

Application Analysis and Intelligent Management of Urban Rail Transit and Affordable Housing Joint Development Projects Under PPP Mode

Di Shen^{1,*}, Yanpeng Jin², Juanjuan Guo² and Fang He²

¹China Institute of Nuclear Industry Strategy, Beijing, China

²China Urban Development Planning and Design Consulting Co., Ltd., China

Keywords: PPP Model, Urban Rail Transit, Project Financing, Joint Development.

Abstract: This paper takes urban rail transit and affordable housing as the main research objects, starting from the commonality of economic attributes of urban rail transit and affordable housing, and analyzes the feasibility of joint development using PPP financing mode from the perspective of major stakeholders. Taking Beijing Subway Line 4 as an example, the preliminary idea and scheme are put forward, and the preliminary income model is given; and the key of joint development is analyzed from the aspects of passenger flow, franchise period and capital. At the same time, the important role that intelligent management may play in the joint development mode is discussed.

1 INTRODUCTION

The latest plan of China clearly put forward that the supply of affordable housing should be effectively increased, and the basic system and support policies for housing security should be improved. The State Council further emphasized in 2021 that it is necessary to improve the long-term rental policy and expand the supply of affordable rental housing. Through the planning, layout and development during the last period, Chinese affordable housing planning and construction has completed the task of phased deployment and completed Phased construction indicators, the development area still takes the urban fringe as the main supply area, which coincides with the location of the first and last sections of urban rail transit.

The development income of affordable housing is low, and construction financing is relatively difficult. With the continuous increase in the construction of affordable housing in China, the funding gap for affordable housing in China is also increasing. In recent years, Beijing, Henan Province and other places have also implemented PPP models. In the exploration of developing affordable housing, there is a large room for development of affordable housing by adopting the PPP model (Huang, 2012). The construction scale of urban rail transit has grown steadily in recent years.

The long construction period, large investment, and high operating costs have caused huge financing problems. Since the construction of Beijing Metro Line 4 using the PPP model in 2005, PPP mode has become one of the main modes of urban rail transit financing.

Urban rail transit and affordable housing have become one of the important ways to live and travel in big cities, but they face the same problems of financing difficulties and low returns. Both have the attributes of quasi-public goods. In the context of the PPP model, the internalization of external costs is realized, emphasizing that a subject implements through the PPP model, and ultimately achieves the purpose of joint development to increase the interests of the government and social capital.

The joint development discussed in this paper mainly refers to the organic integration of urban rail transit and affordable housing development.

2 FEASIBILITY ANALYSIS OF JOINT DEVELOPMENT

In the PPP model, the joint development of urban rail transit and affordable housing involves three main stakeholders, namely social capital, the government,

and residents of affordable housing. This paper analyzes the above three aspects and the feasibility of PPP joint development.

A relatively stable investment with low return and low risk of affordable housing investment is also a sound business strategy in the context of tightening PPP projects. The development income of various types of affordable housing is low profit or even a loss. Compared with the affordable housing without rail transit, after the joint development, the rental and sales price of the guaranteed housing can be appropriately increased, and the externality can be reduced to a certain extent to further improve the profit margin. Conservatively estimate the security The profit margin of the independent housing sector is not less than 5%, and it will increase the passenger ticket revenue. It can be seen that the safety factor of this development model is very high, because the cost is well controlled, and the construction of social housing and loan repayment are supported by the government. At present, the sales revenue of affordable housing and long-term rental housing is a stable source of capital recovery, and the affordable housing has very low requirements for rental and sales promotion and design innovation. This can speed up capital turnover, and the capital turnover speed is better than other investment methods.

The passenger flow of the first and last sections is guaranteed, and the ticket revenue generates additional income compared with the original development model. Before the implementation of the project, there is a good expectation for the financial subsidies during the operation period, which reduces the financial pressure. In addition, the joint development of PPP projects reduces the management workload of the government, and the government can realize the transformation from pre-coordination, investment management to process supervision, and the government has the potential for joint development.

