INTENSITY CONTROL IN MIXED-USED NEW URBAN AREA: A CASE STUDY OF THE WATERFRONT IN XIASHA, HANGZHOU

Zhou Yinan*&Hua Chen**

*Department of Urban Planning and Design, Zhejiang University, 310058, Hangzhou, P.R.China,
sincia@zju.edu.cn
**Department of Architecture, Zhejiang University, 310058, Hangzhou, P.R.China,
huachen1212@zju.edu.cn

ABSTRACT: With the rapid and in-depth growth of urbanization in China, effective planning control is particularly important, especially in new urban areas. From the perspective of location efficiency, regional coordination, mixed use and market operation, this paper establishes an intensity control model for mixed-used new urban area through intensity zoning, index determination, index refinement and flexible implementation. This model is then applied to the case study —the waterfront in Xiasha, which is a typical new urban area in Hangzhou. The model has achieved initial success, providing a new design strategy for shaping an energetic, orderly and harmonious urban form with local identity, but it is still need to be improved to clear whether the strategic goals are reached.

KEY WORDS: new urban area; mixed-use; development intensity; model

1 INTRODUCTION

Since mid-1990s, the level of urbanization in China has constantly improved, the urban constructions have conducted unprecedented activities. On the one hand, urban scale is being enlarged considerably, in terms of rapid increase of urban population, high-speed of spatial expansion, and constant breakthrough in the building height, which due to the impact of the market mechanism. On the other hand, with the successful establishments of Jinmao Tower[1] and Xintiandi project in Shanghai[2], mixed-use development has become an important planning paradigm, so as to introduce more variety and vitality into urban fabric. All these rapid and in-depth changes have not only led to the drastic changes in urban image, but also opened up some new issues on urban planning and management. For instance, many cities set up various development zones in urban fringe by way of soliciting business affairs and inviting investment, or establish a new city zone by the relocation of administrative center to create a “great modern city”. While all these zones have some common problems, like large block scale, single function and inefficient land use. Conversely, in inner city, spontaneous mixed use always leads to functional hybrid, which influences people's daily life seriously because of its functional disorder, crowded living, high density and inadequate infrastructure. Lack of control is always a problem through, thus, it is imperative to take effective planning control during the process of urban development.

In this paper, we will establish an intensity control model to guide new urban area into a healthy and sustainable way. Intensity control is a relatively frontier in China. Perhaps the most detailed study was carried out by Tang Zilai (2003), who established urban density zoning system from three levels, macro, medium and micro, in Shenzhen based on the microeconomics theory. Yao Yahui (2007) conducted a practical application in Chengdu to provide a method of architectural forms zoning through urban

[1] Jinmao Tower: the 88-storey tower with 420.5 meters high, integrates modern office, five-star hotel, commercial exhibition, high-end dinner, sightseeing, entertainment, shopping malls and other facilities in one building.

[2] Xintiandi: Integrate dining, business, entertainment, leisure and culture walking street in a set of traditional buildings of Shikumen.

construction quantity control and land suitability evaluation. Liu Lijun (2008) investigated the way in spatial structure of urban economy, broadening the application fields of urban density zoning. Huang Minghua (2009) enriched the connotation of intensity zoning by presenting the concept in small cities from both efficiency and equity and the technical route of the plan. These researches, urban density study of single function, depend on macroscopical means of space structure, site selection and economic analysis of land use in the stage of master plan and regulatory plan. Obviously, it is not enough, we must develop and apply a technical method of intensity control in new urban area to match the widespread use of mixed use during the stage of urban design.

2 MODEL OF INTENSITY CONTROL IN NEW URBAN AREA

2.1 Intensity zoning—location efficiency

Depending on the guideline of microeconomics theory, intensity zoning should be efficiency oriented in the location. It divides the urban space into several benchmark density zones with Delphi method and GIS technology platform, according to the locational analysis of traffic (e.g., urban railway system and arterial roads), service (e.g., central business center) and environment (e.g., public green space).

The intensity zones designate such regulations as floor area ratio and other supporting provisions which are subject to intensity zoning categories. These regulations are both benefit to create an orderly image of the city and be easy in practice.

However, intensity zoning is not a panacea, especially in a new, small-scale and less certain urban district, which has common characteristics in location condition, primarily up to plan. Thus, we need to use modificatory criteria to supplement the basic zoning.

