

ARTICLE

Study on the Current Situation of Urban Integration of Aboveground Space and Underground Space: Under the Background of China's Land Spatial Planning

Yiyang Li* Luyang Tao*

Faculty of Innovation and Design, City University of Macao, Macao SAR, China

ARTICLE INFO

Article history

Received: 5 May 2022

Revised: 24 June 2022

Accepted: 13 July 2022

Published Online: 21 July 2022

Keywords:

China's land spatial planning

Spatial integration

Underground space

ABSTRACT

Urban underground public space has a synergistic effect with its surrounding urban aboveground functions or facilities, which reflects the complementarity between underground functions and urban functions. The research analyses the degree of integration through the case study of urban aboveground space and underground space in China. The research method of this paper will give different evaluation criteria to public transport and public space and the influencing factors of space integration. The indicators of public transport include the number of subway lines and underground parking spaces. The evaluation standard of public space is the area of underground space and the number of floors of underground space. The subway entrance and exits are selected as the evaluation index for the aboveground and underground transition space. Through the specific analysis of 7 selected cases, it provides arguments for the research. The average rent in the case is taken as the dependent variable. Through the regression model, the influencing factors of the integration of aboveground and underground space are determined. The purpose of the study is to explore the influencing factors of the integration of aboveground space and underground space, and how to optimize the integration of aboveground and underground space.

1. Introduction

In the 1960s and 1970s, the development of underground space began to be put on the agenda in China. Urban underground space planning is the premise and guarantee for the orderly development of urban underground space^[1]. At this time, the utilization of underground space in

China is basically in the basic stage. The development of underground space is mainly engineering development, focusing on underground factories and civil air defense projects, which are less used in people's daily life. It is different from the common underground parking lots and underground shopping malls nowadays. However, today

**Corresponding Author:*

Yiyang Li,

Faculty of Innovation and Design, City University of Macao, Macao SAR, China;

Email: yiyangli327@gmail.com

Luyang Tao,

Faculty of Innovation and Design, City University of Macao, Macao SAR, China;

Email: sztaoluyang@163.com

DOI: <https://doi.org/10.30564/jcr.v4i1.4690>

Copyright © 2022 by the author(s). Published by Bilingual Publishing Co. This is an open access article under the Creative Commons Attribution-NonCommercial 4.0 International (CC BY-NC 4.0) License. (<https://creativecommons.org/licenses/by-nc/4.0/>).

the construction of urban light rail or subway to alleviate the land traffic congestion in big cities has become a priority choice.

With the emphasis on the utilization of urban underground space, increasingly major cities in China are planning or developing urban underground space on a large scale. Although the construction scale of underground rail and underground municipal infrastructure in Chinese cities is huge^[2]. However, the utilization of urban underground public space is still in its infancy. The covered use of urban underground space unable to represent the full development of urban underground public space. A large amount of urban underground spaces is still used as ancillary functions of ground buildings, such as parking, civil air defense and commercial operation. Only a few areas of big cities such as Beijing and Shanghai have the tendency of pedestrian networking of underground public space. Large underground pedestrian network systems composed of underground streets and underground complex nodes have been built in large cities in Europe, America and Japan, such as Manhattan in New York, La Défense in Paris and Sumitomo in Shinjuku.

In management, lack of guidelines and without a comprehensive management agency, China is facing challenges to establish an UUSU (urban underground space utilization) management system that can meet its needs. In technology, further improvements are needed in controlling construction disturbance in complex geological environment^[3]. Up to now, cities with a high degree of development in China have successively encountered the “big city disease”. The development of central urban areas is gradually saturated. Reduced accessibility, poor environmental quality and other problems emerge in an endless stream, which puts forward new requirements for the development of underground space. In this regard, China’s land spatial planning puts forward comprehensive requirements to guide governments and planning units at all levels to comprehensively consider economic population, land use and ecological environment protection to solve the current problems.

The composition of urban underground pedestrian network includes the underground space of urban complex. Although the underground space development of many urban complexes in China has reached a certain scale, and the space quality has gradually deviated from the previous closed and rough design of underground space. The underground space of many urban complexes is still isolated from the city^[4]. It is an isolated space that is not systematic in form, there are various defects in its design related to the city or its own functions, resulting in low utilization efficiency and low accessibility, so that

the underground space of the urban complex cannot be integrated into the urban underground pedestrian network, and thus cannot assume the function of the urban three-dimensional node.

