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URBAN LAYER STRUCTURE AND SUSTAINABLE DEVELOPMENT: A GLOBAL PERSPECTIVE

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Abstract: Under classical urban space theory, the transition of urban form demonstrates a "layering" structural pattern which gradually extends from the center to periphery. Urban layer structure is the combined function of historical and natural selection and industrial and artificial selection. This is the best choice of most cities in historical dialogue across the world. The research purpose of the paper is to analyze urban layer structure formation and evolution logic, explore the unbalanced development problem brought about by the layer structure to the city, seek the practical path of urban sustainable development - layer integration, and build urban layer integration theoretical assumption model and concrete practice path. The literature research method is taken to divide urban layer structure theoretical evolution logic into the "man-centered" formation stage, "object-centered" formation stage and "man-object" harmonious coexistence stage. The model building method is taken to construct the typical practice model of urban layer structure, namely central radiation model, central aggregation model, and multi-point association model, and form the theoretical assumption model of urban layer integration - multi-center radiation-association model. As proved by research results, (1) The "man-object" harmonious coexistence is the new stage of urban sustainable development, while breaking up layer barriers and realizing layer integration is the inevitable trend of future urban space development; (2) The generality of urban layer structure keeping expanding around one central point inevitably suffers from the constraint of "central polarization effect" and "range attenuation law" and gives rise to the unbalanced development problem of layer structure; (3) Layer integration is the inevitable requirement of urban sustainable development, while multi-center radiation-association model can effectively amplify radiation scope and intensity and propel the sustainable development of the city.
Keywords: City; Layer structure; Sustainability; Integration

1 INTRODUCTION

In a survey of the geographical spatial form of main cities across the world, the paper surprisingly finds that nearly all large and medium-sized cities have such circular spatial structure. Is this a coincidence? Why is it a circular structure if this is not a coincidence? What about the internal construction of circular spatial structure? Will such spatial form affect the sustainable development of the city? How to solve such influence? Throughout the inquiry of considerable literature about urban development history and the spatial form in main cities, the paper concludes that urban structure is a geographical spatial form which has been experiencing constant dynamic adjustments or say an entire area in which a central point continually expands outward, upward or downward. Because of the conspicuous "central polarization effects" between the city and surrounding environment, the function on peripheral geographical space is subject to the "range attenuation law". Besides, under the dual role of subjectivity and objectivity, artificial planning with optimal resource allocation in the industrialization age shapes up urban circular spatial distribution layout. To be sure, because of the constraints of factors like geographical environment, administrative planning and artificial control, some cities are in the belt, star, and even five-finger pattern (Copenhagen) spatial layout superficially. But the macro layout of these cities can be still abstracted to circular pattern (including semi-circle and fan pattern). As to geographical spatial activities, the city expands from central area to peripheral area, and from core activity area to suburb activity area, and results in the orderly derivation in a layering pattern from the center to periphery such as life business area, production site, interactive space, and urban-rural integration[1].

2 URBAN LAYER STRUCTURE AND SUSTAINABLE DEVELOPMENT: LITERATURE REVIEW ABOUT FORM

2.1 Formal Connotation of Urban Layer Structure

Before the industrialization age, cities revolved around its production and life activities, and gradually formed a circular geographical spatial form. Till the industrialization age, the city, an important carrier of industrialization, spontaneously develops a more magnificent layer structure under the combined function of natural formation and artificial selection. The reason is that circle is the geographical form which covers largest area and has maximum range benefits. Each point in the same radius is closest to the center, and has maximum resource and factor allocation efficiency. Therefore, urban layer structure is not only a differential pattern originating from the natural property of geographical space, but

also a standard pattern of resource re-allocation under artificial planning. So from the perspective of urban development, most cities in the world develop in a circular structure. Typical representatives include Beijing, Tokyo, London, Paris, Singapore, Chengdu, New York (semi-circle), Chicago (semi-circle).

