

Land Layout and Urban Design of New Cities in Underdeveloped Areas of China: A Case Study of Xixian New Area

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Abstract—China has experienced a very fast urbanization process in the past two decades. Due to the uncoordinated characteristics of regional development in China, a large number of people from rural areas or small towns have flooded into regional central cities, which are building new cities around them due to the shortage of construction land or the need for urban development. However, the construction of some new cities has not achieved the expected effect, the absorption capacity of industry and population is limited, and the phenomenon of capital and land waste is obvious. This paper takes Xixian New Area in Shaanxi Province, an inland area in Northwest China, as an example, and tries to analyze the reasons for the lack of vitality in Xixian New Area from the perspectives of land use layout and urban design. This paper will also select the Energy-Finance-Trade Start-up Area in Xixian New Area as an important research site, and study how to optimize the land use layout and urban design to ease the population of big cities, effectively solve the problems of big cities, improve the vitality and attractiveness of the new city, and promote the sustainable development of the new city. The study can provide reference for urban planning practitioners and policy makers, provide theoretical help for the construction of new cities in other underdeveloped regions of China, and provide certain case references for the construction of cities in other developing countries in the process of rapid urbanization.

Keywords—New city, land use layout, urban design, urban planning.

I. INTRODUCTION

LIKE many developing countries around the world, China has experienced rapid urbanization in the past four decades. China's urbanization rate has risen from 19.39% in 1980 to 63.89% in 2020 [1], and the influx of large numbers of people has led to the rapid expansion of the built-up areas of some cities. In recent years, China's urbanization process has been moving forward at an ever-increasing pace, and the rapid development pattern has brought about problems such as a drastic reduction in available urban space, constraints between industrial structure and urban layout, and rapid population expansion. In response to these problems, many cities have taken the approach of building new cities in order to improve the industrial structure, layout and space of the city, thereby alleviating the pressure of urban development faced by old cities [2].

Like many developed countries around the world, China's new cities have many problems. One of the main problems is

that the new city does not have enough ability to attract the expected residents to settle down, the whole region lacks vitality and attraction, and the uninhabited new city becomes an "empty city", which not only does not play the role of sharing the "heavy burden" of the central city, but also occupies the scarce land resources [3]. This phenomenon is very obvious in the less developed areas in the west of China. Therefore, this paper selects Xixian New Area, a national new area in the inland northwest of China, as the research object, and takes Xixian New Area Energy Finance and Trade Launching Area as the key research area, fully studies the crowd demand, planning concept, industrial development demand and the requirements of the upper planning for the new city, and formulates feasible planning suggestions to ensure the attractiveness of the new city, make full use of the regional resources, and help the new city to develop in a sustainable manner.

II. CONCEPTUAL INTERPRETATION

A. New City

Compared with the main city, the concept of new city refers to the area that is separated from the main city in space and has a complete city-type function group. It mainly falls into the following five categories: new districts formed due to the transformation of the main city and meeting the requirements of urban development strategy upgrading, new districts centered on key large-scale projects, new districts based on urban structure adjustment, new districts formed by urban expansion into the suburbs, and new districts based on the development of small towns.

B. Empty City

The term "empty city" refers to a phenomenon where there is a high vacancy rate of houses within a city due to an insufficient population to occupy them. This leads to the actual number of residents in the city being much lower than the city's planned capacity. An "empty city" does not necessarily mean completely uninhabited areas; it encompasses various urban elements such as buildings and roads. However, these cities are often characterized by a lack of vibrancy and vitality [1], [2].

At present, there is no definite standard for the classification of "empty city" in the world; it can be divided into the type of

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planning advanced or lagging, real estate type, disaster type and decline type [5]. The type of advanced planning means that the planning and construction far exceed the actual demand, the facilities cannot be fully utilized, and the resources are seriously wasted. The typical representative is Chenggong New City in Yunnan Province. Lag planning is the opposite of advanced planning, which refers to a city lacking in functions (such as only undertaking residential functions) and single planning. Beijing Huilongguan with insufficient commercial planning belongs to this type [6].