Combining the requirements of underground space development in the new era and the requirements of China’s land spatial planning. Underground space is an important part of urban public space. By promoting the integrated layout of underground metro stations, public service facilities, public space and infrastructure, a comfortable and convenient underground public space system with integration of above ground and underground, underground interconnection and interworking will be formed. At the same time, appropriate underground transportation and large municipal stations can release more ground and shallow underground space, which can effectively improve the urban walking conditions and improve the comprehensive environmental quality of the city.

The integration of above ground space and underground space has many benefits to the sustainable development of the city. The integration of above ground space and underground space can improve the utilization rate of urban space, save land resources in the urban center, shape a better urban landscape, enhance the commercial vitality of underground commercial space, and alleviate the pressure of urban ground space. Meanwhile, the integration of above ground and underground space is also one of the important tasks and goals of China’s spatial space planning in the new era. In the “several opinions of the State Council of China on establishing a territorial space planning system and supervising its implementation”, it is proposed to “coordinate the comprehensive utilization of aboveground and underground space” and treat space as a resource for protection and development. Therefore, the purpose of the study is to explore the influencing factors of the integration of aboveground space and underground space. And how to optimize the integration of aboveground and underground space.

2. Methodology

Considering the current status of urban development in China, comprehensive underground space development only has construction practice in some large cities. This research case selects 7 typical underground space projects in Chinese cities. Including Underground space of Qianjiang New Town in Hangzhou, the underground space of CBD in Zhujiang New Town in Guangzhou, the underground space of Hongqiao CBD in Shanghai, the underground space of Zhongguancun West District in Beijing, the underground space of Futian business district

in Shenzhen, the underground space of Nanjing Xinjiekou central area and the underground space of Chengdu Chunxi Road business district.

The selection principle of the case selected the representative provincial capitals Hangzhou, Guangzhou, Nanjing and Chengdu. The selected cases of representative municipalities directly under the central government, Shanghai, Shenzhen and the capital Beijing, are all representative underground space cases. The CBD and central area of the basic city can clearly describe the most representative underground space development in China. At the same time, the underground space has different scales and construction dates, including the urban characteristics of northern, southern, central and western China, which is of great reference. The research also follows the principle of easy data crawling. There are multiple ways to access the data.

The research method of the article is to collect data, including the number of subway lines and underground parking spaces; the area of underground space, the number of floors of underground space and the subway entrance and exits. Independent variable rent. Through the regression model to analyze the relationship between dependent variables and independent variables.

The rent well shows the advantages and disadvantages of the above ground and underground space integration in the case. A good above ground and underground space integration can bring a large flow of people, thus increasing the rent of the case. Therefore, the average rent of the store in the case is taken as the dependent variable. The rent data come from the statistics of 15 key business districts of China Index Research Institute in 2021. The indicators of public transport include the number of subway lines and the number of underground parking spaces. The evaluation standard of public space is the quantity of underground construction and the number of floors of underground space. The entrances and exits of underground space in China are often combined with the entrances and exits of the subway, so the transition space above and below the ground is evaluated by the entrances and exits of the subway. According to the rents of different cases and the above evaluation criteria, carry out multiple regression to analyze the impact of the evaluation criteria on the rents obtained by the cases, so as to analyze the construction level of the integration of aboveground and underground space.

3. Research Trends of Underground Space in China under China's Land Spatial Planning

The difficulty in implementing the policy of China's land spatial planning in underground space lies in not taking underground space as a part of land space, and viewing it from a resource perspective. Therefore, it is necessary to reconstruct the planning system and reintegrate underground space into the system of urban planning and design^[5].

Underground space planning often appears in urban special planning, such as the engineering planning system. There are problems in the connection between master planning and detailed planning. At the same time there is a lack of legal benefits like the master planning or detailed planning. The lack of unified requirements for underground space planning makes it difficult to find solutions at the same level through different underground space planning when the needs are the same^[6].

The construction cost of underground space is tremendous. After a period of development, China's cities have the ability to carry out overall planning and construction of underground space. The benefits of urban underground space development China can be mainly divided into seven categories, including the saving of tangible and intangible resources, contain time or space and all kinds of non-renewable energy; And the improvement of the existing quality of life, including the reaction on the life of traditional space, such as increasing the unit area value of underground space in the combination of aboveground and underground space^[7].

The industrial agglomeration effect formed by high-density cities provides a continuous driving force for the economic vitality of cities. The economic benefits obtained are put into the development of underground space. However, even in nowadays highly developed city in China, a huge investment still be required in the development of underground space. For example, the construction of urban comprehensive pipe gallery is only used in a few areas, and the construction of urban subway still needs to be fully evaluated.