The formation of urban layer structure is deeply affected by spatial interaction theory "central polarization effect" and "range attenuation law". The city expands geographical spatial layout inside out around specific production activities during the process of development. The "Thünen circle" proposed by German agricultural economist Johann Heinrich von Thünen refers to the circular layer structure [2,3] which prioritizes farm land use means in urban peripheral region; the "concentric circle" proposed by American Sociology Professor Burgess from University of Chicago divides five major functional zones according to industry development requirements and makes orderly configuration from urban center to periphery according to the concentric circle law [4,5]; the "garden city" proposed by British urban planner Howard divides different layers of functional districts to satisfy sophisticated social demands [6]; the 'center-periphery" theory proposed by Latin America economist Raul Prebisch constructs city system according to the regional distribution difference in resource, market, technology and environment [7] and stresses the unbalanced property of regional development. From "Thünen circle" to "concentric circle", and "center-periphery" structure, all types of urban layer structure are the spatial geographical forms based on spatial law, industrial formation and administrative planning. Influenced by "central polarization effect" and "range attenuation law", layer development imbalance problem is inevitable. Smith R (2010) held that layer structure was based on spatial interaction theory and "range attenuation law". According to his analysis, multi-dimensional centripetal space layering layout of natural and humanistic landscape is caused by the imbalance in "point-axle" space development. Pan Xuming and Wu Xuehui (2011) judged that urban layer structure was in an unbalanced urban space layout formed against the context of non-uniform factor market and industry dislocation development from the perspective of industry economy and region economy integration[8]. Xu Liquan and Wan Yanhua et al (2018) thought that urban time-space evolution demonstrated characteristics of "near-region expansion", 'full coverage", "layer diffusion" and "cross-border integration" [9]. Fujita Masahisa (2005), Japanese spatial economist, adopted famous "center-periphery' model to analyze urban layer structure, and illustrated that urban structure was a spatial layout formed by mid-stream, upstream and downstream industry chain supply-demand advantage principle during industrial development process [10]. The formation of urban layer structure eventually comes down to the satisfaction of spatial law industrial development requirements, which will necessarily widen the gap between circles in economic power, population wealth and social public service, i.e., development imbalance problem. What are the contributors of the imbalance of urban layer structure development? Li Tian et al （2009）, and Wang Jia (2018) thought that resource endowment difference was the objective cause. Some regions with favorable locations and development foundation integrated differential land rent effects. For instance, the downtown area that took the lead to form "depression effects" enjoyed an edge in comparative cost, spatial capacity, environmental capacity and attracted the unidirectional flow of production factors [11-12]. Chen Jiyu and Liu Yong (2018) considered policy orientation imbalance as the subjective cause. In the initial stage of urban development, behavior and system design usually formulated major financial and taxation systems, industrial layout and transportation planning policies in favor of advantageous areas [13-14].

From the perspective of spatial form characteristics, urban layer structure theory has two basic units of "circle" and "layer" in general layout, in which the former means regional centrality full of unitary property, and the latter means regional space level objectivity full of multi-dimensional property. Distinct intersection between "circle" and "layer" in space forms intuitive urban "layer" structure, and objectively reflects how urban society landscape gradually spreads from the center to periphery and outlines orderly sense of layering in the centripetal space. The urban-rural spatial layout in each city across the world shows that most of these cities follow "Thünen circle" and concentric circle model, and urban space is divided into the internal layer, middle layer and external layer inside out in a typical layering structure. (1) internal layer: usually in urban downtown area which has been completely urbanized. Because of the high population and architecture density, the internal layer is the high-density gathering place of residence, commerce, administration and education. Dominated by the tertiary industry, this industry also integrates vigorous technical innovation industry, and headquarters economy. There is nearly no trace of first industry. (2) medium layer: usually in rural-urban fringe area which has been urbanized to a large extent. However, the layer still has intense rural characteristics in a semi-urban and semi-rural state. With moderate population and architecture density, it is dominated by the second industry clusters, residence and business. The medium layer demonstrates main functional area characteristics, and primarily develops the second and tertiary industry instead of first industry.(3) external layer: usually in remote urban suburbs. The external layer with low degree of urbanization sparsely scatters urban satellite towns and rural towns, but it does not demonstrate high urban clustering state. Due to low population and architecture density, this layer is dominated by the first industry, and few regions have built transferred secondary industry parks. It primarily develops tertiary industry such as rural scenery and rural tourism.

