commercial and industrial activities 5. Administrative offices, religious, cultural, social, health, and sports facilities	1. Entertainment industry, as well as 2. Gas stations
	Core Zone (MK)	1. Commercial, office, and administrative buildings 2. Retail, catering, hospitality, and entertainment services 3. Other non-disruptive commercial and industrial activities 4. Religious, social, health, and sports facilities 5. Gas stations equipped with parking structures and large parking lots 6. Residences for guards, security personnel, owners, and operational managers 7. Other residences in accordance with the scale specified in the construction plan	1. Gas stations not listed in item 5 of the left column 2. Residences not listed in items 6 and 7 of the left column

Figure 3: Permitted and Specially Permitted Building Types in the Mixed Construction Area (M)

2.2 Development-Guidance Planning and Framework Planning

According to the *Building Code*, development control is a crucial task of both Preparatory Land-Use Planning and Binding Land-Use Planning. Binding Land-Use Planning provides the legal foundation for development control, while the Preparatory Land-Use Plan guides the preparation of Binding Land-Use Plans. In Germany, Framework Plan (Rahmenplan), a non-statutory planning layer, is frequently employed in key areas to integrate Preparatory Land-Use Planning and Binding Land-Use Planning.

2.2.1 Preparatory Land-Use Plan (Flächennutzungsplan)

Pursuant to §5(1-2) of the *Building Code (BauGB)*, the Preparatory Land-Use Plan (Flächennutzungsplan) establishes the land-use framework for municipal development. It articulates municipal authorities' comprehensive development intentions by designating zoning typologies and land-use categories across development sites. While binding on governmental administrative actions, these provisions lack direct enforceability over private development activities.

Municipalities typically adapt land-use categories from the Federal Land Utilization Ordinance (BauNVO) to local contexts. Berlin exemplifies this through its quadripartite residential zoning classification reflecting development intensity gradients (Figure 4). Others like Munich directly specify development-site typologies within their

Preparatory Plans. Select cities including Berlin further prescribe linear spatial configurations for specialized uses, such as primary commercial corridors.

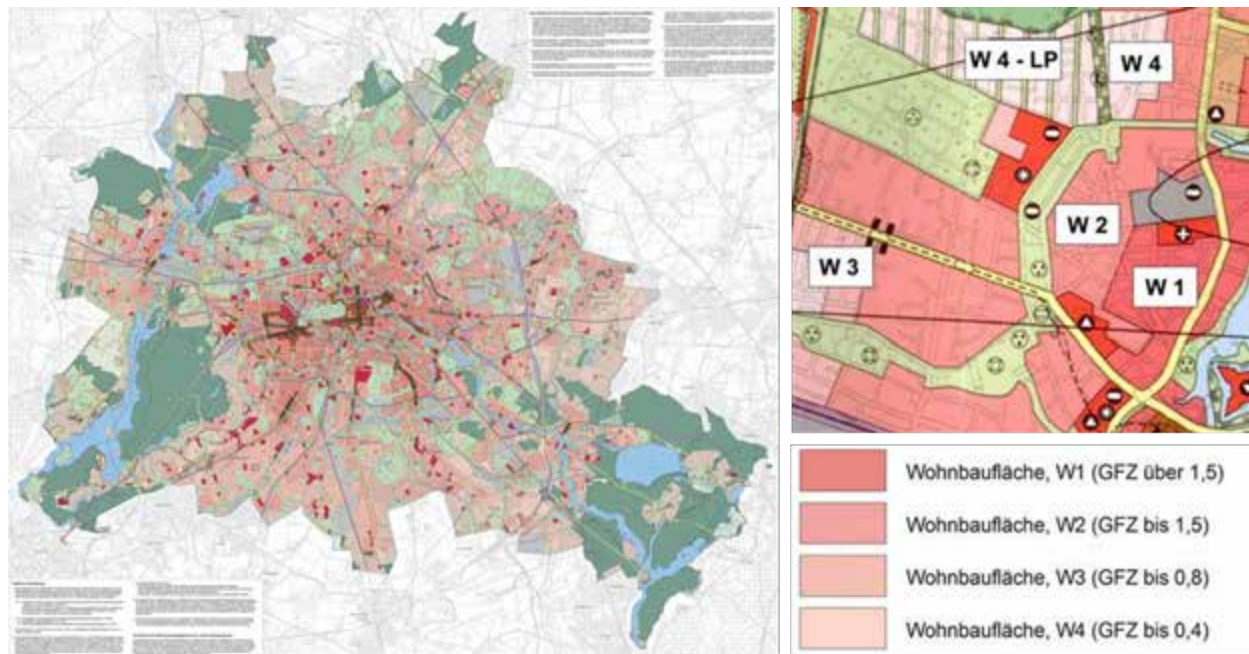


Figure 4: Preparatory Land-Use Plan Flächennutzungsplan of Berlin

During Germany's extensive growth phase, major cities updated Preparatory Plans at 15-20 year intervals. In the current redevelopment era, most municipalities have discontinued comprehensive Preparatory Plan revisions. Instead, they implement incremental amendments guided by urban development strategies, key-area framework plans, and neighborhood-scale development concepts responsive to grassroots initiatives.