Moreover, China's high-density cities have also encountered various problems, such as the shortage of land resources and ecological space. The expanding population requires more space to ease the flow of people. The huge commercial space is moved underground, combined with parking and underground street. These underground spaces free up a large area of pedestrian distribution square on the surface. The seven urban indicators that may affect the development of urban underground space utilization include population density, per capita GDP, the proportion

of tertiary industry, industrial density, urbanization rate, real estate development investment and car ownership^[8].

At the same time, large cities in China. The contradiction between public resources in the city of personal motor vehicle travel deepens. Therefore, urban rail transit with fast operation speed and large passenger throughput has become the way to solve the problems of large cities, especially the underground rail transit line. In the near future, the development of urban underground space in China has broad prospects, but there are still some institutional and technical obstacles in the development and utilization^[9]. From the perspective of underground space cases, the indicators are the number of subway lines and underground parking spaces; building area of underground space.

Combined with the needs of the development of the times. The trend of underground space utilization in Chinese cities has changed. In the past, when the construction of ground facilities could already meet the needs, the construction of underground space was mainly to expand the space, and to transfer some functions of the building to the underground from the perspective of functional zoning, such as computer rooms and parking garages. High-rise buildings need a deep foundation, and the underground space enclosed by the box-type foundation is added for practical use, and the underground space is basically only used for the building itself. At the stage of rail transit network formation, many cities form a huge underground space by connecting underground rail transit stations with the underground floors of surrounding buildings, which not only facilitates people's action between rail transit and buildings, but also sets up shops in the underground space, endowing the underground space with commercial and interactive functions outside the passageway.

4. Case Studies

▪ Underground space of Qianjiang New Town, Hangzhou

As one of the cores of the four major cities in the Yangtze River Delta (Shanghai, Nanjing, Hangzhou and Hefei), Hangzhou has a unique position in the development of urban agglomeration in the Yangtze River Delta. Hangzhou is a part of the ecological functional area in the south of the Yangtze River Delta. With Huangshan and Tianmu Mountains around, it is an important part of the national ecological environment resource area. In the master planning, the development focus of Hangzhou has gradually expanded from the development around the West Lake to the Qiantang River area. As the new core of

Hangzhou's planning, Qianjiang new town pays attention to the requirements of protecting the environment and ecology, realizing the combination of green development and protective development, making long-term plans, overall design, reserving the interface between the existing development and subsequent development.

The underground space development scale of Qianjiang new town is 2.58 million square meters (Figure 1). The underground public service places and social places are arranged in combination with subway stations, carriageways and sidewalks and underground parking spaces. Through the extensive use of sunken squares and daylighting wells, sunlight and vegetation are introduced into the underground space.

There are four floors underground in Qianjiang New Town, Hangzhou, passing through Hangzhou Metro Line 2, Line 4, Line 7 and Line 9. The four subways pass through a total of four subway stations in Qianjiang New City, namely Qianjiang Road subway station, Jiangjin Road subway station, Xinye Road subway station and citizen center subway station. According to statistics, there are 37 entrances and exits in the four subway stations. The total development volume of underground space is about 2.3 million m². There are 30000 underground parking spaces in the core area, equivalent to an underground parking garage of about 900000 ~ 1200000 square meters^[10]. Rent of key business districts in the first half of 2021. The average rent is 711 yuan per square meter per month (China Index Research Institute).



Figure 1. The Underground space of Qianjiang New Town, Hangzhou

▪ The underground space of CBD in Zhujiang New Town in Guangzhou

The underground space of Guangzhou Zhujiang

New Town covers an area of about 440000 square meters (Figure 2). The area spans the main traffic roads. The conventional traffic is developed. The underground space is combined with Guangzhou Metro Line 3, Line 5 and Metro APM Line (Zhujiang New Town Automated People Mover System). Zhujiang New Town is a subway transfer station with 6 entrances and exits, which has four stations and eight entrances and exits in total.

It is one of the important traffic nodes. The Pearl River New Town area includes a wide range of public buildings, commercial office buildings such as Bank of Guangzhou and Evergrande center, cultural buildings such as Guangzhou Library, Guangdong Provincial Museum and Guangzhou second children's palace, entertainment buildings such as Guangzhou Grand Theater, etc. abundant public buildings are equipped with sufficient underground parking space, but on the whole, they serve their own office buildings. A large number of facilities will be moved underground in the Pearl River New Town area, and the aboveground space will be connected with the underground space through the sinking square. There are 7511 parking spaces on the three floors of the underground space in Zhujiang New Town, Guangzhou. The average rent is 1110 yuan per square meter per month.

