

Track 12; Healthy City Planning: Food, Physical activity and Social justice

Research of an Indicators System for the Compact Urban Form based on the Healthy City Criteria

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Abstract: The compact city theory develops different connotations in different eras. In the information age, the way people live has changed, which leads to the reconstruction of urban functions and forms, and therefore it is necessary to develop the compact city theory accordingly. This thesis firstly reviews the development history of compact city theory in different eras, and then explores the impact of information age on urban functions and forms, and considers that living space of people has changed from real physical space to physical space integrated with virtual network space in the information age. Finally, it is concluded that function division in the future city will be more blurred, land use will be more compatible and mixed, and the city's structure develops from single center to multi-center or homogeneous center network, based on which new measurement index for compact city is proposed to measure compactness of city in the information age.

Key words: compact city, virtual network space, urban form, Internet

1.Introduction

China has a huge population of Internet users. The 43th Statistical Report on Internet Development in China issued by China Internet Network Information Center (CNNIC) shows that as of December 2018, China has 829 million web users, with the penetration rate of 59.6%, and has 871 million mobile-phone subscribers, with internet access rate by mobile phone of 98.6%. The rapid development of Internet and related information technology industry has brought new changes and experiences to the life of citizens. Working is not limited in physical space and video conference becomes quite common. Due to rapid development of e-commerce, citizens can directly buy goods and meals in any store in the city through APP, and these goods and meals can be delivered to them within half an hour. In addition, citizens can directly pay the phone bill, Internet access fee, and water and electricity charges online with mobile phone, and it is unnecessary to go to the business office. Information network technology helps citizens

to break through the constraints of physical space and influences the distribution of traditional urban functions. Since urban form is undoubtedly the most direct reflection of social conditions in urban space, existing study of urban form is not suitable to cities in the new era and new explorations should be proposed.

2 Development History of Compact City Theory

2.1 Origin and Development of Compact City Theory

2.1.1 Origin of Compact City Theory: Industrial Revolution

After the second industrial revolution, internal combustion engine fueled by gas and gasoline occurred and automobile became popular vehicle for the public. Convenient traffic has greatly changed the way people live, promoting communications between people and enlarging the scope of activities of people. After the 1950s, automobile became the popular vehicle for the public and cities developed into transport-oriented pattern from small, crowded classical city. It also brought negative effects, such as sprawl and blind expansion of city, low-efficient land use in suburb, decline of downtown, repeated construction of municipal facilities such as roads and plumbing pipelines in new area. People began to learn how to face and solve these new problems.

In 1973, George B. Dantzi and T.L. Saaty wrote *Compactcity: Aplanfora Liveable Urhan Environment*, and in the same year, he explained the theory of compact city in the lecture of *The ORSA New Orleans Address on Compact City*. He proposed to achieve concentrated construction of urban infrastructure by controlling the size of city and increasing population density and reduce the use of cars by automatic transport system covering the whole city, which can be considered as pioneer of compact city theory.

2.1.2 Development of Compact City Theory: Impact based on Sustainable Development Concept

Since the middle of the last century, urban environmental problems have been worsening, and a series of problems such as resource crisis and land desertification began to threaten human survival. In 1987, the world commission on environment and development first elaborated the concept of sustainable development in its report "our common future", which has gained broad consensus from the international community.

Under the background of sustainable development, the European Community Commission issued the *Green Book of Urban Environment* in 1990, which regarded compact city as "a solution to residential and environmental problems" and considered compact city as a sustainable urban form (European Commission,1990). After that, "compact city" has become the focus of many western urban planning and research of scholars, gradually changing from a vague idea to a theoretical system with certain depth, and is regarded as the thought and principle of urban planning by many cities and scholars.

2.2 Connotation and Framework of Contemporary Compact City Concept

The theory of compact city is an urban planning theory of urban sustainable development strategy and a systematic urban space construction method proposed in the process of

contemporary urban development aiming at a series of environmental, economic and social problems caused by urban sprawl (Jun JIN,2017). Up till now, unified definition of compact city hasn't been proposed. From the understanding of domestic and foreign scholars of the concept of compact, mixed-used urban functions (Chuanglin FANG,2007), intensive urban form (Wei LANG,2017)and high urban density (Lin LI,2012) are the consensus of domestic and foreign scholars about the compact city theory, also the study of compact city is mainly conducted around the functional structure of city and spatial form.

