

Application framework of urban morphology in planning practice: A case study of Beijing

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Abstract

Although it is generally recognized that a connection exists between urban form and urban planning practice, there is still a long way to go before the theories, concepts and methods of urban morphology can be widely applied to daily planning practice. Firstly, the paper makes a theoretical thinking. It is concluded that: 1. Urban form and urban planning practice are dynamic processes of space-time interaction; 2. Urban morphology research and urban planning are the relationship between knowledge and practice; 3. Urban morphology research needs to be combined with urban planning business. Secondly, the paper puts forward an application framework of urban morphology in planning practice, including four aspects: knowledge base, analytical dimension, technical support and planning practice. The framework focuses on the space geometry, industrial economy, traffic organization, residential space, urban design, land use and policies in the research of urban morphology under different scales, more closely related to the main focuses in the discipline and practice of urban planning. Thirdly, this paper describes the application of the framework in Beijing planning practice in recent years and illustrates it plays a role and value in the actual planning business.

Keyword: urban morphology, urban planning, urban form, planning practice, Beijing

Introduction

Despite a consensus to build a bridge between urban morphology and urban planning practices, it is undeniable that the progress and results in this respect have been unsatisfactory. Many scholars have analysed the reasons for this, and the main arguments can basically be divided into two categories. First, it suggests that there is no systematic framework or system of work that links the two in terms of cognitive and knowledge interface. For example, urban planning tends to be based primarily on the functional allocation of land use, rather than broader considerations related to physical form (Hall, 2000; 2008). Planning practitioners are not aware of the intrinsic qualities of the built environment and its evolution in various complex interrelationships (Ünlü, 2018). There is a lack of common language and methodological framework between the two (McCormack, 2013; O'Connell, 2013). Second, some operational or methodological deficiencies lead to insufficient beneficial guidance of morphology in planning practices. For example, morphological research is mainly focused on historical urban centres and small cities and is not very applicable to the morphological analysis and design of emerging cities. The study of urban morphology involves more non-English speaking countries and is more geographically specific, which hinders the dissemination of its practical experience (Oliveria, 2016). Urban morphology is a comprehensive field that integrates architecture, geography, history, urban planning and other disciplines, but there is no research

institution dedicated to urban form research in higher education (Whitehand, 2010; 2018), which results in the inability to help students build bridges between different domains of knowledge. Of these two types of causes, the first has a cognitive, long-term and profound impact and therefore requires attention and a theoretical and systematic reflection to find a possible solution.

Theoretical Thinking

The spatiotemporal interaction between urban morphology and urban planning

As a comprehensive discipline, urban planning is policy-oriented, forward-looking, systematic, long-term, and legal. The core of urban planning is to solve the scale and spatial layout of urban land use, influences urban physical space through urban function design, and lead the future evolution of urban spatial form and structure. As a result, urban planning is an essential tool for regulating the use of urban land resources. At the same time, due to the choices and decisions of different urban agents, such as markets, enterprises and households, urban planning solutions also have a certain degree of adjustment in the process of implementation. Therefore, it combines both top-down urban planning and bottom-up self-organization and self-adaptation in the evolution of urban spatial form.

The corresponding relationship between urban form and urban planning is not instantaneous. The urban form is the outcome of the formulation and implementation of urban planning over a long time (Whitehand, 1977; Brenner et al., 2000). There is a time lag between urban form and the functional arrangement of the city. At the same time, the functional design of the city by human beings due to social and political functional needs is also influenced by the previously formed urban form (Mesev, 2009). The two influence and interact with each other complexly and dynamically. Therefore, the role of urban planning and its implementation in guiding the evolution of urban spatial form, as well as the influence and feedback of urban form on the preparation and implementation of urban planning, needs to be addressed in planning practice.

Knowledge-practice relationship between urban morphology and urban planning

Urban morphology is a knowledge domain that describes, defines and theorizes about the built environment of cities (Scheer, 2016) and is also an organized body of knowledge that studies the relationship between society and the built environment it creates and occupies over a long period (Conzen, 2013). Urban planning, in essence, is a decision-making process involving multiple disciplines collaboration so that knowledge and the application of knowledge are essential elements in this process (Yu, 2012). The knowledge of urban morphology should be part of the knowledge system of urban planning as it provides knowledge acquisition and methods for decision-making (Barke, M., 2018). For some scholars, urban morphology itself is not only a body of knowledge, but also a field that combines 'knowledge' and 'practice' (Whitehand, 2012). The guidance of urban morphology knowledge in planning practice is of great positive significance to gain

understanding, recognition and conviction from planning practitioners and is also conducive to promoting the integration of knowledge and action between the two.