Most of the empty-city problems in the construction of new cities in China belong to the planning advanced type and the real estate type [7], and the Xixian New Area also belongs to these two types. Hence, this paper primarily analyzes these two types, specifically focusing on the study of new cities characterized by the wastage of urban facilities and resources, a high housing vacancy rate, and a lack of vitality due to the

failure to reach the expected resident count.

III. THE OBJECT OF STUDY

A. Overview of EFTSA (Energy-Finance-Trade Start-up Area) in Xixian New Area

Xixian New Area is located between Xi'an and Xianyang, Shaanxi Province, China (Fig. 1). It covers an area of 882 km² with a total urban and rural construction land of 360 km², of which 272 km² are urban construction land. There are five cities: Airport New City, Jinghe New City, Qinhan New City, Fengxi New City and Fengdong New City. Among them, the EFTSA is an important development area of Xixian New Area, which is located in the north of Fengdong and Fengxi New City, facing Feng River to the west, Taiping River to the east, Weihe River to the north, Xi'an Ring Highway and Longhai Railway to the south, with an area of 17.3 km².

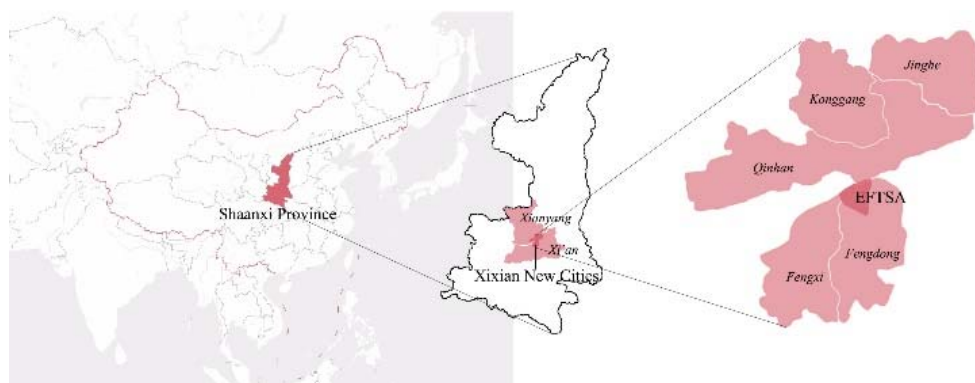


Fig. 1 Location analysis

B. Development Orientation

1) Overall Planning Level

In the master plan, the development of the EFTSA in Xixian New Area is positioned as a modern city led by science and technology, and the area is to build an ecological corridor of the Wei River and strengthen the new axis. In terms of industry, it is necessary to gather Silk Road international exchanges, education and scientific research, trade and finance industries. In terms of urban functions, it should carry the spatial development structure of the core area of Guanzhong Plain and build a new axis of modern Xi'an.

2) Zoning Planning Level

At the level of zoning planning, in terms of industry, the EFTSA will concentrate its resources on the development of high-tech and exhibition industries, with a focus on high-tech research and development and incubation, convention and exhibition business, sports, cultural tourism, real estate development, urban agriculture and other industries. In terms of urban functions, the EFTSA is one of the core sectors of the Guanzhong Metropolitan Area, playing a leading role in the Guanzhong Metropolitan Area. At the same time, as a national demonstration base, the EFTSA also undertakes the task of coordinating the reform of scientific and technological resources.

3) Summary of Positioning

The comprehensive master plan and zoning scheme for the energy trade and economic startup zone are outlined in the description. The startup zone is strategically positioned as a demonstration of science and technology leadership in development. In the future, industries will be centered around high-tech, trade, finance, real estate development, education, and scientific research. This will contribute to the construction of a modern new axis in Xi'an with a strong focus on maintaining a favorable ecological environment.