2.2.2 Framework Plan (Rahmenplan)

Framework Plans operate as flexible non-statutory instruments bridging Preparatory and Binding Land-Use Plans. Their primary function is defining meso-scale development objectives for both greenfield and urban regeneration areas through systematic spatial frameworks. These integrate five core dimensions: spatial configuration, functional organization, building morphology, open-space networks, and transportation systems.

Most Framework Plans prioritize development-site allocation and utilization guidance with methodologies varying according to planning objectives. For new development areas Munich's Riem Conference City emphasizes rational functional zoning while Hamburg's HafenCity focuses on intra-zone functional integration. In renewal contexts Stuttgart's City Core Framework directs controlled functional mixing while enhancing central residential capacity. These outputs support Preparatory Plan adjustments and provide technical guidance for Binding Land-Use Plan preparation.

2.2.3 Binding Land-Use Plan (Bebauungsplan)

The Binding Land-Use Plan (Bebauungsplan) functions as a legally binding local ordinance that specifies land-use parameters for individual plots, ensuring sustainable urban development aligned with public interest and social equity. It constitutes the statutory basis for building construction, renovation, land transactions, management, expropriation, and consolidation. A core mandate involves regulating development and construction by defining the scope and typology of developable sites within the plan area, while adaptively refining building-use provisions stipulated in the *Federal Land Utilization Ordinance (BauNVO)*. All provisions derive authority directly from the *Building Code (BauGB)* and *BauNVO*.

Binding Land-Use Plans are categorized by content and formulation method into three distinct types: Qualified Plans (Qualifizierter Bebauungsplan), which regulate use types and development intensity parameters; Project-Based Plans (Vorhabenbezogener Bebauungsplan), formulated through developer-municipality agreements under Development and Infrastructure Plans (Vorhaben- und Erschließungsplan); and Simplified Plans (Einfacher Bebauungsplan), applied when Qualified Plan criteria remain unmet. Qualified Plans are typically initiated by municipalities without predetermined developers, prioritizing public welfare through market-neutral standards. Project-Based Plans conversely reflect collaborative development between public authorities and private entities, balancing communal interests with market responsiveness. Critically, all plan types incorporate flexible use provisions to accommodate functional conversions and evolving project demands during operational phases.

2.3 Construction Permits

Development projects encompassing new construction, renovation, demolition, or functional conversions require mandatory construction permits under Article 29 of the *Building Code (BauGB)*. Prospective developers must formally submit a construction application (Baugesuch) to the competent authority prior to commencing work. This triggers a comprehensive review of public-law compliance, wherein authorities verify adherence to safety protocols, environmental safeguards, aesthetic coherence, and functional viability standards before granting authorization.

Conformity with designated uses in the Binding Land-Use Plan (Bebauungsplan) constitutes a foundational permit prerequisite, with approval pathways diverging according to plan typology. Qualified Plans necessitate demonstrable alignment between project proposals and both the Binding Land-Use Plan and supplementary construction regulations. For Project-Based Plans, compliance must extend concurrently to the Binding Land-Use Plan and the ratified project infrastructure plan (Vorhaben- und Erschließungsplan). In localities governed by Simplified Plans or entirely lacking Binding Land-Use Plans, Article 34 BauGB enables permit issuance where developments harmonize with neighborhood characteristics.

Critically, the flexible regulatory framework established by the *Federal Land Utilization Ordinance (BauNVO)* and Binding Land-Use Planning allows existing developed sites to secure construction permits without formal plan amendments. This procedural efficiency sustains continuous land-use governance throughout the asset lifecycle while maintaining regulatory integrity.

3. Zoning Control Objectives and Technical Methods

German urban land-use control, particularly the general-use regulations in the *Federal Land Utilization Ordinance (BauNVO)* and the specific-use regulations in Binding Land-Use Plans, is designed to guide rational functional zoning and orderly integration. It divides urban land into functional zones dominated by living, working, and leisure to prevent functional conflicts. Each zone ensures its main function while allowing complementary functions. This enhances the utilization of building facilities in construction and use, meets the needs for functional conversion, and promotes effective functional integration. These features are evident in the differential control requirements for residential, industrial, and service facility-related land-use types, as well as in specific cases.