3 Urban Space under Impact of Information Age

In the context of the information age, the influence of the Internet on cities can be roughly divided into the following two aspects. (1) the rapid development of Internet information technology and related industries has changed the lifestyle of urban residents. As the main carrier of human activities, the huge changes in urban residents' production and life will inevitably lead to the reconstruction of urban functions and forms. (2) the "virtual space" formed by the Internet is interwoven with the geographical space of the real city, which influences and promotes each other and forms an informationized city under the background of the new era.

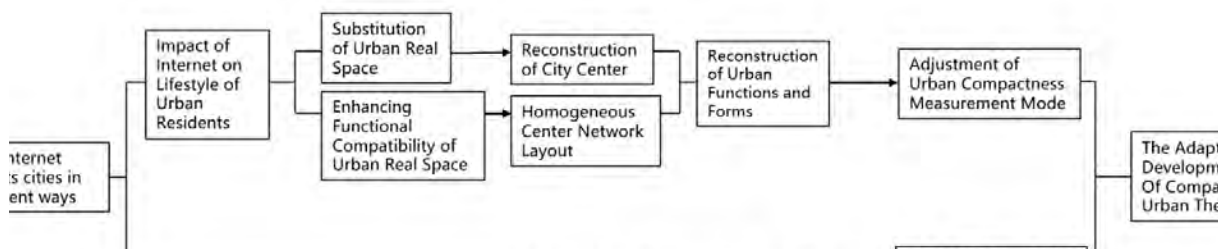


Figure 1 Concept map

3.1 Impact of Internet on Lifestyle of Urban Residents

The biggest impact of network information technology to the lifestyle of urban residents is that the "virtual space" which is formed by it is distinctly different from traditional physical space defined by entity, distance and the boundary. It specifically refers to the online virtual information space built by human by virtue of information media internet based on integration of many technologies, and its virtuality, instantaneity and interaction is transformative (Yaoyu LIN and Jiaming WU,2010). The impact on the life and work of urban residents mainly includes the following two aspects:

3.1.1 Substitution of Urban Real Space

The virtual network space has intense substitution effect to partial reality spaces in cities. Namely, partial of original pedestrian flows may realize through the virtual network space. The substitutable pedestrian flows have the inevitability of non-face-to-face communication and the network performability of behavior activities. In real life, a lot of pedestrian flows can be realized through virtual network spaces. For example, WeChat group and QQ group can be

regarded as the transfer of physical space for friends to meet and chat in the real world into the virtual space. Internet shopping platforms such as Taobao and JD can be regarded as the transfer of real shopping malls and supermarkets into virtual space. Similarly, the opening of online payment for urban public services such as mobile phone bills and utility bills can also be regarded as a substitute for the traditional public service spaces.

3.1.2 Enhancing Functional Compatibility of Urban Real Space

Traditional urban physical functions are divided into four major categories: residence, work, recreation and transportation. Under the background of informatization, hidebound classification and layout are abandoned by traditional physical functions in cities, which develop towards mutual compatibility and function integration. Production domain and current domain blend gradually, and living space and working space are compatible. For example, integrating working and living, SOHO (home office) mode rises mainly due to the development of network information technology. Further mixing of various leisure and entertainment spaces in cities is also the trend of urban development in the information age. For example, a large number of complex buildings integrating retail, leisure and culture appear in cities.