Integration of urban morphology and urban planning business

In recent years, some scholars and cities have attempted to embed morphology into planning preparation in the form of referable parameters, guidelines or rules (Hall, T., 2007; Hall T., 2008;), calling them 'design rules' or 'form-based rules' (Hall T., 2013). Some books like manuals, guidelines (Oliveira, V. ,2016; Karl Kropf, 2017; Ünlü T., 2019) are written for planners to consult and apply them to guide urban planning practice. While these beneficial attempts make significant progress and are highly appreciated, they are mostly related to specific sites or local urban spaces and involve specific planning themes, such as the inheritance of historical contexts or urban design. They are technology-oriented and are not closely related to the routine work of planning compilation and implementation management. The goal of establishing a common language and system framework between the two will require more effort. The positive effect of urban morphology on planning practice should also include the daily control of planning since urban form is ultimately determined by planning practice through numerous incremental decisions (Whitehand, 2007) and urban metabolism should be evaluated within planning practice (Oliveira & Rita,2021). Consequently, urban morphology should be linked to the daily work content, methods and requirements of the planning business.

Proposed Application Framework

Based on the theoretical considerations, it can be concluded that only by forming a complete application framework that integrates knowledge, technology and working mechanism can urban morphology truly enhance its ability to help analyse and solve problems in planning business. An application framework of urban morphology in urban planning practice is proposed from the perspective of systematization, completeness and practicality (Figure 1). The framework aims to promote the interaction between urban form and urban planning in space and time and is built based on the knowledge management characteristics and business contents of urban planning, including four components: knowledge base, analytical dimension, technical support and application practice.

Knowledge base

The study of urban morphology has been forming a broad body of knowledge. According to the literature reviewed, urban morphology has been studied from five perspectives: landscape ecology, economic structure, transportation planning, community design and urban design, focusing on environmental protection, economic efficiency, accessibility, social welfare, aesthetics, and pedestrian friendliness (Clifton et al., 2008), which involved various disciplines such as sociology, economics, geography, architecture and history. There are many overlaps between different disciplines and the research methods are mutually used for reference and the research results are mutually influential and stimulative. In the study of urban

morphology, urban planning involves political, social, economic, environmental, landscape, ecological and policy aspects due to the comprehensive nature of the discipline itself, the complexity of urban problems, the diversity of planning objectives, and basically covers the contents and methods of the above disciplines. Moreover, theories from these disciplines are also used to depict urban spatial problems and to analyse and explain their causes. Therefore, the application framework needs to first establish an interdisciplinary knowledge base, so that the discipline of urban planning becomes an intersection and integrated interface between geography, sociology, economics, politics, and architecture in the study of urban morphology.

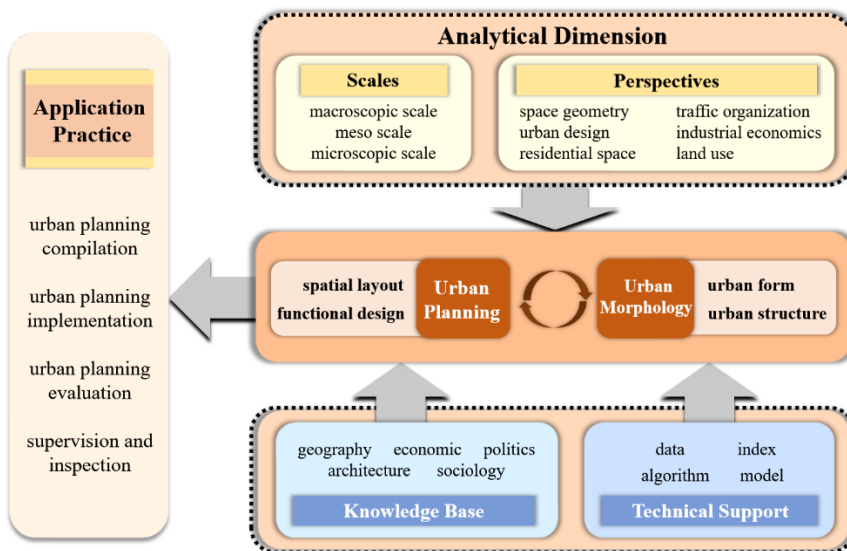


Figure 1. The proposed application framework of urban morphology in planning practice

Analytical dimension

Based on research in related disciplines, urban planning needs to make choices or make a comprehensive research on specific problems and characteristics of cities to form its own analytical dimension of urban morphology. Table 1 illustrates the analytical dimensions in Beijing from multiple perspectives and scales.