2.2 Intensity index—regional coordination

The most important contribution rendered by the medieval city is its overall image (see Fig.1). “Urban space and scale are interconnected with each other”; “City appears to be a continuum”. It is reflected in the similarity of its urban density, floating within the scope of 5%.

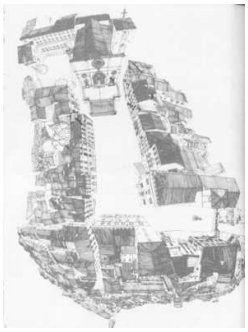


Figure 1 Overall image of the medieval city
Source: Edmund N.Bacon, "Design of Cities: Revised Edition", New York, Penguin Books, 1976.

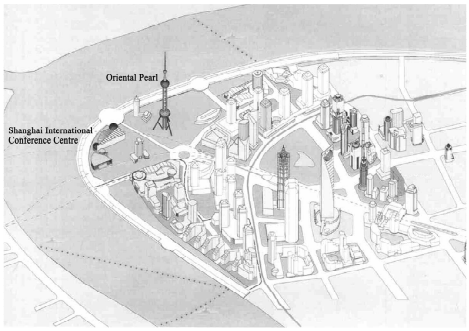


Figure 2 Space form of Lujiazui central district
Source: Li Daxia, "On Shanghai Stock Exchange Building", Time Architecture, No. 1 (2000), pp.38-41.

Judging from the China’s situation today, it is difficult to ensure the integrality and continuity of the city image. The overall image of the city often relies on a collection of evaluation results on single block construction projects made by the experts. This may influence the molding of urban spatial environment to a certain extent. Take waterfront public space of Huangpu River in Shanghai as an example (see Fig.2), building massing and border surface contrast sharply on both banks of the river, which weakens the integrity of the waterfront space. And the unrelated groups of buildings standing in Pudong further affect the coordination of the district. Shanghai International Conference Centre treated as ‘Gold Medal’ by the public, has attracted several disputes about the relationships between the building and its surrounding. It is argued that the building is a misfit in the whole environment, because of the disharmony architectural form and dimension.

Regional coordination is probably an important guideline to skim over the interrelation of the parts (new

urban areas and the existing one) into a whole. In such a whole, arrangement of spaces and intensity of the development would prepare for the districts, and sustain it over areas of metropolitan scale. But this is not to say that the image should be the same in each case.

2.3 Index refinement—mixed-use

Mixed-use is the practice of allowing more than one type of use in a certain space or a certain time. On the basis of Erik Louw's research(2005), we can develop a typology for mixed land use from a spatial perspective and represent four dimensions (see Fig.3):(I) the shared premise dimension, which refers to multifunctional use at a particular point, i.e. premises in a building or dwelling used by one household, (II) the horizontal dimension, i.e. mixed-use between buildings on the flat surface, (III) the vertical dimension, land uses are vertically mixed by building two or more functions above each other, a well-known example being housing over shops, (IV) the time dimension, when a particular space is used by two or more functions after each other, for example, a school can be used as a community centre in the evening and a theatre can be used for conferences during the daytime and as a cinema in the evening. All these dimensions have much to do with urban development intensity. Thus, we transform various influential mixed-use dimensions into corresponding mathematic models to refine the intensity index.

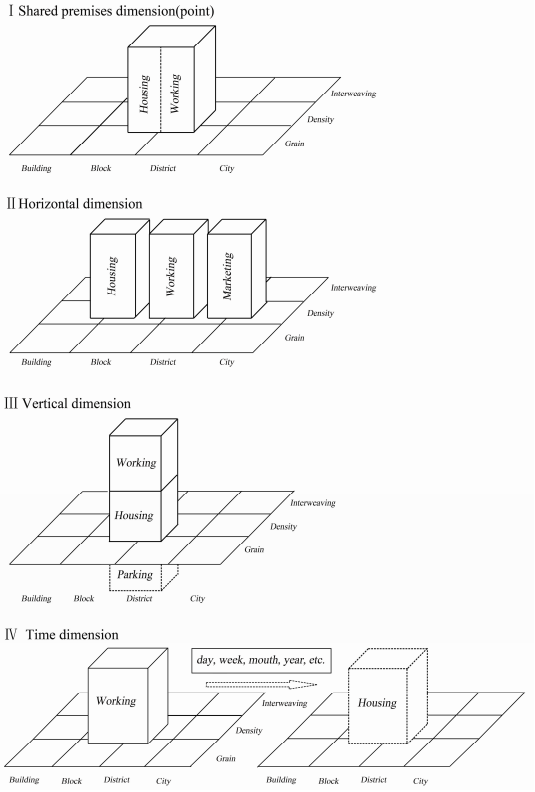


Figure 3 A conceptual model of mixed land use for four dimensions

Source: Eric Hoppenbrouwer & Erik Louw, "Mixed-use Development: Theory and Practice in Amsterdam's Eastern Docklands", European Planning Studies.No.7(2005)（7）