IV. SPATIAL STATUS OF EFTSA IN XIXIAN NEW AREA

A. Large Scale Block

At the beginning of construction, the EFTSA in Xixian New Area took into consideration the industry, regional functions and the needs of the target population, but the land layout was not scientific (for example, the distance between residential land and commercial land was too far away, and the location of commercial land could not cover the service radius it should contain) [2], resulting in too long travel distance and other problems. Buyers' short-range and convenient needs cannot be met. The impact of the small block and dense road network construction is also limited, as the eastern residential area still primarily consists of large blocks, and the quality of street

construction remains inadequate. Under such circumstances, many people only use the houses in the area as investment projects and do not live there, or only work in the area but still live in the main city. In either case, the pressure on the main city has not been lessened, and the traffic load between the new city and the central city has increased.

B. Large Scale Block

In order to promote urbanization development, the Shaanxi government has introduced a lot of relevant policies to attract investment. Given the substantial preferential benefits, a significant number of investors are rushing into real estate development projects within the EFTSA, resulting in a development model where new cities are primarily driven by real estate development without careful planning [6]. Although the industrial planning of EFTSA has considered the industrial cooperative development strategy with other new districts to a certain extent, as well as the industrial division of labor with Xi'an and Xianyang, in general, it lacks scientific demonstration and practical test. The effect of investment attraction in the completed zone has not reached the expectation. The lack of consideration of industrial structure at the beginning of the planning often leads to the appearance of industry loss and vicious competition of industrial homogeneity in the new city, which directly affects the employment opportunities of the new city. The poor employment environment cannot attract other workers to settle down in the new city.

C. Lack of Urban Functionality

This phenomenon is closely related to the previous one. In the construction of new cities starting from real estate development, a large number of residential buildings are built in the initial stage, but commercial and other industries are not considered. As a result, some new cities in China exist in a "sleeping city" mode similar to the initial construction of new cities in the West. The people living in the new city have to face the long-distance commuting caused by the lack of functions [1].

D. Lack of Urban Functionality

The problem of "empty city" in EFTSA may be due to insufficient consideration in the planning of supporting facilities. Although cultural, educational, commercial, entertainment, transportation, medical and other facilities are set up in the planning to meet the needs of residents' daily life, the planning of their quantity and distribution is lacking, resulting in the inability to form a convenient living circle in the region. The inconveniences in daily life significantly diminish the appeal of the new town to potential buyers, leading to a considerable number of vacant residences and an uninhabited state in the new town "empty city."

V. SPATIAL PLANNING AND URBAN DESIGN ANALYSIS BASED ON A THREE-DIMENSIONAL SYSTEM

A. Dimension 1: Needs of Residents

Based on the regional development orientation, industrial requirements and functional orientation of the upper planning,

we can roughly judge that the future expected types of residents in EFTSA may mainly fall into the following categories: (1) Practitioners of high-tech, trade and finance and other industries introduced in the region according to the upper planning; (2) the dependents of the practitioners in the above industries; (3) retirees who wish to settle in the region because of its ecological resources, educational resources and other advantages; (4) indigenous people in the region.

The basic needs of expected residents generally include: good quality of internal living environment and external landscape of residential buildings, perfect commercial, medical, entertainment, cultural and educational supporting facilities around the residential area, convenient public transportation and so on. The main needs of various types of residents are as follows:

1) Needs of Industry Practitioners

Most of these people are young, have higher income, have higher education, and have shorter commuting time, so they want to minimize the distance between work and home. In addition, this group of people generally has high requirements for the quality of housing and surrounding environment in the residential area, and hopes that the community can have an open, inclusive and diverse cultural atmosphere to meet their spiritual needs in addition to their basic needs. Simultaneously, since a substantial portion of individuals in this demographic is either facing or will face the prospect of starting families, it becomes essential to factor in the proximity to educational, healthcare, retirement, and other essential facilities [7], [8].

2) Needs of the Dependents and Retirees of Industrial Workers

The dependents of industrial practitioners analyzed here refer to individual professional personnel, whose needs are roughly the same as those of retirees, so they are classified as one type for analysis. Such groups are mainly husbands, wives, children and parents of practitioners. Therefore, in their living needs, emphasis is placed on kindergartens, primary and secondary schools and other facilities providing education for children, medical care and nursing services for the elderly, diversified community public space system for all ages, good community atmosphere and community relations [9].