3.2 Reconstruction of Urban Functions and Forms

3.2.1 Reconstruction of City Center

Functions of traditional city center are mainly concentrated on retail, entertainment and office. Basically, difference of center level could be regarded as difference of commodity and entertainment quality and level. However, with rapid development of e-commerce and improvement of commodity and service capability provided by e-commerce, daily demands of citizens are beginning to be gradually replaced by internet, and their travel purpose will also be changed. Initially, internet weakens citizens' demands for going out to purchase daily articles and clothes. Later, they purchase home appliances and mobile phones at home. Now, they are even able to book three meals a day, nail beauty and physical therapy services at home. It means that certain demands that could not be replaced by internet, such as sports, education and outdoor activities, will become main travelling purposes of citizens. Functional focus of city center will shift towards personal experience program. Proportion of traditional retail and entertainment programs will be decreased, and such programs shall be shifted to high quality experience program, such as brand flagship stores, large stadiums, theaters, and large park green spaces that pay attention to personal experience.

3.2.2 City Developments From Single Center Towards Homogeneous Center Network Layout

Considering that great increase of compatibility of urban functional spaces leads to mutual mixing and complementation of residential district, business district, office district and sci-tech park, city layout tends to present multi-center network form and city expansion towards peripheral areas also presents multi-polarization composite development trend. With support of advanced telecommunication and transportation network, business activities in the city will be more scattered spatially in information age, and urban space structure will be gradually

developed towards balanced and scattered direction, and be shifted from single center to multi-center and later networked open space structure.

3.3 Duality of City in Information Age

Original urban physical space is interwoven with virtual space formed by information network. However, there is a certain degree of separation between the two types of spaces. The people therefore have dual identities, namely the citizens and the netizens, and the city itself has many expressions of the two different forms, namely street network and internet, physical store and online store, physical bank and online bank, hospital and remoted medical service platform, stock exchange and electronic transaction system, physical site work and online work. New information network space, and physical urban spaces formed by bricks, concrete and rebar coexist and complement with each other, presenting unique “dualized city” feature of information society.

4 Adaptation of Compact City Theory to City in Information Age

According to the influence of the Internet on cities in the information age, the theory of compact city should be developed and optimized accordingly.

4.1 Adjustment of Urban Compactness Measurement Mode

From the perspective of city planning, functional compactness of city is to configure and organize urban functions stipulated in master plan of the city. In current city development, scientific and reasonable planning requires arrangement of main city functions in different zones as per master plan of the city. Different urban area undertakes certain main city function. Previous functional compactness of compact city mainly refers to overall functional mixing in city level or highly functional compactness in certain urban area, such as downtown area.

Internet increases functional compatibility of urban spaces and obscures original functional zoning concept of city. Compatibility of production and logistics areas (retail space) of the city will become more and more prominent. Boundary and spatial concept of work, entertainment, living and leisure areas will be more obscured. Most urban functional spaces will be shifted to present interdependence and integrated development relationship (Zhongwei SUN,2007). Highly functional compactness of the city and blocks will be developed towards more micro direction, viz. create one space that could satisfy multiple demands, such as living, work and leisure demands at the same time.

4.2 Add The Measure Of The Virtual Space Of The Internet

The city under the information age is composed of real space and virtual space. The transformation of urban residents' lifestyle from traditional reality mode to reality and virtual integrated mode is the root of change. The virtual space breaks the concept and connotation of the traditional urban space, and complements and competes with the existing material space piled up by bricks, concrete and steel to form a new urban space, replacing some cities and their building space. The urban area is expanded in an intelligent way, with higher space efficiency and stronger comprehensiveness (Le CHE and Zhiqiang WU,2015).

The virtual space formed based on information technology saves a lot of physical space, but makes the city more compact and efficient. In the real world, the virtual space is not visually expressed and is imperceptible. However, in the study of the compactness of the city, this part of the “space” has a great impact on the city, particularly, the relevant measure of the city compactness. .

4.3 Preliminary Assumption on Measurement Index of Compact City

4.3.1 Mobile 2-dimensional Code Transaction Volume Per Unit Area

According to the 2018 Mobile Internet Payment Security Survey Report issued by China UnionPay, 570 million people in China use mobile phones to pay at present. Of the 100,000 questionnaires, 82% respondents have used mobile payment, which is much higher than fast payment and E-bank payment. Therefore, it is reasonable to use the relevant data of mobile payment as the coupling point between the virtual space of the Internet and the real world. The report also shows that 2-dimensional code payment has accounted for 70% of mobile payment, covering almost all types of mobile payment. By analyzing the transaction volume big data of the 2-dimensional code payment, it can indirectly reflect the usage amount of the Internet virtual space in a certain area, and provide basic data support for the compactness measurement of the virtual space.