Under the background that the main contradiction in Chinese society has been transformed into the contradiction between the people's growing needs for a better life and unbalanced and insufficient development, affordable housing should not be synonymous with low-quality, low-cost, remote and inconvenient housing. It should be a livable housing like ordinary commercial housing, and its geographical location and traffic conditions should meet the basic requirements of the people for convenient travel. After the joint development, the convenience of living and employment for some families with housing difficulties has been improved. (Yu, 2009)

Affordable housing and urban rail transit have certain income potential. (Xiong, 2006) For affordable housing, the existing market will not lead to monopoly, and there is a certain degree of competitiveness; the cost of the two can be recovered to a high degree, and there is a certain profit; the project risk is not high, and the income is stable. Therefore, the project risk/benefit of the two projects is relatively small, which is suitable for marketization. Urban rail transit development has certain risks in project operation due to errors in passenger flow forecast and long franchise period, especially the lack of passenger flow in the first and last sections; simultaneous development with affordable housing has become an effective supplement, and the financing model of both can be adopted PPP mode. The common economic attributes of the two are the same, and the passenger ticket income and the house price promote each other. After the joint development, the external cost will be further internalized to form a win-win situation.

3 PRELIMINARY PLAN OF JOINT DEVELOPMENT MODEL

3.1 Financing Plan

The PPP social capital parties of subway projects are usually local state-owned subway investment groups and general contractor groups. At the general contractor group level, there are usually professional real estate development companies, such as China Communications Real Estate, etc. Social capitals of urban rail transit PPP projects generally have the prerequisites for real estate development and affordable housing development.

The main investor of the PPP project is the SPV company, and the SPV company can set up a wholly-owned subsidiary to develop affordable housing. At the same time, in order to enhance the security of affordable housing development, SPV's wholly-owned real estate development subsidiary can sign an agreement with the shareholder company to participate in the development of affordable housing as a real estate development consultant.

Taking Beijing Metro Line 4 as an example, the financing plan determined in the 2005 franchise agreement is compared with the joint development plan for the first and last sections of the station and affordable housing.

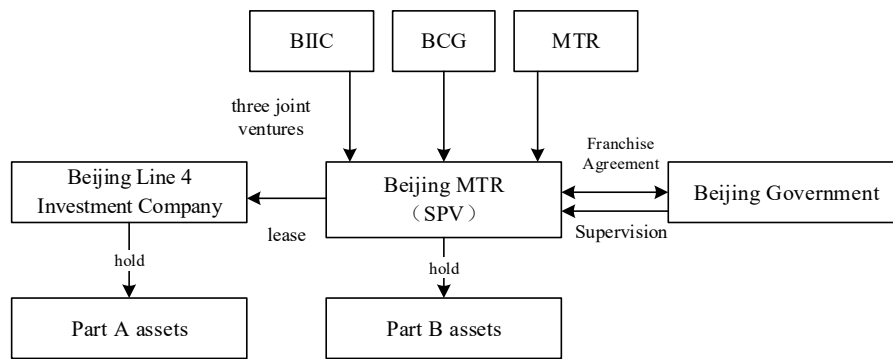


Figure 1: Financing model of Beijing Metro Line 4 (drawn by author).

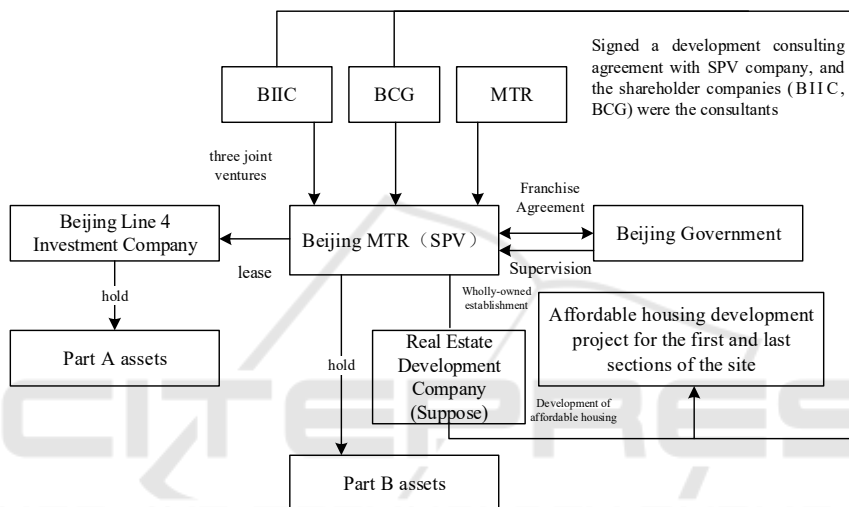


Figure 2: Simulation diagram of financing mode of Beijing Metro Line 4 (drawn by author).