2.2 Evolution of Urban Layer Structure

From the "Thünen circle" theory proposed in early 19th century to present "growth polar nucleus" theory, urban layer structure experiences a dynamic development process which makes continuous adjustment with technical progress and industry structure. In accordance with the layer structure core concept, it falls into three stages, namely "man-centered"formation stage, "object-centered" formation stage and "man-object" harmonious coexistence stage.

2.2.1 "Man-centered" formation stage

The early urban formation stage always takes "man" production and life convenience as the core concept. Typical representatives include "Thünen circle" and "concentric circle". In 1862, German agricultural economist Johann Heinrich von Thünen systematically expounded the "man existence-centered" location theory and analyzed general location characteristics of the city from the perspective of layer structure. This is referred to as the "Thünen circle". The theory holds that the city plays a leading role in regional economic growth, and its facilitating role to regional economy is inversely proportional to spatial distance. The development of regional economy should center around the city and gradually expand outward in a layering spatial distribution pattern [15]. "Thünen circle" is the circular layer structure which takes peripheral farmland use means as the core concept. It belongs to a theoretical model under complete homogeneous conditions. However, despite its theoretical guidance function on urban structure layering, it lacks pertinent practice. In 1925, Burges, Sociology Professor from American University of Chicago, performed a research on urban land use functional area layout, pointing out that the five major functional zones in the city were orderly allocated from the center to periphery with the concentric circle principle. He viewed it as the ideal pattern of urban land use structure [16]. The spatial structure of this pattern takes industrial and commercial service for man as the core, and gradually extends inside out from central business area to transitional area, working class residence area, middle class residence area, superior or commuter residence area in an orderly layering state. However, he overlooked the correlation between man development and land use. As proved by the development spatial form of leading cities in the world, the most typical representatives of concentric development pattern are London of Britain, Paris of France, Beijing and Chengdu of China, etc.

2.2.2 "Object-centered" evolution stage

Accompanied by the advent of the first industrial revolution, the convenience of transportation further widens people's production and living space, and border of the city extends outward. It marks the advent of "object-centered" evolution stage of urban layer evolution process. In 1898, British urban planner Howard put forward the "garden city" theory. Aiming at the prevalent humanism urban planning problem in modern society, Howard proposed pioneering material thinking composed of urban size, layout structure, population density, green belt and other urban planning problems, and presented a series of innovative entire urban planning thinking systems [17], the functional positioning and landscape at different layers conformed to social wealth production and natural state. Irrespective of the early start of garden city theory, it still has significant referential value to modern city planning, especially post-modern "organic decentralization" theory, "satellite town" theory. "Garden city" is not only the theoretical guidance to urban planning, but also the innovation of social reform. This theory not only raises a series of creative insights and assumptions about urban space planning problems, but also designs a full set of overall urban-rural development social systems. Its goal is to constantly solve all sorts of problems triggered by deformed development of big cities, push forward the urban-rural planning thinking system characterized by urban-rural balance, apply above theories in practical urban construction, and form colorful urban space forms. For instance, in 1944, on the basis of "garden city" theoretical foundation, London planned to build "central city- green belt-satellite city" spatial form. Cities of China like Chengdu, Shijiazhuang and Wuxi also put the garden city theory into practice and arranged general urban functional areas according to local resource advantages such as industry chain, mountain, farmland, lake and grassland.