3) The Needs of Indigenous Peoples

We expect to reserve a certain area of residential area for indigenous people who are willing to continue to live in this area in the planning. Before the development and construction of the indigenous people in this area, they mainly rely on farming or migrant work as their source of income. The basic housing needs of migrant workers are roughly the same as those of other types of residents. Most of them hope to continue to engage in farming or other low-skilled, non-intellectual work. Considering the lifestyle and economic situation of this group of people, unnecessary non-walking trips should be reduced as much as possible. Therefore, urban agricultural industry in the area near their residence can be considered to provide jobs for them and absorb labor force for the industry.

B. Dimension 2: Orientation of Industrial Development

Through the comparative analysis of the industrial types of the five cities in Xixian New Area, the vicious industrial competition between the five cities is avoided, the industrial linkage is formed, and an industrial system with misplaced development and prominent characteristics is established for the positioning of EFTSA. Based on the integration of energy resources development and energy finance in Shaanxi Province, the linkage of scientific and technological innovation industry and ecological scientific research industry has formed three core sectors. Guided by green finance and trade, the EFTSA can provide technical support, data storage services, energy storage technology support, and urban image publicity and display services for the other four cities in Xixian New Area. Within the EFTSA, the ecological scientific research industry can provide technical support for the innovation and technology industry, and the innovation and technology industry can provide data and technical services for the energy financial and trade industry, and the energy financial and trade industry can provide funds for the incubation of ecological scientific research and the transformation of results. This requires appropriate industrial zoning for the three major sectors, and strengthening the links between the three sectors.

C. Dimension 3: Trend and Hotspot Orientation

Low-carbon development is the future trend of urban development. Xixian New Area can make use of their latecomer advantage to make efforts in low-carbon industries and build low-carbon cities. The ecological scientific research industry can focus on the research and development of carbon sequestration and carbon reduction technologies, help the resource utilization of carbon dioxide break through the technical bottleneck, and the scientific and technological innovation industry can take low-carbon scientific and technological innovation as the main direction. Cities should also be planned and designed in the direction of reducing carbon emissions.

VI. LAND LAYOUT PLANNING AND URBAN DESIGN

A. Land Layout Planning Strategy

1) Group Layout

In view of the problems such as loss of urban vitality and pendulum traffic congestion caused by too clear functional zoning, the start-up area should consider the moderate decentralization of functions (Fig. 2 (a)), and divide functional areas based on industry. Each area should have independent and complete urban functions to form a cluster urban layout, and the groups should be divided by green spaces or main roads. Within the group, functions such as business and commercial areas, public service areas, and residential areas are divided, and interspersed with each other. Each function can form various levels of district-group-block level to meet various needs of residents.

2) Dense Road Network of Small Blocks

At present, there are a small number of Chinese traditional

large-scale blocks in EFTSA, each block is a large closed community, and the road system is mainly based on a single and sparse trunk road network, which is a typical urban model in the planned economy period. However, with the enhancement of China's economic activities and the expansion of the urban population, the urban problems caused by the traditional mode have become increasingly prominent. In recent years, China has proposed the urban model of dense road network with small blocks to increase the density of road network and alleviate traffic congestion (Fig. 2 (b)), to reduce the block area, increase the urban public space, and improve the vitality of the city.

3) Transit-Oriented Development

Problems such as traffic congestion, pollution intensification and high carbon emission caused by cars as the main means of transportation have received international attention. New Urbanism proposes a TOD model, that is, a subway station or bus station as the core, and a circular development within a 15-minute walk (Fig. 2 (c)). There should be a subway or intercity railroad linking Xi'an, Xianyang and Xixian New City. A complete public transportation system will be established among the various groups within EFTSA, and the three sectors will be connected by automatic driving lines. A variety of public transportation such as community buses and shared bicycles will be developed within the groups.

4) Perfect Green Space System

Two major water systems, namely, Feng River and Wei River, which meet in the north of the start-up area, shall protect the wetland ecological environment of Feng River and Wei River and protect the animal habitat by dividing the non-construction land. Multiple forms of green space such as point, line and plane shall be retained in the construction land (Fig. 2 (d)), and the green space inside the site and Feng River shall form a complete ecological corridor. A multi-level green space system of central park, group park, block green space and residential area green space shall be constructed, and linear green space shall be connected in series to form a complete park system.