The original development model of Beijing Metro Line 4 is shown in Figure 1.

BIIC: Beijing Infrastructure Investment Co., Ltd.; BCG: Beijing Capital Group; MTR: Hongkong Mass Transit Railway Co., Ltd.

The financing model (assumption) after the joint development of the first and last sections of the site and the affordable housing is shown in Figure 2.

It can be seen that the financing complexity of affordable housing development is not high, it will not affect the main structure of financing, and it can give full play to the real estate development advantages of the shareholder company.

3.2 Revenue Model

The joint development of the first and last sections of the site under the PPP mode brings more diverse benefits and forms a complementary cycle. The schematic diagram of the revenue model is shown in Figure 3.

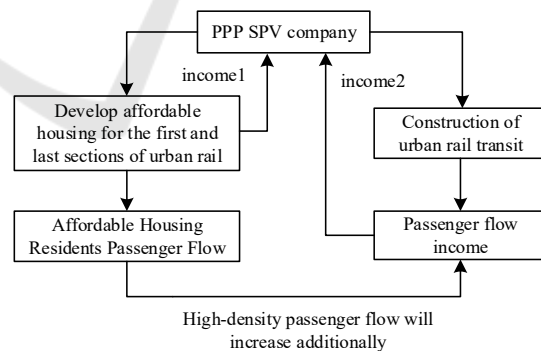


Figure 3: Schematic diagram of possible revenue models (drawn by author).

The impact of the project decision-making period, construction period, and operation period on funds after joint development is shown in Table 1.

Table 1: Comparison table of financial impact of two modes (drawn by author).

	Regular PPP	Joint Development
Investment		
Subway Investment	Regular investment	Regular investment + part of social capital investment in affordable housing (relatively tiny)
Government investment in the development of affordable housing	-	Partial government investment in guaranteed housing
Income		
Ticket revenue	Regular revenue	Regular revenue +I ₁ +I ₂
Affordable housing sales income	-	Income from the sale of affordable housing with a relative increase in selling price
VGF or ticket subsidy	Regular supplement	Regular supplement
Residential property management in-come	-	Property management fee
Expenditure		
Operating cost	Regular cost	Regular cost
Debt service	Match total investment	Match total investment

Note: I₁=Additional passenger flow brought by short occupancy period and high relative density of residence; I₂=Additional passenger flow brought by strong travel willingness.

Due to the joint development under the PPP model, the SPV company has more sources of income, and the source of income of the project company has been greatly expanded.

4 THE KEY ANALYSIS OF THE JOINT DEVELOPMENT MODEL

The occupancy period is short, and it is easy to quickly form passenger flow in a short period of time. The sales of affordable housing are generally controlled by the government. Compared with commercial housing, the sales cycle of affordable housing is short, and residents can move in quickly and can move in in a short period of time.

The high density of living is conducive to the accumulation of passenger flow. Affordable housing is a medium and high-density community, and the floor area ratio is generally about 3.0, which is higher than that of commercial housing (commercial housing pursues living comfort, and the floor area ratio is generally less than 2). Affordable housing has a high density of residents, which can provide a stable source of passengers for the first and last sections of rail transit.

Residents have a strong willingness to travel, which is convenient for continuous passenger flow. The traffic congestion on the ground in the morning and evening peak hours and the high requirements for

commuting on time have caused the residents of affordable housing to have a strong willingness to choose rail transit. Therefore, under the same conditions, in the socio-economic analysis, the shadow price of rail transit for residents of affordable housing is higher than the shadow price of passengers in commercial housing, which increases the fare income to a certain extent and reduces the financial burden of government subsidies.

5 EMPIRICAL ANALYSIS

Rail transit investment parameters: According to the common rail transit length of 20 kilometers, the construction cost is 1 billion yuan/km. The annual passenger flow in recent years is 300,000 person-times per day, the per capita passenger ticket is 5 yuan, and the recent line passenger ticket income is 500 million yuan per year after rounding up. The passenger ticket subsidy is 10%-100% of the passenger ticket revenue (refer to the *2020 Statistics and Analysis Report of Urban Rail Transit* of the China Urban Rail Transit Association), which is temporarily estimated at 20%, or 100 million yuan.