By the 1940s, Latin American economist Raul Prebisch presented the more rich "center-periphery" structural theory. His original intention was to demonstrate the unfair development patterns and policies between developed countries and backward countries [18]. Later on, Firedman introduced the "center-periphery" theory into regional economics, judging that the regional system of any country was made up of binary sub-space systems, and meantime, approving of the objectivity of regional distribution difference in resource, market, technology and environment. When the spatial aggregation in some areas presents accumulative development momentum, these areas consequently gain overwhelming economic competition advantages, and grow to be the center of regional economic system. Compared with the center (developed area), the periphery (backward area) in disadvantageous status lacks economic autonomy and evolves spatial binary structure that has been constantly reinforced as time passes by [19]. After the Second World War, "layering economy" centering around large cities gradually becomes the mainstream of economic growth in all countries. Regional economic growth should center around the city, gradually expand outward in "layering" spatial distribution pattern, and constitute an internal economic contact network featured by "polarization-diffusion" effects between central city and hinter land or surrounding towns. But unfortunately, both "garden city" structure and "center-periphery" structure do not answer the mutual relation between socioeconomic variables and land use.

2.2.3 "Man-object" harmonious coexistence stage

The "Thünen circle" and "concentric circle" dominated by humanism as well as object-centered garden city and "center-periphery" structure all focus on the single aspect of either "man" or "object", and can't realize the harmonious coexistence between man and nature. The "growth polar nucleus" structure was first raised by French economist Peru in 1950. Under the "growth polar nucleus" theory, growth in geographical space is not in an even state, but a dotted state with varying degrees of intensity instead. By affecting regional economy via all sorts of channels, growth polar nucleus can realize the growth in "promotion" and "spatial gathering" meaning, introduce facilitating industry into a specific area to form aggregation economy and growth center outward, and finally push forward regional economy growth [20-21]. Afterwards, the "growth polar nucleus" theory is further enriched and developed by French economist Boudaille, American economist Friedman, Sweden economist Myrdal and American economist Hirschman to varying degrees, and progressively expanded from economic space to geographical space, and from material personality space to personalized material space, thus realizing the harmonious coexistence between man and nature (object) and fully

answering the sufficient and necessary relation between man development, economic substance variable and land use. The growth polar nucleus theory in geographical space field judges that the city is a growth center which can activate peripheral economic growth (scope of object) and social development (scope of man). It exerts the organizing role in regional economic activities by way of dominance effects, multiplier effects, polarization and diffusion effects [22], and expedites man development process.

2.3 Imbalanced Development Problem and Solution for Urban Layer Structure

From “Thünen circle” and “concentric circle” to “garden-city”, “center-periphery” and growth polar nucleus structure, all city layer theoretical forms center around the geographical space pattern under specific “man” and “object” layout, and surrender to “range attenuation law”. In other words, the city radiates from the center outward. Layer development imbalance is caused because areas closer to the city have stronger radiation ability and areas farther to the city have weaker radiation ability. The evolution of urban layer structure exerts the efficacy of “range attenuation law” to the uttermost so as to solve poverty, polarization and social problems caused by development imbalance. Then how to overcome the issue that central radiation ability weakens with distance? It takes constant efforts in optimizing and improving urban space structure and form. Theoretically speaking, central radiation subject to “range attenuation law” may set up intermediate nodes (sub-central nodes) in former center radiation attenuation limit to expand peripheral radiation and form a compound multi-center radiation structure. Therefore, the theory builds sub-central nodes at different layers and radiates to periphery outward from the central nodes. First of all, it directly expands the radiation range of former central nodes. Secondly, it reinforces the radiation intensity at the border of two central nodes. Thirdly, it continually expands the scope and intensity of radiation from sub-central nodes.

3 URBAN LAYER STRUCTURE AND SUSTAINABLE DEVELOPMENT: EVOLUTIONARY PRACTICE MODEL

Urban layer structure theory analyzes the basic characteristics of urban expansion from different perspectives, and gives theoretical instructions to the development of urban economy and regional economy. In particular, it has realistic guiding significance for developing countries to improve urbanization development quality, scientific planning of urban geographical and spatial layout, and propel economic high-quality development [23-25]. Layer structure, as a typical urban development theory, has gained widespread application in international urban construction, and built many quality urban economic circles. Especially, large cities represented by Beijing, London, New York, Singapore, Chicago and Chengdu have also gained practice evolution experience.