Before detailing the index of development intensity, mathematic models of different relationships between mixed-use dimension and urban density are given. When we focus on the functions of housing (residence), marketing (commerce) and working (industry), it is clear that these functions can be mixed in various ways at different spatial scales and at different times. They, the three primary functions in city life, have decisive influence over urban development intensity.

Supposed that a block is used to single-function development (housing, working or marketing, respectively), the determined floor area ratio (FAR, an important index to reflect the intensity of land use) is denoted by f_1, f_2 or f_3. When it comes to mixed-use, housing, working and marketing function take up a_1%, a_2% and a_3% of the total area. In addition, we record the total quantity of construction as Q, the total area as S and the mixed FAR as F. Thus:

Shared premise dimension: it is usually difficult to distinguish the proportion of each function, so we assumed that $a_1 = a_2 = a_3$. Thus,

$$F = a_1 f_1 + a_2 f_2 + a_3 f_3 \tag{1}$$

Horizontal dimension: according to the functions of various buildings, we divide the block into three small ones, occupying a ground space of S_1, S_2 and S_3. Thus,

$$F = \frac{Q}{S} = \frac{Q}{s_1 + s_2 + s_3} = \frac{Q}{\frac{Qa_1}{f_1} + \frac{Qa_2}{f_2} + \frac{Qa_3}{f_3}} = \frac{1}{\frac{a_1}{f_1} + \frac{a_2}{f_2} + \frac{a_3}{f_3}} \tag{2}$$

Vertical dimension: It is reasonable to introduce the reduction factor (k, k≤1) into vertical dimension, which is largely affected by building height restriction. Thus,

$$F = k\frac{Q}{S} = k\frac{Q(a_1 + a_2 + a_3)}{S} = k(\frac{Qa_1}{S} + \frac{Qa_2}{S} + \frac{Qa_3}{S}) = k(f_1 + f_2 + f_3) \quad (3)$$

Time dimension: In this context, we should control the development intensity based on the maximum FAR among each single-function using. A house, for instance, where over 24 hours one lives and works can be measured the same intensity as single working used (when $f_1 < f_2$).

2.4 Flexible implementation—market operation

As well as a policy of public participation, flexible planning forms part of a strategy for reasonable planning, which offers multiple options for such a changing, complex society in a market economy. Hong Kong with territory and high conglomeration of population provides useful reference in this regard: differentiated control principles and standards are adopted for different land uses and site locations, i.e., residential uses apply hierarchical control, the highest plot ratios are different in metro area, new town and rural areas. While look at the negative intensity control in China today, it set a ceiling on development intensity, lacking flexibility and easy to be broken through.

New urban area adopted the policy of mixed-use, is the conflicting interests of the government, the public and the developers. There are so much uncertainty and unpredictability that flexible implementation of development intensity, based on land feature, should be seen as an important instrument in planning management to adapt the current changeful market.

Land for public constructions should be controlled with lower limit to guarantee the public sharing; the profit ones should use upper bound guideline to avoid the market's passive affection of blind development; while the ones sharing the virtues of both sides can involve the control within a prescribed scope to active the market.

2.5 Summary of the model

We develop an intensity control model for mixed-use development in new urban area. First, with microeconomics theory of location as a guideline and Delphi method, GIS technology platform as techniques, we designate the development intensity division; Second, we roughly determine the index of development intensity in every zoning considering the surrounding and similar areas as references; Third, we transform various influential mixed-use dimensions into corresponding mathematic models and refine the intensity index. In addition, we present flexible implementation means basing on the land features and market operation (see Fig.3).