3.1 Protecting Residential Ambience and Guiding Functional Integration

Residential function is the core of urban areas. Currently, it is crucial to ensure the comfort and privacy of residential communities and buildings while preventing interference from other business types. At the same time, to enhance urban vitality, inclusion, and creativity, it is necessary to reasonably guide the orderly integration of residential and non-residential functions.

Germany has established various use zones through its land - use control system, creating a graded - mixed - use pattern for residential and non - residential functions. This pattern, supported by refined protection measures, achieves balanced development. The residential - and mixed - use construction - land types in Germany exhibit a "graded-mixing" characteristic, with the compatibility of different land - use building functions gradually shifting from strict protection of the residential atmosphere towards promoting functional mixing. Pure residential land

(WR) prioritizes the protection of residential functions, with small - scale local services like commerce requiring special permits. General residential zone (WA) focuses on local service facilities. Urban-type zone (MU) has high functional flexibility with a high proportion of residential functions. Mixed-use zone (MI) requires a rough balance between residential and other uses. Core zone (MK) has a subordinate residential function, ensuring diverse integration through scale - limit regulations and restricting residential layout to avoid interference. For instance, Berlin's I-16 Binding Land-Use Plan stipulates that the residential function around Leipzig Square must account for at least 20% and specifies the minimum vertical elevation for residential placement. The "graded-mixing" of residential and other urban functions creates diverse scenarios, enhancing the habitability of residential environments and promoting the composite utilization of urban spaces.

In Binding Land-Use Planning, supplementary measures are often introduced to coordinate the relationship between residential and non-residential functions and to safeguard the quality of the residential environment. Specifically, certain exclusions for building facilities or limitations on the location of non-residential functions are imposed to prevent interference with residential areas. Meanwhile, horizontal and vertical spatial separation, as well as building protection, are utilized to mitigate the impact of high-intensity activities and traffic noise on residential spaces.

3.2 Internal Combination and External Coordination of Industrial Functions

The industrial function serves as a pivotal driver of urban development. In the realm of industrial land-use control, Germany takes into account a multitude of factors. It caters to the locational and space-environmental requirements of diverse industrial sectors, including manufacturing, storage and transportation, R&D offices, and business offices. Moreover, it coordinates the relationships between different industries and between industrial and urban functions to minimize interference. Additionally, it integrates upstream and downstream industrial chains, jointly plans office, R&D, and manufacturing facilities to foster industrial synergy, and guides the integration of industrial functions with residential and other functions to enhance urban vitality.

To accommodate the needs of industrial clusters, Germany has established two types of industrial-use construction lands: the Commercial and Industrial Zone (GE) and the Industrial Zone (GI). The Commercial and Industrial Zone (GE) is designed for enterprises with minimal environmental impact, such as manufacturing, office operations, warehousing, and utilities. These enterprises typically generate low levels of noise, dust, and odors, allowing them to be situated adjacent to or mixed with residential or mixed-use areas. In contrast, the Industrial Zone (GI) permits all types of enterprises, including heavily polluting ones like chemical plants and power stations. This zone is generally separated from residential or mixed-use areas to mitigate potential environmental and health risks. This zoning strategy, which is based on the environmental impact of enterprises and the local land-use integration needs, effectively balances industrial development with urban environmental quality.

In terms of commercial and office functions, the Mixed-Use Zone (MI), Urban-Type Zone (MU), and Core Zone (MK) all primarily accommodate these uses while also permitting other commercial and industrial facilities. The Core Zone (MK) enforces stricter environmental-impact requirements on enterprises, prohibiting significant interference. In special cases, the General Residential Zone (WA) can host commercial and industrial activities that do not cause significant interference. This use-control framework provides flexible and inclusive spaces for the layout of commercial, office, small manufacturing, and handicraft activities, thereby promoting the integration of industrial functions with other urban functions.

3.3 Hierarchical and Categorical Management of Service-Supporting Functions

Germany employs a hierarchical and categorical approach to manage service-supporting functions, encompassing commercial, social life, and specific service facilities. This approach standardizes these functions in terms of category, scale, and spatial layout, thereby balancing service convenience with the avoidance of use-interference to enhance facility efficiency and sustainable operation capacity.

In the realm of use control, residential, mixed, and industrial zones are assigned different priorities to optimize

functional integration and minimize conflicts. Mixed zones feature relatively flexible regulations to accommodate a diverse array of public service needs. Residential zones, in contrast, are subject to more stringent restrictions to safeguard against potential interference from commercial and industrial activities. Industrial zones, meanwhile, adhere to strict requirements to ensure professionalism and minimize environmental impact.