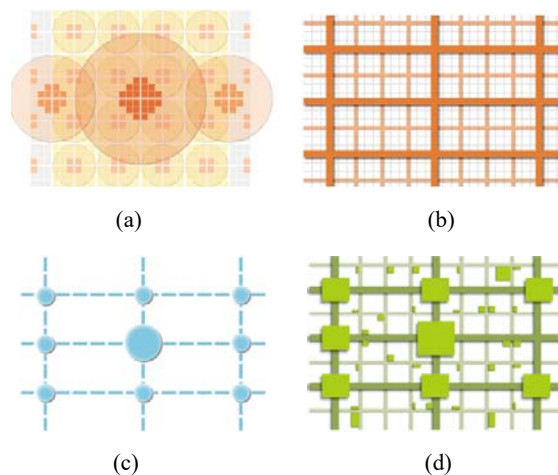


Fig. 2 Land layout planning strategy: (a) Group layout, (b) Dense network of small blocks, (c) Public transportation orientation, (d) Perfect green space system

B. Urban Design Strategy

1) Spatial Cohesion Strategy of Functional Districts

It is necessary to consider the spatial continuity between business, commercial, residential, park and other functions, and open up the slow corridor and sight corridor. It will help promote the integration of functional areas, increase the efficiency of crowd flow and enhance the vitality of the city. In the design of the business district, openings should be reserved in all directions to open up the channel between the business district and parks and businesses (Figs. 3 (a) and (c)), so as to

facilitate residents' commuting and daily leisure. At the same time, attention should be paid to the transition of the building volume of the business district to form a suitable D\H. The business district should be close to the business district and residential area (Fig. 3 (b)), adopt flexible building forms, increase the surface area of commercial buildings, enrich the space of urban streets, and make urban streets become social places. The residential area should establish a good connection with the park (Fig. 3 (d)), and play the role of the park's health and healing.

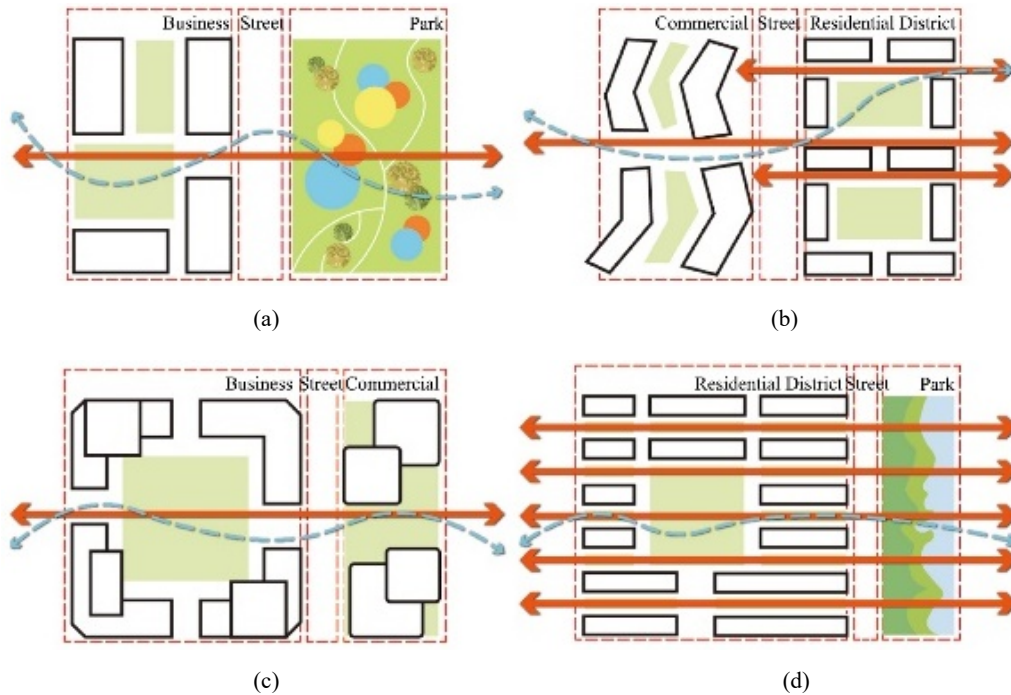


Fig. 3 Strengthening the connection of different functional areas: (a) Business district and park, (b) Business district and residential district, (c) Business district and commercial district, (d) Residential Areas and Parks