Firstly, urban form includes the geometric shape of material space and the spatial distribution of material elements. Urban morphology should study the layout form of material elements, the geometric features of urban built space and the statistical characteristics of socio-economic aspects in different spatial units. Secondly, from the local perspective, Beijing is the capital of China, a world city and an ancient city with a history of 3,000 years. Looking back at the history of urban planning and urban development in Beijing, it can be find that planning practice has long been concerned with population, scale of construction land and buildings, functional organization and spatial layout of land use, historical and cultural preservation and inheritance, shaping of featured urban landscape, ecological and environmental protection, balanced allocation of public services, housing supply, community governance, transportation organization, etc. Based on these elements, the application framework identifies six perspectives as the key aspects for urban

morphology in Beijing's planning practice: space geometry, industrial economy, transportation organization, residential space, urban design, and land use. Provided that urban planning is essentially a public policy of the government, the public policies of industry, economy, housing, and urban management etc. are also taken as key factors that affect urban form in the analysis. Thirdly, urban form differs in its characteristics, drivers and concerns at different scales which result in the analytical content should be distinguished. The more macroscopic, the more emphasis is placed on the general observation of geometry, scale, density, functional layout and network. The more microscopic, the more it focuses on urban texture, open space, vitality, urban design, social equity and other urban imagery and citizen perceptions. In general, the perspectives and three scales of analysis should be linked in order to explore the city from a holistic view.

Table 1 Multi-perspective and multi-scale of urban morphology analysis in urban planning practice in Beijing

Analytical dimension	Space geometry	Industrial economy	Transportation organization	Residential space	Land use	Urban design	Policy mechanism
Macro	boundary and shape of built-up area (compactness, fractal dimension, etc.)	distribution of industrial land, synchronization of employment and industrial land, etc.	road traffic network, rail traffic network (length, density, etc.)	overall layout of residential space, population distribution (suburbanization, density, height, etc.)	the balance of overall urban land use structure, etc.	urban overall landscape management and control, etc.	Industrial policy, Housing policy,
Meso	interior of external groups (satellite cities, new towns, etc.)	functional area (industrial park, development zone, etc.)	land use and urban transportation, etc.	spatial layout of sub-regional residential functions (density, height, etc.)	the balance of regional overall land use structure, etc.	heritage of the city's historical landscape, etc.	Management policy, etc.
Micro	urban waterfront space, open space, etc.	economic vitality reflected by POI, etc.	transport site impact radius, accessibility, etc.	Community differentiation, etc.	land use diversity, etc.	urban texture, urban imagery, etc.	

Technical support

The technical support includes indexes, algorithms, models and data that guarantees the technical implementation of the application of knowledge base and analytical dimension. The indexes include both urban geometry indicators (e.g. centrality, shape index, patch fractal dimension and compactness ratio) and socio-economic statistical indicators (e.g., population or housing density, accessibility, and vehicle ownership) (Huang, J. et al., 2007; Lowry, J. H. et al., 2014). The per capita park green area, the density of the road network in the built-up area, the per capita floor area of public cultural service facilities etc. are also key observations, as they are evaluative indicators that reflect both the spatial form of the city and the quality of urban development. Algorithms and models are a collection of computational methods to carry out

quantitative analysis, simulation and prediction of urban form development. Through the corresponding software tools, various kinds of data are consolidated, and the calculations of indexes are realized. Through quantitative research methods of the space syntax, logistic regression, cellular automata, fractal geometry and artificial intelligence technology such as neural networks etc., the historical evolution of urban form is simulated, the possible development of the future form could be predicted. Data refers to the basic data and social big data that can satisfy index calculation, algorithm analysis and model operation. It reflects different planning schema, the spatial forms developed by the implementation of urban planning and the spatial distribution of social and economic activities. The basic data include planning results data, city status data, planning approval data, geographic data and other spatial datasets. The social big data comprise mobile phone usage data, public transportation IC card data and POI data, etc.