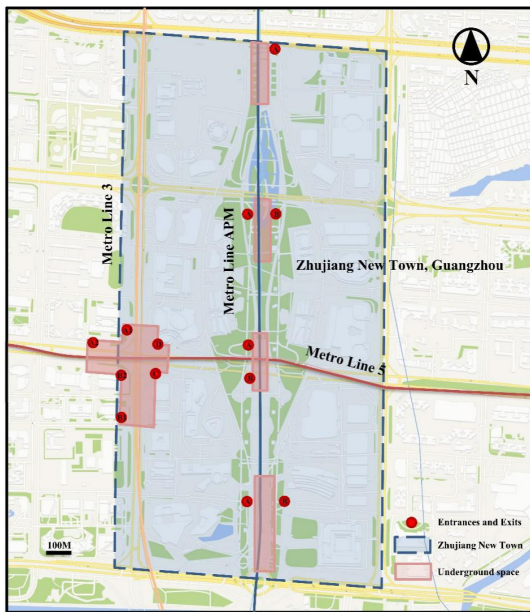


Figure 2. The underground space of CBD in Zhujiang New Town in Guangzhou

▪ **The underground space of Hongqiao CBD in Shanghai**

As the gateway area of the Yangtze River Delta, Shanghai has gradually become the core of highly developed economy since the concession era. The extended development axis

and one of the four most important urban agglomerations in China have promoted the development of centralized population and economy. The scope of services covers the city and surrounding areas. Shanghai, Nanjing, Hangzhou, Hefei, Ningbo innovative service corridor has been opened to drive the development of coastal areas, areas along the Yangtze River Estuary and Qiantang River Estuary. It is also an important endpoint of the riverside economic belt proposed in December. The planning and construction of Shanghai plays an exemplary role in the economic peak and is a beacon for the future development of many cities.

The underground space of Shanghai Hongqiao CBD (Figure 3) has commercial, cultural and entertainment facilities, dynamic traffic combining underground pedestrian traffic and vehicle traffic, static traffic of underground parking and comprehensive pipe gallery.

Shanghai Hongqiao CBD already has three subway lines: Line 2, Line 10 and Line 17. The main transportation hub of Shanghai Hongqiao CBD is Shanghai Hongqiao Station subway station, with a total of 6 entrances and exits. The underground space development scale is 1.02 million square meters and 11750 static parking spaces^[11]. There are three floors underground, and the average rent is 345 yuan per square meter per month.

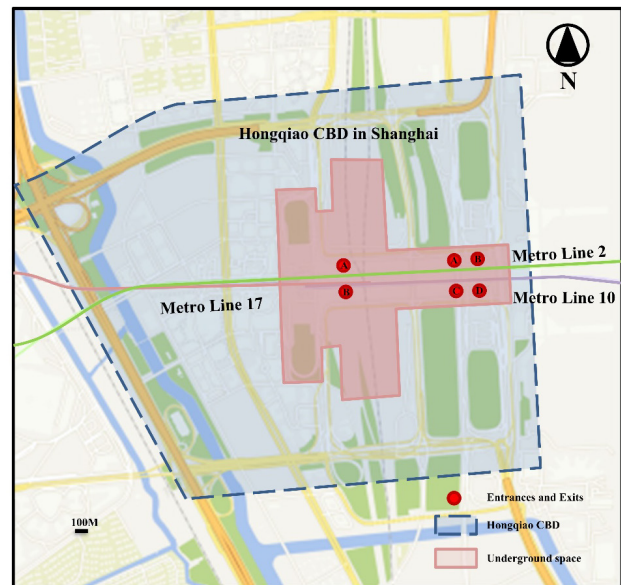


Figure 3. The underground space of Hongqiao CBD in Shanghai

▪ **The underground space of Zhongguancun West District in Beijing**

As the core of Beijing Tianjin Hebei Urban Agglomeration, Beijing, with the imperial capital of the

feudal era as the core, expanded the city outward in a circle through reconstruction, forming the rudiment of today's Beijing urban form. However, in the long-term population agglomeration, cities are gradually overwhelmed and become one of the representative cities of "big city disease" in China. Space resources are tight, and the development of aboveground space is close to saturation. In the goal of ecological sustainability and promoting high-quality development, the development of underground space in Beijing has become one of the links to solve urban problems.

The Western District of Zhongguancun in Beijing (Figure 4): Its underground floor area is 500,000 m², and the number of motor vehicle parking is 10,000. This underground space is divided into three floors. It is the largest three-dimensional transportation network in China which is formed by underground space development, utility tunnel and underground round driveway.

The underground and the ground are connected with each other, and the underground facilities serve the ground. The independent buildings on the ground in Zhongguancun are connected in series to realize the three-dimensional development of the above ground and underground.