3.1 Practice Evolution Model of Urban Layer Structure

Throughout the practice exploration of urban layer structure theory in urbanization development process, scholars have made theoretical research from multiple perspectives. For instance, Li Xifan and Hu Xiaowu began from the perspective of economic geography and spatial form in the research, only to find three modes of Chinese urbanization “layering structure” in spatial characteristics - central divergence mode, regional centralization mode and point-axis association mode [26-27]. Song Yingchang (2005), Zhang Yabin and Zhang Minmin (2010) concluded the five development stages of international city layers, namely “hard nucleus” stage, “overflow” stage, “layout” stage, “integration” stage and “coupling” stage [28-29]. Wang Jili et al (2018) paid attention to the research on Beijing layer structure. As proved by their research findings, urban functions and population expanded inside out, and this was related to the urban main road circular settings. The ring road generalized the basic vein of urban layer structure development [30-31]. Combining with above studies, it could be seen that urban layer structure spatial form basically presents three development modes.

3.1.1 Central radiation mode

Central radiation mode develops from the association relation between external, internal and central layer in layer structure theory. What it adheres to remains to be the “range attenuation law”. Such mode that stresses the radiation of a large city towards peripheral suburbs and forms single central radiation mode is most typical in global urban development. It develops few central towns (districts and towns) or few small towns around large cities, and then these central towns or small towns develop few villages (large rural communities). This is how “large-city-central down(small town)-village” urban cluster mode comes into being. For instance, urban-rural integration in Suzhou, China is mainly under the central divergence urban-rural integration mode. Suzhou large cities constitute a cluster mode with small towns such as Kunshan, Wujiang and Changshu. In this process, the central city Suzhou fully uses its advantageous resource radiation ability to break up urban layer barriers.

3.1.2 Central aggregation mode

Central aggregation mode is a common mode among global cities in the process of development. Under this mode, the central city grows through incorporating the resources in nearby small and medium-sized cities, and develops core urban circle with limited resources. Its prime disadvantage is that its cohesive force surmounts external radiation force. The central aggregation mode emphasizes central subject’s cohesive force. The greatest possibility of central city is to incorporate peripheral resources so that resources are in unequal distribution in peripheral small and medium-sized cities. Urban layer profile is more distinct and urban-rural difference is more prominent. The urban development mode

in the Pearl River Delta Economic Zone, China is most approximate to it. To be specific, the urban layer structure in the Pearl River Delta Economic Zone takes shape throughout the intersection of urban centralization mode and industry aggregation mode. Urban space centralization development mode represented by all urban districts follows a "top-down" intensive development mode. While industry aggregation spatial development mode represented by rural built-up area follows a "bottom-up" extensive development mode dominated by grassroots. The two interacts and supplements to form a center aggregation mode with intense cohesive force.

3.1.3 Multi-point association mode

As the key mode of future evolution in urban space, multi-point association mode extends the practice of growth polar nucleus theory. From the perspective of economic growth, large cities in the area seize good locations with resource endowment advantages, and scatter in the dotted state. These large cities are nothing but the few "central nodes" in multi-point association mode. These large cities (central points) generate demonstration, organization and motivating functions on regional economic activities via dominance effects, association multiplier effects, and polarization-diffusion effects. At present, the multi-point association developed mode is rarely adopted in reality, but it is still the main mode of urban layer structure development in the future. The multi-point association mode connects many large cities as a whole via convenient transportation network and communication network, and takes advantage of the "polarization-diffusion" effects between large cities and downtown area or peripheral areas to integrate urban layers.

3.2 Comparative Analysis on Urban Layer Structure Mode

Please refer to Table 1 for the advantages and disadvantages of three practice modes.