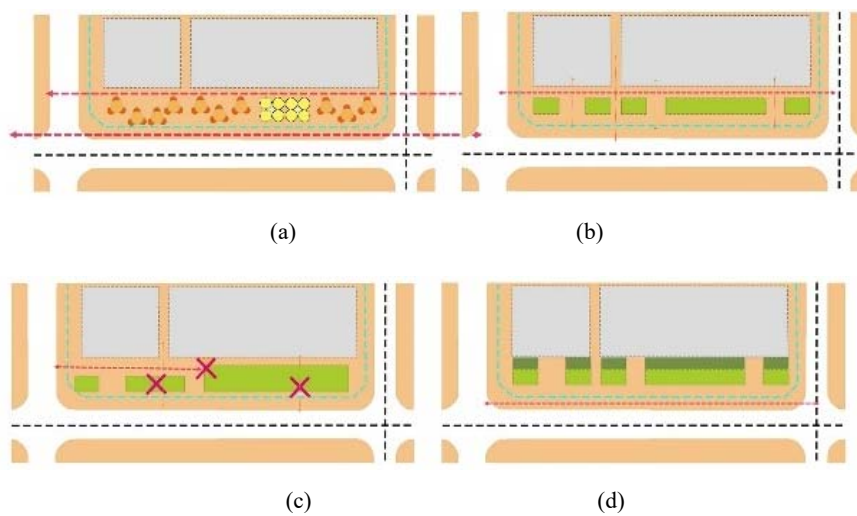


Fig. 4 Street design approach: (a) Commercial sidewalks, (b) Green dividers, (c) Free crossing, (d) Non-commercial streets

2) Street Space Strategy

Streets are the places where numerous citizen activities

unfold, often serving as the most vibrant public spaces within a city. In the past, many city managers paid insufficient attention

to street space, and many spontaneously formed street business places were banned, resulting in the gradual loss of street vitality. We encourage the establishment of tea houses or stalls at the commercial interface (Fig. 4 (a)) to enhance the vitality of the streets. In conjunction with the greening of roads, streets can be divided into active, green and passable areas, with free movement between them (Figs. 4 (b), (c)). In non-commercial streets, greening or graffiti can be adopted to reduce the negative impact of gray walls on people (Fig. 4 (d)).

3) Green Space Strategy

The Feng River ecological belt should prioritize the preservation of the original ecological matrix and undergo transformation with minimal costs, aiming to establish a waterfront country park that maximizes the natural ecosystem's regulatory impact on air, water, and soil. The agricultural ecosystem in suburban areas should be completely preserved, ecological agriculture should be developed, and the food supply function of the ecosystem should be brought into full play. Green spaces in urban centers should be combined with

surrounding functions to create spaces that serve the needs of more people. Green spaces within the business district should focus on creating social gathering areas while ensuring optimal exposure to sunlight. These green spaces must be designed with both aesthetic and functional considerations in mind, and they can also be integrated with various business activities. Residential green space should take into account privacy and security, but also pay attention to the residential area to green space accessibility.

4) Building Strategy

The building plan form should reduce the building enclosure and increase ventilation and sunlight (Fig. 5 (a)). The building plan forms adjacent to green spaces and commercial areas can be more diverse and increase the visibility of the landscape (Fig. 5 (b)). The building facades should be properly matched to create an undulating skyline, but to avoid excessive height difference (Fig. 5 (c)). The fifth façade of the building should be fully utilized to increase vertical greening and reduce building energy consumption.