On account of the lighting and ventilation of the underground space is relatively poor compared with the ground space, at present, even buildings built alone will set the underground space as a parking lot. The parking lot on the ground floor of Zhongguancun in Beijing has four exits and five entrances connected with the ground roads. It connects the underground parking garage of 12 buildings in the area through the underground vehicle system. Compared with the separate underground parking spaces in each building, it integrates the traffic flow. The establishment of commercial catering and service ecology on the second floor of the underground attracts the flow of people from the ground to the underground, which not only brings vitality to the underground space, but also improves the utilization rate of the underground space. The engineering system serving the West District of Zhongguancun in Beijing is a centralized integrated pipe gallery, which is located on the third floor underground and goes down to the pipe gallery area through the commercial service area on the second floor.

The underground of Zhongguancun West District in Beijing is Beijing Metro Line 4. The subway station is ZhongGuanCun subway station, with 7 entrances and exits with a development area of 190000 square meters and 1000 parking spaces^[12], three floors underground, the average rent is 1368 yuan per square meter per month.



Figure 4. The underground space of Zhongguancun West District in Beijing

▪ The underground space of Futian business district in Shenzhen

Shenzhen Futian business district also accommodates the business population and residential population, develops underground business services and entertainment, and rail transit and car companies enter the underground space to connect the flow of people. The underground development area is 400000 square meters. The underground transportation center will be built with Futian passenger station as the framework, and the underground transportation center will also be built with Futian passenger station as the underground transportation center. At the same time, Shenzhen Futian business district has introduced the concept of ecological construction into the underground, introducing sunshine and vegetation into the underground space, creating a pleasant underground space environment.

Metro lines 1, 2, 3, 4, 11 and 14 are distributed underground in Futian business district, Shenzhen (Figure 5). There are four subway stations in Futian business district, Futian subway station, citizen center subway station, shopping park subway station and exhibition center subway station, with 59 entrances and exits. The underground development area is 400000 square meters. There are three floors underground, 42000 parking spaces, and the average rent is 1734 yuan per square meter per month.