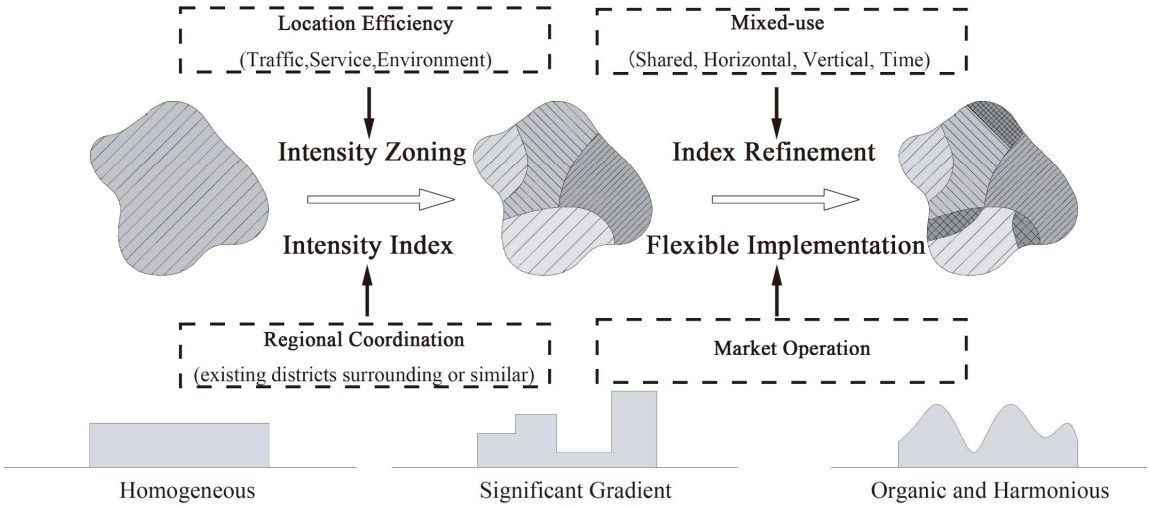


Figure 4 Model of density control in mixed-use urban area

The model takes full accounts of location efficiency, regional coordination, mixed-use development and changing demands according to the ever-diversifying reality. It is an essential breakthrough in the field of intensity control, compared with the former methods—FAR reduction method basing on land scale[3], FAR analysis on economics[4].

3 INTENSITY CONTROL IN CASE STUDY

3.1 The study area and its environs

Xiasha, a new urban area in Hangzhou, developed from Hangzhou Economic and Technological Development Zone, relying on the traditional town of Xiasha. It is a representative Chinese new town with double natures: historical evolution and supplementary construction.

Since the 21st century, with the expansion of administrative area and the development of social economy, strategy of Xiasha has changed from 'area built-up' to 'city construction'. Functionally, it converts to synthesization, rather than singleness; spatially, it shifts from outward expansion to internal optimization. All these request an intensive study on the degree of development scale and capacity, as well as urban form, so as to avoid the adverse consequences, like unlimited urban sprawl, inefficient land use and unsustainable development.

Adjacent to the famous Qiantang River, the waterfront of Xiasha is located at the southernmost of Xiasha, with a planning area of 470 ha. Considering the history and evolvement of Xiasha, we identify the study case's main functions as residential area, business area, culture area, pioneer park and sports area, according to characteristic and superiority of the area.

3.2 Development intensity zoning

[3] FAR reduction method based on land scale: FAR reduction focuses on the requirements of service facilities in residence. The bigger the block size is, the greater the degree of reduction is. The method may be not applicable to new urban area with mixed-used, where is more complex and uncertain.

[4] FAR analysis on economics: The best economic FAR and the minimum one is determined by the interaction between FAR and land value. While the land value is not exactly sure in new urban area, in which case, the method is inapplicable.

Figure 5 Urban density zoning based on the principle of efficiency

Under the guideline of location efficiency, zoning takes into the considerations of traffic, service facility and environment of the study project, and obtains the weighted value of key elements through the system analytic hierarchy process, with Delphi method.

The study project has favorable transportation, which can be judged from the different grades of the roads surrounding (weighted 0.25) and the distance to arterial road (weighted 0.2). Service facility based on the convenience of public services, due to the distance to the commercial center (weighted 0.3). Judgments concerning the environment location are focused on the ecological resources, such as wetland, inland river, the nearer the better (weighted 0.15). Of course, the negative effect of the sewage treatment plant on the west side cannot be ignored or wished away, which weighed 0.1. We weight the valuation for every element, based on the attracting radius of the corresponding factors, ranging from 1 to 5. On this basis, we designate the development intensity zones in descending order of density (see Fig.5).