Application practice

Urban planning usually includes planning compilation, implementation management, evaluation, supervision and inspection which forming a constant loop of feedback process. Among this process, the implementation evaluation is particularly important for establishing a link between urban morphology and planning practice (Oliveira & Sousa, 2012). In this process, planners need to face the layout of the physical space elements, the characteristics of urban space geometric shape, spatial characteristic of the driving force behind and policy, the social space attribute corresponding to physical space, the way the physical and non-physical space elements relate to each other and act on each other as well as the laws and patterns of them. Therefore, the knowledge base, analytical dimension and technical support of urban spatial form research are integrated into the planning business, to provide analysis and decision support for the whole planning process.

Applying framework in Beijing's planning practice

Beijing Municipality started a new round of urban master planning in 2016. During the compilation process, the implementation of the previous version of the master plan (2004-2016) was comprehensively evaluated, and a new urban space development goal was established. From 2017, after the approval of the new master plan, the preparation of subdivision planning, detailed planning and other subordinate plans were steadily progressing. In 2018, The Regulations of Beijing Municipality on Urban and Rural Planning (Revised Draft) established a mechanism of 'city examination & evaluation in spatial planning' which helps to provide early warnings in the implementation of the master plan. These planning efforts provide opportunities to put urban morphology application framework into practice. Based on this application framework, the spatiotemporal interaction between the evolution of urban form and urban planning in Beijing was analysed, thus verifying that the urban spatial form evolves due to the result of the joint action of top-down urban planning guidance and bottom-up self-organization of different urban agents (Figure 2). Different dimensions such as geometry, land use structure, population development, transportation system, residential space, the urban fabric is analysed and evaluated thus extracting the influential drivers of Beijing's urban spatial

development. Using this as a set of parameters, a spatiotemporal interaction model of Beijing's urban form and urban planning was developed to simulate and predict the possible impacts of the new urban master plan on the future spatial development, and to make suggestions for future planning implementation. These practical explorations not only provide the reference basis for planning compilation, but also provide services for the annual urban health examination and five-year planning implementation evaluation.

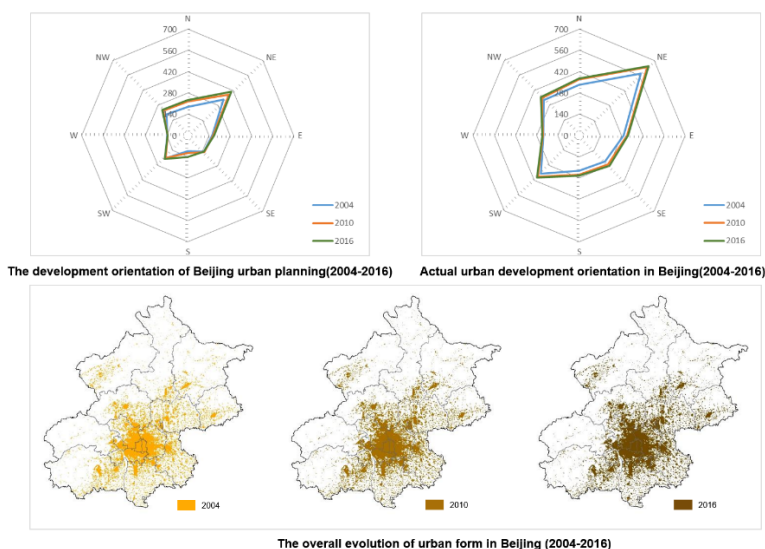


Figure 2. The spatiotemporal interaction between the evolution of urban form and urban planning in Beijing

Discussion and Conclusion

Beijing has proposed an application framework to strengthen the connection between urban morphology and urban planning practice. The main features of this framework are: 1) it includes theoretical and technical research and integrates with urban and rural planning practice; 2) it develops analytical dimensions from multiple perspectives and scales by incorporating the research contents and methods of related disciplines and combining the focus of urban planning discipline itself; 3) it not only portrays the forms of urban physical space such as element composition and spatial layout, but also analyses the layout of urban functions under certain forms and the connections between them; 4) it is conducive to exploring the dynamics, causality, interaction and feedback mechanisms between urban physical space form and social functional arrangement. In this way, urban morphology is promoted to be deeper applied in planning practice, and the unification of knowledge and action in urban planning practice is strengthened. Based on the exploration in recent years, this application framework should be adapted to the development of planning business, data environment and technical conditions in the future, and make further experiments and improvements.

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