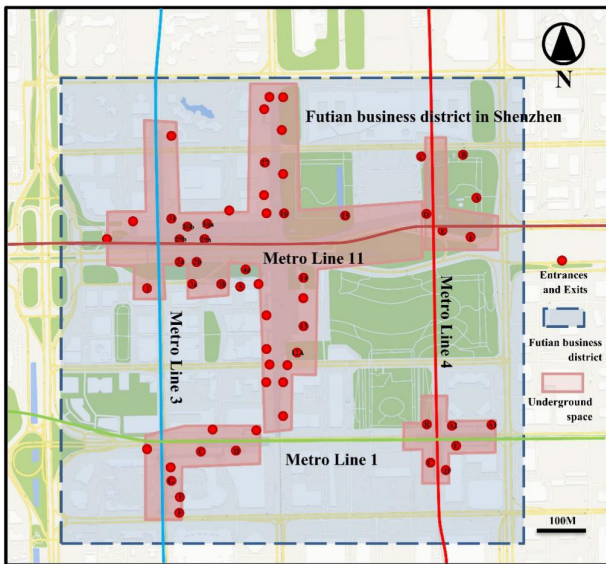


Figure 5. The underground space of Futian business district in Shenzhen

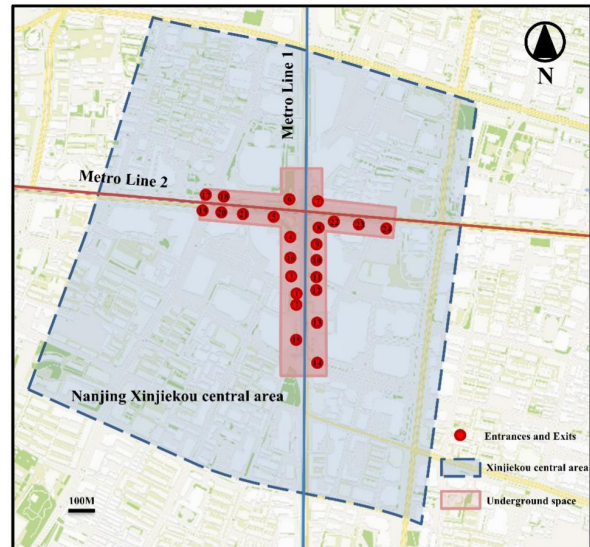


Figure 6. The underground space of Nanjing Xinjiekou central area

Underground space of Nanjing Xinjiekou central area

Nanjing Xinjiekou is positioned as a comprehensive commercial and commercial center with international influence (Figure 6). Xinjiekou is a renovation area for upgrading the underground space in the renewal of the old city of Nanjing. The current situation of Xinjiekou central area has formed a relatively large-scale urban underground space, especially the underground commerce and underground parking, which are mature and belong to the leading level in Nanjing and even in China. The underground mall has attracted a large number of tourists. It has established a connection with Xinjiekou station and evacuated the passengers arriving by subway in time, laying a foundation for building a three-dimensional business district in Xinjiekou. The underground parking lot provides a large number of parking spaces for the central area. Combined with the ground parking and the parking building, it forms a three-dimensional parking system, which relieves the parking pressure and ensures the daily operation of the city. There are 2900 parking spaces in the underground space of Xinjiekou central area. The total amount of existing underground space construction is about 1.4 million square meters. There are five floors underground, two subway lines, Line 1 and Line 2. The subway station is a Xinjiekou transfer station with 24 entrances and exits. The average rent is 1089 yuan per square meter per month.

Underground space of Chengdu Chunxi Road business district

In the corridor from Chunxi Road to IFS underground commerce, there is a small number of subsidiary commercial layout. The business type is mainly retail and catering, and there are few cultural and entertainment stores. The distribution of commercial space is highly guiding. The shops are arranged along the channel from the subway exit. The area of the shops is uniform, which has become a good connection between the traffic space and the commercial space. It not only introduces commercial functions, but also retains the traffic efficiency and guidance of the traffic space^[13].

Chengdu Chunxi Road station is the transfer station of Chengdu metro Lines 2 and 3, with 6 entrances and exits (Figure 7). The surrounding commercial and cultural resources are sufficient and public service facilities are perfect, which provides passenger flow and service facilities for the development of underground commerce in the metro station. The underground commercial space of Chunxi Road studied in this paper includes the underground commercial space at the south end of Chunxi Road subway station and the ocean taikooli underground commercial space at the northwest end. The underground of Chunxi Road has a connecting corridor with the surrounding mature commercial bodies, through which the hall of Chunxi Road station and the surrounding mature underground commercial system are combined into a complete commercial whole. Chengdu Chunxi Road business district has an underground development area

of 11983 square meters, three floors underground, 910 underground parking spaces around the business district, and the average monthly rent is 1107 yuan.

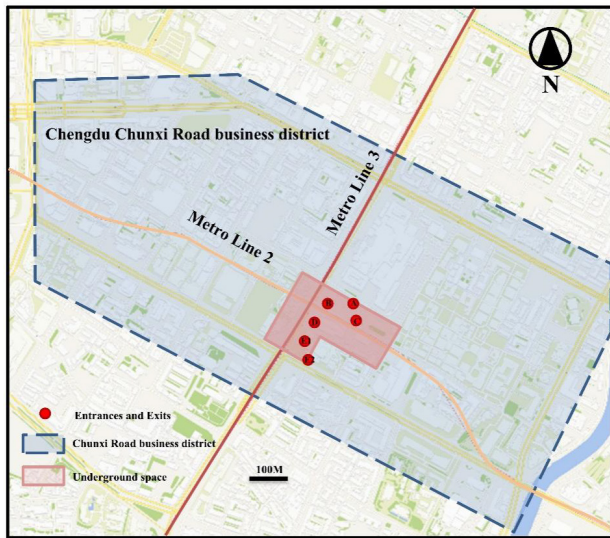


Figure 7. Underground space of Chengdu Chunxi Road business district

5. Data Analyses

According to statistics (Table 1), among the seven selected cases, the highest rent is 1734 yuan per square meter per month in Futian business district, Shenzhen, and the lowest rent is 345 yuan per square meter per month

in Hongqiao CBD, Shanghai. In the case, the largest underground development area is 2300000 square meters in the core area of Qianjiang New Town in Hangzhou, and the smallest development volume is 11983 square meters in the underground space of Chunxi Road business district in Chengdu. The largest number of parking lots is 42000 underground in Futian Business District of Shenzhen, and the smallest number is 910 underground in Chunxi Road Business District of Chengdu. There are six subway entrances and exits in the underground of Futian business district in Shenzhen, the CBD of Zhujiang New Town in Guangzhou, the CBD of Hongqiao in Shanghai and the underground space of Chunxi Road business district in Chengdu. It can be seen from the data that the newly-built underground space, such as the underground of the core area of Qianjiang New City in Hangzhou, has reserved a large amount of space in consideration of many factors. The volume is huge, and there are many parking spaces and entrances and exits. The underground of Hongqiao CBD in Shanghai and Futian business district in Shenzhen shoulder the function of connecting high-speed railway stations, so a large number of entrances and exits are arranged to evacuate people, as well as a large number of underground parking spaces. The underground space in Nanjing Xinjiekou central area and Chengdu Chunxi Road Business District, where the underground space business is developed, shows that there are few parking spaces, but the rent is high.