3.3 Draft of intensity index

Started from the regional coordination, we study the intensity index of the project by reference of a surrounding project and a similar one.

The project surrounding: Jiusha Avenue. Jiusha Avenue runs through central district of Xiasha, where an appropriate adjustment made in accordance with the provisions of regulatory plan in the respect of FAR control. To harmonize with it, the study project must be conducted in concert with it.

The similar project: Qianjiang Century City. The 4.8km^2 Qianjiang Century City, Xiaoshan District, Hangzhou, opposite to Qianjiang New City in bund, has much in common with our study project, which will be developed into a new city center according to the plan. Studies show that Qianjiang Century City provides flexible indicators to offer an easy operation on the basis of district subdivision.

Based on the above comparisons (see Tab. 1), we roughly determine the index integrated with intensity zoning for different functional buildings in waterfront of Xiasha (see Tab.2). It is not surprising that mixed land use presents higher development intensity. While developed by a single-function, commerce represents the highest density, residence comes the second, culture and entertainment the lowest.

Table 1 Density control of similar plots

	Jiusha Avenue		Qianjiang Century City	
	FAR	BHR[5]	FAR	BHR
Residence		divide into six levels:5-20, 21-50, 51-80, 81-120, 121-160, 161-250, 5-20m for podium, 50m for culture and entertainment construction, 250m for landmark buildings, 80-160 for others	1.5，2.5	50
Commerce	5.0-5.5		3.5	50
Culture and Entertainment	2		1.6	24
Education and scientific research			3.5	80
Commerce/residence	2.2-4.5			
Administration/ Commerce	3		3.5，4.0	100,150
Commerce / Culture and Entertainment	3		3.0，3.5，4.0	50，80，150，250
Administration / Commerce / Culture and Entertainment			6	250

Table 2 Density control of waterfront area of Xiasha

		Zone Ⅰ	Zone Ⅱ	Zone Ⅲ	Zone Ⅳ	Zone Ⅴ
Residence	BHR	18	24	35	40	50
	FAR	1.2	1.6	2.4	3	3.5
Administration	BHR	18	24	50	80	150
	FAR	1.4	2.2	3.2	4.5	5.5
Commerce	BHR	18	24	50	160	250
	FAR	1.5	2.4	3.5	5	6
Culture and Entertainment	BHR	12	20	30	80	100
	FAR	1	1.2	1.4	1.8	2
Sports	BHR	12	20	30	40	50
	FAR	0.8	1	1.2	1.5	1.8

3.4 Refinement of the index

Mixed-use is the most prominent feature of the waterfront area of Xiasha (see Fig. 6), which must be given more attention. It is reasonable to refine the intensity index through various dimension models studied above (see Tab. 3).

[5] BHR：Building Height Restriction(m)

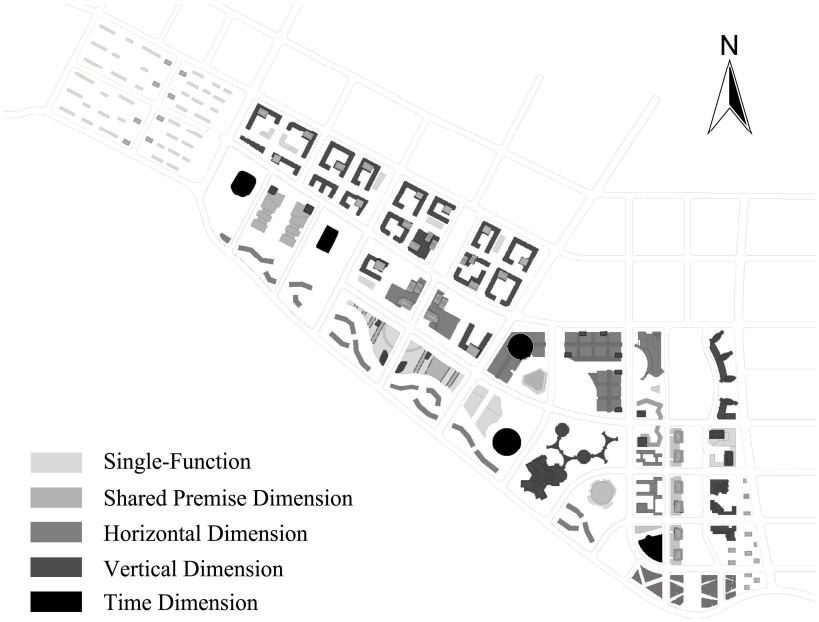
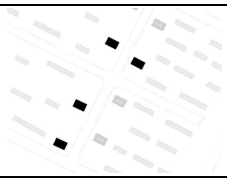
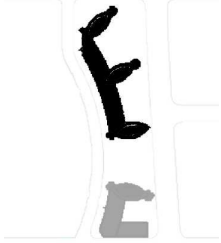
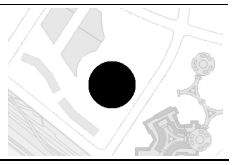