The calculation formula is

$$D = \frac{Qc}{A}$$

D—Density of qr code trading volume

Qc—Qr code trading volume

A— The area of the area to be measured

4.3.2 Mobile APP Downloading Volume and Diversity Per Unit Area

Different APPs can provide different types of Internet services, which indirectly reflect the impact of virtual space on the real world. For instance, by analyzing the downloading volume of instant delivery and meal delivery APPs (such as Ele.me, Meituan, etc.), it can reflect the compatibility of catering and other functional spaces in urban commerce; by analyzing the downloading volume of online shopping APPs (such as Taobao, JD, etc.), it can reflect the compatibility of urban commerce and the other functional spaces; according to the downloading volume of real-time communication APPs (WeChat, mobile QQ, etc.) that breaks through the interpersonal isolation of physical space, it can reflect the real-time communication degree of the urban residents of certain areas in the Internet virtual space.

The calculation formula is

$$I = \frac{Ains}{A}$$

I—A certain type of APP installation density

A_{ins}— A certain type of APP installed

A—the area of the area to be measured

$$V = \frac{\sum x^m}{N} \quad (m < x)$$

V— The diversity of APP

m—Types of apps owned by a single user

x—Total APP type

N—Total number of respondents

5 Conclusions

In the information age, the post-human living space has realized the transformation from the real physical space to the spatial mode of the virtual space of the network and the real physical space integrated. The thinking mode of the researchers, planners and managers also needs to change from reality to semi-realistic and semi-virtual mode. Moreover, we shall also pay close attention to the development trend of modern information technology, so as to control the direction of urban development and planning.

The compact city theory has developed under the different background of different times. As Castells (2001) said, "the expression form of architectural space changes with the rise of informational cities. In the next few years, architecture and design are likely to be redefined in terms of form, function, process and value. " The advancement of information technology and the popularity of Internet have changed the lifestyle and give us new insights and reflections on the changed urban spatial form and the virtual space that cannot be directly observed in real space. Therefore, the adaptive development of compact urban theory is a matter of course.

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Reference :

EC/European Commission, Environment (1990) Green paper on the Urban Environment , COM (1990) 218 final ,p20-22.

George B D. The Orsa new Orleans address on compact city [J]. Management Science (pre-1986), 1973, 19(10). ABI/INFORM Global.

Manuel Castells, *The Rise Of The Network Society* [M] . XIA Zhujiu trans, BeiJing : social sciences academic press(CHINA), 2001: 512.

Le CHE, Zhiqiang WU, Xiaobing DENG.A Research on Spatial Changes in the Perspectives of the



- Knowledge Economy and Ecological Sustainability [J] . Urban Planning Forum, 2015(4) : 20-26.
- Chuanglin FANG, Welfeng QI. Research Progress and Thinking of Compact City and Its Measurement Methods [J]. Urban Planning Forum, 2007(04):65-73.
- Jun JIN. The Morphology Theory And Spatial Measurement Of Compact City In China [M].Nanjing : Southeast University Press, 2017 : p50.
- Wei LANG, Christopher John Webster. Urban Vitality in Compact Cities: Seeing Hong Kong Through Kelvin Lynch's Lens [J]. Urban Planning International,2017 ,32(03):28-33.
- Lin LI, Xinpei Huang. The Research on Compactness Based on Analyzing the Meaning of“ Compact”: Constructing the System of Concepts and Indexes for“ Compactness”[J]. Urban Planning International,2012,27(01):33-43.
- Yaoyu LIN, Jiaming WU. Analysis Of International Practice Of Low-Carbon City [J]. Urban Planning International,2010,25(01):121-124.
- Yalong MAO, Jingtang HE.Study on City Function Position of Urumqi City and Approach [J].Urban Studies, 2009, (10) : 49-54.
- Zhongwei SUN. The Geography of Cyberspace: Review and Prospect [J]. Advances in Earth Science,2007(10):1005-1011.