Table 1. Indicators of 7 cases

Cases	Indicators					
	Rent	Area	Metro lines	Underground parking spaces	Underground floors	Number of Metro entrances and exits
The underground space of Qianjiang New Town in Hangzhou	711	2300000	4	30000	4	37
The underground space of CBD in Zhujiang New Town in Guangzhou	1110	440000	3	7511	3	14
The underground space of Hongqiao CBD in Shanghai	345	1020000	3	11750	3	6
The underground space of Zhongguancun West District in Beijing	1368	190000	1	1000	3	7
The underground space of Futian business district in Shenzhen	1734	400000	6	42000	3	59
Underground space of Nanjing Xinjiekou central area	1089	1400000	2	2900	5	24
Underground space of Chengdu Chunxi Road business district	1107	11983	2	910	3	6

To sum up, the seven case spaces can be divided into three categories. The first type is the underground space where CBD types gather comprehensive functions, such as the underground of the core area of Qianjiang New Town in Hangzhou, the underground of Zhongguancun West District in Beijing, and the underground of the CBD of Zhujiang New Town in Guangzhou. The second type is the underground space connecting the high-speed railway station as the transportation hub, such as the underground of Hongqiao CBD in Shanghai and the underground of Futian business district in Shenzhen. The third category is the underground space of Xinjiekou central area in Nanjing and the underground space of Chunxi Road business district in Chengdu, which are mainly underground pedestrian streets and have developed underground commerce. These three types basically include the types of underground space development in China.

In this part of the regression model, rent is taken as the dependent variable (Table 2). The indicators of public transport include the number of subway lines and underground parking spaces. The evaluation standard of public space is the quantity of underground construction and the number of floors of underground space. The transition space above and below the ground is evaluated by the entrance and exit of the subway. Through the regression of 7 cases of different types, this paper analyzes the factors affecting the integration of above ground and underground space, and whether the integration of above ground and underground space will be affected by public transport, public space and transition space.

The regression coefficient (Coef.) represents the parameter of the influence of the independent variable x

on the dependent variable y in the regression equation. The larger the regression coefficient is, the greater the influence of x on y is. The positive regression coefficient means that y increases with the increase of x, and the negative regression coefficient means that y decreases with the increase of x. R-squared is the determination coefficient, or goodness of fit, which is the square of the correlation coefficient and the part of the independent variable interpretation in the total deviation of Y. P value is used to explain the significance of regression coefficient. Generally speaking, P value <0.1 (*) means that the 10% significant level is significant, P value <0.05 (**) means that the 5% significant level is significant, and P value <0.01 (***) means that the 1% significant level is significant. St.Err. It is the regression standard error, which reflects the average difference between the actual values of dependent variables and their estimated values.

It is found that the construction area of underground space (8.39e-06) and the entrances and exits of underground space (67.8611) will have a positive impact on the rent, while the construction area of underground space (-0.0536711), the number of floors of underground space (-573.8478) and the number of subway lines (-192.6692) will have a negative impact on the rent. The R2 of the model is 1, showing a high goodness of fit. The P values of the construction area (0.522) of underground space, the number of subway lines (0.011), the number of underground parking spaces (0.013), the number of floors (0.012) of underground space and the number of entrances and exits (0.006) were <0.05, showing a high significance. The data show that more parking spaces, floors and entrances and exits of underground space will enhance the value of underground space.

Table 2. Results of regression model t-statistics in parentheses

Rent	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Area	8.39e-06	9.00e-06	0.93	0.522	-0.0001059	0.0001227	
Metrolines	-192.6692	3.349695	-57.52	0.011	-235.231	-150.107	**
Parking spaces	-0.0536711	0.0010755	-49.90	0.013	-0.0673369	-0.0400053	**
Floors	-573.8478	11.02809	-52.04	0.012	-713.9729	-433.7227	**
Entrances and exits	67.8611	0.6608375	102.69	0.006	59.46437	76.25784	***
Constant	2858.219	28.03848	101.94	0.006	2501.957	3214.482	***
Mean dependent var	1066.286		SD dependent var	444.867			
R-squared	1.000		Number of obs	7			
F-test	18790.363		Prob > F	0.006			
Akaike crit. (AIC)	36.001		Bayesian crit. (BIC)	35.677			
*** p<.01, ** p<.05, * p<.1							

6. Conclusions

It is found that the number of subway lines, underground parking spaces, underground construction, underground space and subway entrances and exits in the case will affect the rent, and the rent also confirms the flow of people in the underground space and the integration of above ground and underground space. In the context of China's territorial spatial planning, major cities have accelerated the construction of underground space. At the same time, they are also vigorously promoting the integration of aboveground space and underground space to create a comprehensive underground space of transportation hubs, parking lots and commercial space. The limited urban ground space has been gradually integrated with the underground space, and more use space has been developed. However, as reflected in previous studies, the new underground space such as the core area of Qianjiang New Town in Hangzhou and Futian business district in Shenzhen has a large underground area, while the underground space built in the old urban area such as Chunxi Road business district in Chengdu has a small underground space, which is difficult to meet the growing space demand.