Figure 6 Different dimensions of mixed-use in Xiasha

Table 3 Illustration of density control for typical mixed-use block

	Description of a typical block	Proposed floor area ratio	Block diagram
Shared premise dimension	SOHO, Intensity Zone Ⅲ housing-working shared one, each accounting for 50%	according to FAR rules in Tab.2, as well as Formula Ⅰ,we can reach the conclusion that the proposed FAR is 2.8	
Horizontal dimension	Waterfront Landscape Construction, Intensity Zone Ⅲ, commerce-culture-sports mixed buildings in horizontal dimension, accounting for 55%, 35%and 10% respectively	according to FAR rules in Tab.2, as well as Formula Ⅱ,we can reach the conclusion that the proposed FAR is 2.0	
Vertical dimension	Business Centre，Intensity Zone Ⅳ, multi-function integrated in vertical dimension, such as official business(30%), hotel(40%), exhibition(5%), entertainment(15%), shopping center(10%)	according to FAR rules in Tab.2, as well as Formula Ⅲ,we can reach the conclusion that the proposed FAR is 6	

Time dimension	Conference and Exhibition Centre, Intensity Zone Ⅳ, be used as a cinema in the evening	according to FAR rules in Tab.2, the proposed FAR is in accordance with Culture and Entertainment use, assigned 1.8	

3.5 Control implementation

Because of the uncertainty of the rapid development, strategies of Xiasha must have flexibility and elasticity, shifting from the original plan-oriented administrative ones to the value-based ones orienting both plan and market, as well as the original concrete and rigid ones to the flexible ones with strong resilience. Therefore, the development intensity defined in the plan should be a flexible control under certain conditions to realize effective allocation of resources through marketing.

Building lands of waterfront in Xiasha fall into four primary categories based on the nature of constructions: residential sites for commodity houses, social ones for cultural and sports facilities, office-purpose ones like business office, entrepreneurship center and commercial ones like department stores and pubs. In the context of flexible implementation, the social benefit land can adopt the minimum control, the commercial and office-purpose land can adopt maximum control, the residential land, combining the properties of both social and economic functions, can be allowed to fluctuate 5% more since then to afford a scope for developers' choices.

4 CONCLUSIONS

After the lighting development of more than a decade, China's urban construction has shifted from quantity-oriented to quality-oriented. On the face of it, the key consideration of urban planning is how to provide an effective control strategy for the harmonious development of our society.

The study establishes a development intensity control model for mixed-use development in new urban area from the perspective of location efficiency, regional coordination, mixed use and market operation. Under the guideline of microeconomics theory, this paper designates the development intensity divisions with Delphi method and GIS technology. And then, it roughly determines the index of development intensity in every zoning considering the interrelated areas as references. Moreover, it refines the intensity index by corresponding mathematic models. In addition, the paper presents a flexible implementation mean for market operation.

The model has achieved initial success in the case study—the waterfront in Xiasha, a typical new urban area in Hangzhou, providing a new design strategy for shaping an energetic, orderly and harmonious urban form with local identity, but it is still need to be constantly reviewed and adjusted. In aspect of intensity zoning, the impacts of the elements and their weights need to be reconsider with the changing in social values; planning effect assessments of the alternative courses need to be carried out before the districts being used as reference samples in view of index determination; with respect of index refinement, the practical applications of the mathematical models are much worth further research, as well as the corresponding relations among function, mixed-use and density; and as for flexible implementation, it is necessary to integrate rigidity and elasticity, and compatibility of land use is also vital in flexible control. In general, control of development intensity is not a matter once and for all. It requires constant refinement to be really useful.

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