Table 1 Comparison table of three practical models of urban ring structure

Mmode/Type	Advantage	Disadvantage	Basic Conditions
Central radiation mode	Excellent radiation	Lack of cohesive force	Dominant advantages in central cities
Central aggregation mode	High cohesiveness	Lack of internal linkage	Balanced economic development conditions in peripheral small and medium-sized cities
Multi-point association mode	Interaction between multiple points	Strong external diffusion force and poor internal cohesive force	Developed transportation, communication and other infrastructure

3.3 Similarity and Difference and Future Orientation of Urban Layer Structure

Pursuant to above analysis on mode advantages and disadvantages in Table 1, it can be seen that the three modes all expand around one "single center". The difference between the three modes is that central radiation mode has higher requirements on center city, central aggregation mode has equalization requirements on the development of all cities, while multi-point association mode has higher requirements on communication, network and other infrastructure. Therefore, the three modes have respective advantages and disadvantages. As a result, in urban construction, attention should be paid to exerting the advantages of the three modes, and avoiding their respective disadvantages. At the same time, the authority shall use local advantageous resources and practical experience to beak up the inertial thinking of "single center" and form "dual-center" and even "multiple-center" urban space structure. Typical representatives are the "dual-center" mode in "San Francisco-Silicon Valley", San Francisco of America, "triple-center" and even "multi-center" urban space forms in "Beijing-Xionan New District- Tianjin" Delta framework.

4 URBAN LAYER STRUCTURE AND SUSTAINABLE DEVELOPMENT: INTEGRATED MULTI-CENTER MODE

As there exists layer phenomenon during urban development process objectively, there indeed exist some differences between circles in development level[32-33]. While the sole way to remove layer difference is to integrate layers. Layer integration usually falls into urban internal "urban-rural" integration and "urban-urban" integration. As to urban sustainability under layer structure, the first step is to break up the constraint of urban layer structure single center "range attenuation law", and realize urban-rural integration. The prime theoretical assumption foundation is to realize the leap of urban structure from "single center" to "multiple centers".

4.1 Theoretical Form Integration: Urban Layer Structure Complex

From the perspective of urban layer structure theoretical form, urban layer integration is actually a complex that integrates multiple types of urban layer structure. This paper takes Chengdu of China and Chicago of America as the research subject. In development form, both Chengdu of China and Chicago of America are typical concentric circle development mode cities in which urban center orderly allocates functional zones outward. Affected by the costal geographical characteristics, Chicago expands the city around the center in a semi-circular mode. By contrast, Chengdu

forms a classical concentric circle mode on the geographical characteristics of Chengdu Plain. In development goal, Chengdu city aims to develop to be a "world garden city". Referring to the difference between areas in resource endowment, there are four functional zones, i.e., planning ecological development zone, optimization development zone, promotion development zone and expansion development zone. Chengdu's "world garden city" is consistent with Howard's "garden city" hypothesis in nature, as both of them express the core thinking of "beauty of nature, social justice and urban-rural integration". In development thinking, Chengdu consults the "center-periphery" theory in urban layer structure, highlights the core role of city in regional economic growth and forms an internal economic association network with "polarization-diffusion effects" including main urban central areas, peripheral centers, featured towns. Meantime, it also takes growth polar nucleus theory into account, encourages city centers to activate peripheral economic growth and social development dominance effects, multiplier effects and polarization-diffusion effects, and produces organization association functions on urban economic activities.

4.2 Theoretical Hypothesis Model: Multi-center Radiation-Association Model

In practice evolution, present urban layer structure models mainly consist of central radiation mode, central aggregation mode and multi-point association mode. But under the framework of urban integration sustainability, urban development mode prefers a compound model or say the "multi-center radiation-association model".

On the whole, multi-center radiation-association model has formed a multi-center structure featured by "main urban area+ new urban center" in economic activities and administrative planning. The center builds few sub-centers (satellite cities) in peripheral areas, sub-center builds few featured small towns in peripheral areas, and featured towns then connect together to form few rural communities. This is how the multi-center radiation -association model featured by "urban center-satellite city sub-center-featured town-rural community" comes into being. Such multi-layer mutual association and radiation could be specifically proved by administrative concept integration, spatial function integration, industrial planning integration and infrastructure integration.