In practice, it is relatively difficult to integrate the completed plots, especially the medium-scale multi block integration project. In China, many underground corridors are used to connect the built underground space, but the difference between the post construction connection project and the original integration project is that the post construction connection project does not consider the overall flow of people, and the necessity of the post construction connection channel is in doubt if the connection of the connected facilities is not considered in the design. In addition, when connecting, the space under the crossing road is often affected by the pipeline, the reserved openings of adjacent facilities are difficult to adapt, and the fire protection specifications are not met. In view of the cost and development cycle of underground space development, a unified standard should be established when considering the interconnection of underground space. Even if the construction cannot be carried out due to cost control, the space should be reserved according to the unified standard.

From the perspective of economic benefits, people tend to move on the shallow surface, while Zhongguancun in Beijing is parking on the first floor underground and the second floor underground is for people's commercial catering. In fact, the transformation activities in the future were not envisaged at the beginning of construction. In the planning of Beijing CBD, according to the traffic

planning of Beijing Central Business District and the comprehensive planning, the underground first floor of Beijing CBD is mainly a pedestrian system, and the underground garages of adjacent construction land on the underground second floor are interconnected as much as possible, which is different from Zhongguancun. Based on the irreversible nature of underground space development, planning and construction activities should be ahead of schedule.

Conflict of Interest

There is no conflict of interest.

References

- [1] Peng, F.L., Qiao, Y.K., Cheng, G.H., et al., 2019. The present situation, problems and Countermeasures of urban underground space planning in China. *Geoscience Frontier*. (03), 57-68.
- [2] Cheng, G.H., Wang, R., Zhao, M.H., et al., 2019. The present situation and development trend of urban underground space development and utilization in China. *Geoscience Frontier*. (03), 39-47.
- [3] Zhu, H.H., Ding, W.Q., Qiao, Y.F., et al., 2019. A brief analysis of the problems and challenges in the development and utilization of urban underground space in China. *Geoscience Frontier*. (03), 22-31.
- [4] Shao, J.Z., 2016. *Urban underground space design* Nanjing: Southeast University Press.
- [5] Li, X., Chen, Z.L., Shu, Y., et al., 2020. How far is the underground space from planning to implementation. *Urban Planning*. (02), 39-43+49.
- [6] Chen, Z.L., Yang, Y.J., Yang, H.Y., 2003. Conceptual planning of underground space in Qianjiang new urban core area. *Hangzhou Urban Planning*. (10), 89-91.
- [7] Zhang, H., Zhu, J.W., 2019. A summary of the research on the social benefits of urban underground space development. *Value Engineering*. (11), 187-189.
- [8] Chen, Z.L., Chen, J.Y., Liu, H., et al., 2018. Present status and development trends of underground space in Chinese cities: Evaluation and analysis. *Tunnelling and Underground Space Technology*. 71, 253-270.
- [9] Zhu, H.H., Luo, X., Peng, F.L., et al., 2018. Development strategy of urban underground space planning in China Strategic research. *Chinese Academy of Engineering*. 19(6), 12-17.
- [10] Ru, W., Chen, H., Xu, L.Y., 2006. Compilation and thinking of underground space planning in the core area of Qianjiang New City -- on the development and utilization of urban underground space in China.

- Journal of Underground Space and Engineering. (05), 712-717.
- [11] Peng, F.L., Zhao, J.W., Liu, K., et al., 2013. Discussion on the development control of CBD underground space based on the control planning level -- Taking Shanghai Hongqiao Business Core Area Phase I as an example. *Journal of Urban Planning*. (01), 78-84.
- [12] Zhang, P., Chen, Z.L., Liu, K., et al., 2016. Analysis of traffic characteristics at the entrance and exit of underground parking system in Zhongguancun West District, *Beijing Journal of PLA University of science and Technology (Natural Science Edition)*. (01), 43-48.
- [13] Zhang, J.Y., 2021. Research on vitality measurement and promotion design of underground commercial space of subway station (Master's thesis, Southwest Jiaotong University).