Affordable housing investment parameters: According to the map query results, generally the first and last sections of the site can cover 4-5 affordable housing communities. (Tang, 2021) In this calculation, the scale of common affordable housing communities is calculated as 100,000 square meters per community, the construction and installation cost is

5,000 yuan/square meter (the cost of land transfer is temporarily excluded), the investment in a single affordable housing community is 500 million yuan, and the number of projects is 4. The government partial guaranteed housing capital ratio is 20%. The unit price of affordable housing near the subway is 10% higher than that far from the subway. Taking an affordable housing community of 100,000 square meters as an example, it is estimated based on the living area index of 25 square meters per person, that is, a population of 4,000 living people, in addition to a supporting service population of 200 people, according to the daily population of 70% of the population passes through rail transit Entering the city, since the guaranteed room is in the first and last stages, the transportation distance is long. Assuming that the fare is 5 yuan/person, the guaranteed room ticket income is 28,000 yuan/day. Calculated based on 240 working days/year, the passenger ticket income is 6.72 million yuan/year. In addition, considering factors such as service personnel, family visits, and weekend trips, the annual ticket revenue is about 7 million yuan, the 30-year franchising period, the passenger ticket revenue brought by only one affordable housing community is 210 million.

It is obvious that the joint venture model has better profitability and can be researched and promoted. The preliminary financial estimates of the two models are shown in Table 2.

6 THE IDEA OF INTELLIGENT MANAGEMENT

Under the PPP model, due to the joint development of affordable housing and rail transit in the first and last sections, the subway operating company and the

property management company have become a community of interests with the same profit goal. In the operation stage, the property management unit of affordable housing can fully analyze and study the travel habits of residents through big data technology and intelligent algorithms. Intelligent decision-making for operation arrangements, optimal arrangement of passenger flow and transportation, and exploration of special subway trains with characteristics, such as station express trains and special travel trains for holidays, improve the happiness of residents in the first and last sections, and further improve the competitiveness of the real estate market in the first and last sections. (Zhang, Wang, 2022)

7 CONCLUSION

The government should encourage social capital to invest in the construction of low-cost affordable housing. In the process, the government will give some financial preferential measures, such as long-term, preferential loan interest rate or loan interest compensation, to ensure the continuity of the joint development model. Under the joint development mode, more application space is given to intelligent management, forming a new and more efficient management mode.

Since the land transfer metal is an important source of government revenue, the transfer of land for affordable housing development will result in a loss of the transfer fee. It is suggested that the government should scientifically and rigorously verify the project before the project. The first and last sections of the site are transferred to commercial housing and affordable housing land. The reduced amount of gold in come and the increased amount of income due to additional passenger flow during the franchise period of

Table 2: Financial calculation data comparison table (drawn by author).

	Regular PPP	Joint Development
Investment		
Subway Investment(billion¥)	20	22
Government investment in the development of affordable housing (billion¥)	-	$2 \times 20\% = 0.4$
Income		
Ticket revenue(billion¥)	0.5	$0.5 + 0.005 \times 4 = 0.52$
Affordable housing sales income(billion¥)	-	0.2
VGF or Ticket subsidy(billion¥)	0.1	0.1
Residential property management income(billion¥)	-	$4 \times 3 = 12$
Expenditure		
Operating cost(including debt service) (billion¥)	0.4	0.4
Comprehensive rate of return(including government subsidie)	7%	8.1%

the subway line after full occupancy, the two amounts are compared to fully verify the economic benefits of the project implementation.

REFERENCES

- Huang Na. Research on diversified financing methods for the development of affordable housing in my country [D]. Beijing Jiaotong University, 2012.
- Tang Tang. Analysis on the construction and development of affordable housing [J]. Housing and Real Estate, 2021(30):11-12.
- Xiong Ruizhi. Research on the joint development strategy of urban rail transit and real estate in my country [D]. Huazhong University of Science and Technology, 2006.
- Yu Jinyao. Incorporating affordable housing land into urban rail transit construction planning [N]. People's Political Consultative Conference, 2009-06-29 (B01).
- Zhang Wanning, Wang Jingrong. Analysis of Urban Public Transportation Development under the Background of Intelligent Transportation [C]//. Proceedings of the 2022 World Transportation Conference (WTC2022) (Transportation Planning and Interdisciplinary)., 2022:782-785. DOI: 10.26914.

SCITEPRESS
SCIENCE AND TECHNOLOGY PUBLICATIONS