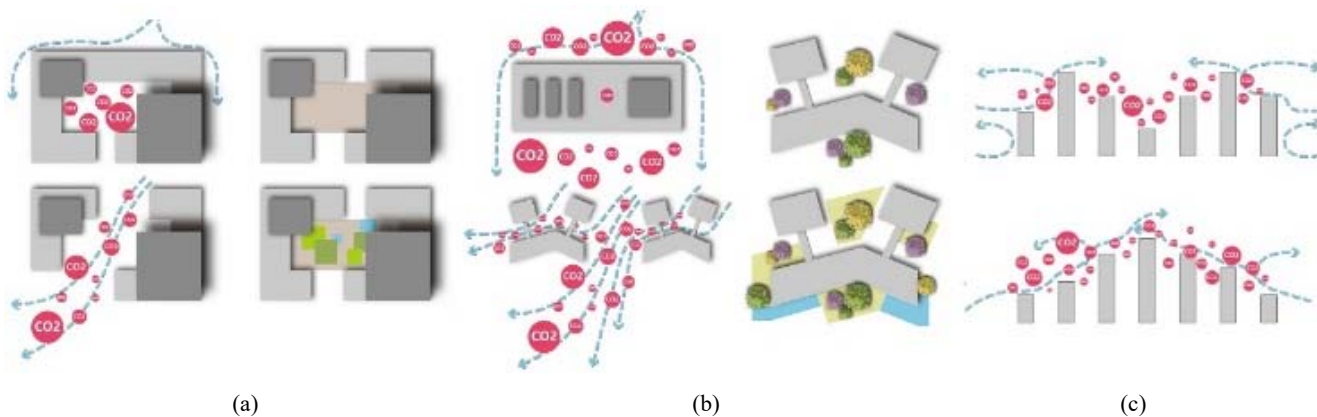


Fig. 5 Architectural design strategy: (a) Reduced containment, (b) Diversified plan, (c) Staggered skyline

VII. CONCLUSION

A. Enlightenment of Land Layout Planning

1) Residential Neighborhoods Adjacent to Business Districts

By altering the arrangement of the business and residential districts [10], a strategic blend can be achieved, ensuring a balanced proportion of both within a designated zone. This approach not only prevents the business district from becoming devoid of activity and less secure after working hours, but also adds to its liveliness. Additionally, it serves to reduce the commuting distance for employees residing in close proximity. It should be noted that when adopting this form of layout, we should deal with the problem of land proportion [9].

2) Scattered Layout of Residential Areas to Develop in a Diversified Way

The planning of all residential areas in a certain area and the formation of excessively large neighborhoods should be avoided. Instead, residential areas should be strategically distributed based on anticipated resident requirements and land utilization attributes within the region. The development of

diverse communities with varying types and focal points should be emphasized [11].

3) Improve the Supporting Facilities System and Build a Complete Living Circle at Different Levels

According to the needs of different functional areas, the supporting facilities should be planned according to local conditions [12], and at the same time, each part of the supporting facilities should form a complete system to ensure that they have the ability to provide the necessary services for residents and do not waste resources, so as to build convenient living circles at all levels and improve residents' satisfaction [13], [14].

4) Reasonable Layout of Road Transportation Facilities to Improve Travel Convenience

During the initial planning phase, it is crucial to strategically organize road and transportation infrastructure in alignment with the specific land usage characteristics. This entails harmonizing the demands of various modes of transportation with the urban land's spatial arrangement. This approach

ensures the fulfillment of residents' travel requirements and fosters the advancement of transportation methods, prioritizing public transportation [15].

B. Inspiration of Urban Design

The design of different functional areas in all aspects of their space should be unique and reflect different themes, so as to avoid the loss [16] of regional characteristics and vitality caused by monotonous and copied urban design [16].

The design of public spaces should be approached holistically, not only to prevent excessive repetition of design elements but also to establish harmonious connections between different public spaces. This approach aims to avoid creating a sense of detachment while ensuring that various public spaces exhibit distinct and recognizable features. Simultaneously, it works toward constructing a cohesive and comprehensive public space system.

The detailed design of various public spaces should prioritize people's practical use of space rather than solely focusing on visual aesthetics. It is essential to maximize the functionality of the space, infuse it with diverse themes and styles, and ultimately enhance the overall vitality of the area.

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