4.2.1 Administrative concept integration: redefine city system

At the layer of city planning, the concept of urban layer structure has been gradually weakened. The new city system comprising central urban area, satellite city, featured town and rural community does not incorporate the concept of layer.

4.2.2 Spatial function integration: general planning for cohesive county development

The layout of geographical spatial function intends to realize regional aggregation by gathering resources in adjacent small and medium-sized cities, and jointly using limited resources to develop main functional zones. In real practice, the authority shall explore how to plan and optimize residence zone, business service zone, industry expansion zone, modern agricultural zone, ecological zone (restricted development area), prohibited development zone (dotted distribution) and other functional zones, divide functional zone boundary and push forward the development across administrative planning.

4.2.3 Industrial planning integration: leading industry forms "polarization-diffusion" effects

Urban center is usually referred to as the growth pole in a region, and likewise, the area subject to urban center industry planning cohesion and radiation is referred to as the "polarization area". Production factors in areas near to the growth pole flow to the growth pole. As the growth pole constantly reinforces its economic power, it also reinforces radiation and diffusion effects. Once such diffusion effects break out the boundary between administrative divisions, there will arise conflicts and contradictions between polarization and diffusion. The city can take urban center as the growth pole and exert its "polarization-diffusion" effects on peripheral areas via the industry planning integration across administration divisions, thus facilitating the diffusion of production factors from growth pole to peripheral areas and the regression of peripheral growth to center area.

4.2.4 Infrastructure integration: axial association function of transportation, communication and other infrastructure

Together with the progressive growth of economic center's appeal, the exchange of production factors between point and point depends on the axis association role of transportation lines, power supply lines, and water supply lines. Such axis primarily serves regional growth pole, but it still has strong appeal to latent population and industry. When population and industry automatically gather alongside the axis, there will appear new growth points. The point-axis intersection forms the basis of multi-center radiation-association model.

5 CONCLUSION AND DISCUSSION

On the whole, urban layer structure is more prominent in the industrialization age. To some extent, it forms the layer structure in different functional zones to improve industrialization efficiency. In post-industrialization age, there is just one way to urban sustainability - layer integration.

First of all, the theory assumes the formation of a layer integrated development complex. The development of urban space form should dare to break up the "single center" inertial thinking, and replace it with the "multi-center" urban space development framework, form "polarization-diffusion" effects in multi-center radiation and finally realize the integrated development between urban center and peripheral areas. For instance, the "triple-center" urban space form

formed by “Beijing-Tianjin-Xiongan” triangle framework makes for the derivation and development of new forms in large urban space.

Secondly, the city should practise and explore multi-center radiation-association mode. The first step is to break up inertial thinking to realize conceptual integration, redefine city system, gradually weaken layering concept, and abandon layering concept in urban planning. Secondly, it is necessary to realize the integrated development of spatial functions, gather areas in geographical space layout, integrate adjacent cohesive resources, and jointly use limited resources to develop main functional zones. The next step is to ensure full flow of factors in industral planning and form “polarization-diffusion effects” in urban center. When production factors gather in urban center growth poles, the polarization effects of growth poles will be reinforced, and also its radiation and diffusion effects on peripheral areas. Finally, the city should enhance the axial association of infrastructure and raise production factor flow efficiency, such as forming an axis between road, water, power and other infrastructure. New regional growth points emerge when population and industry automatically gather alongside the axis. The multi-center radiation-association mode will be created on the basis of smooth point-axis intersection.

Admittedly, considering the technical development trend in future society, such as the influence of new technologies represented by AI and unmanned driving on transportation, education, medical treatment and emerging industries, urban spatial form will also experience drastic changes. Prior to quantum transportation, urban spatial form is still constrained by geographical from and spatial layout, and the city should still make optimal layout by spatial optimization and space-time compression. Under such circumstances, circle is unquestionably one of the best choices, but internal layer space-time will be integrated as a whole.

COMPETING INTERESTS

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AUTHOR CONTRIBUTIONS

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