From a multi-dimensional perspective, Germany enhances planning precision and efficiency by specifying service targets, scales, business types, and adjusting licensing levels. Binding Land-Use Plans focus on the spatial layout of service facilities, often prohibiting residential use on building ground floors to promote orderly distribution along public activity areas. They also consider service radii and market laws to improve residents' lives and community vitality while ensuring facility operation efficiency. Furthermore, plans maintain flexibility to adapt to dynamic construction and operational needs.

4. Insights from Germany's Urban Development Control

Germany's mature urban development control system offers valuable lessons for achieving sustainable and orderly urban growth, characterized by its clear objectives, robust legal foundation, comprehensive toolkit, and refined implementation methods.

4.1 Clear Objectives and Control Principles

As a key mechanism ensuring the orderly development of urban space, Germany's urban development control prioritizes rational functional zoning and promotes functional integration. This approach effectively balances multiple objectives and development needs.

Functional zoning focuses on preventing industrial pollution from impacting other urban functions, strictly protecting residential areas to ensure a high quality of life for residents. Simultaneously, functional integration considers the blending of diverse functions within public activity centers and across different industrial sectors, fostering vibrant and dynamic urban spaces. Germany further enhances this approach through a tiered framework for residential-nonresidential functional integration tailored to specific contexts. This methodology facilitates effective spatial connectivity between functions while preventing mutual interference.

These principles not only meet urban development demands but also create a land use pattern that serves urban residents and other market and societal actors. By doing so, it enhances the efficiency of infrastructure and public services, contributing to the overall sustainability and livability of urban areas.

4.2 Robust Legal Foundation

Germany's urban development control system boasts a robust legal foundation, providing strong support for urban planning and sustainable development. Centered around the *Building Code (Baugesetzbuch)* and supplemented by the *Federal Land Utilization Ordinance (Bundesbaunutzungsverordnung, BauNVO)*, these legal instruments work in tandem to form a well-structured and coordinated legal framework. This framework ensures the scientific nature and effective implementation of urban planning. Other countries can draw on the rigor and coordination of Germany's legal system to enhance the standardization of their own planning controls.

4.3 Comprehensive System of Development Control Tools

Urban development control relies on the close cooperation of diverse instruments including policies, spatial planning, and permits. Germany integrates land use control into these mechanisms, coordinating them through functional zoning and integration principles to form a comprehensive system. This operational framework functions through three interconnected components: First, foundational legislation such as the *Building Code (Baugesetzbuch)* and *Federal Land Utilization Ordinance (Bundesbaunutzungsverordnung, BauNVO)* explicitly defines spatial planning mandates, content parameters, and control objectives. Second, local spatial plans translate these legal requirements into practice while simultaneously providing feedback loops for refining control measures. Third, construction permits enforce regulatory compliance throughout both construction and operational phases, ensuring continuous implementation of control standards.

For nations seeking to enhance their land planning systems, Germany's model demonstrates how synchronizing control instruments through unified objectives, standardized technical approaches, and integrated administrative procedures can significantly elevate the precision, rigor, and normative standardization of regulatory planning controls.

4.4 Refined and Efficient Development Control Methods

Development control regulations and technical methods are crucial for ensuring effective land use control. Germany's sophisticated land use control system incorporates several key features contributing to its success:

1 "Land Use + Building Function" Framework: The system categorizes land into types that permit mixed building functions. This framework defines the suitability and compatibility of uses and specifies primary and accessory functions. This supports appropriate functional zoning and integration while allowing flexible conversion of building uses.

2 "Type of Building Facility + Additional Constraints" Approach: Constraints are specified based on the type of building facility, precisely preventing functional interference. This ensures different uses can coexist without negatively impacting each other.

3 "General Regulations + Specialized Requirements" Method: Combines general rules with specific requirements tailored to particular contexts, guaranteeing both control precision and adaptability. This reduces administrative costs while maintaining flexibility and responsiveness to local needs.

Many countries can learn from Germany's advanced practices in these areas. By adapting these methods to their specific national contexts, they can enhance their control capabilities, refine land use control instruments, achieve efficient urban development, and promote coordinated urban growth.

5. Conclusion

Germany's development control system offers an instructive model for global spatial planning governance. Through rational functional zoning and integrated land-use coordination, it synthesizes statutory frameworks, spatial planning instruments, and permitting mechanisms into a cohesive regulatory ecosystem. This system balances public welfare imperatives, market dynamics, and developmental needs by integrating precise yet adaptable technical methodologies with clear planning directives, thereby enabling effective construction land management. As cities worldwide transition from quantitative expansion to qualitative enhancement—with urban regeneration and stock redevelopment emerging as dominant strategies—Germany's experience delivers actionable insights for international practice.

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