Research on Contractual Relationship Optimization of Urban Construction Waste Disposal PPP Project

Qiu Yue
School of management, Wuhan University of Technology, Wuhan, Hubei, 430070, China
E-mail: 745006067@qq.com

Abstract. With the rapid development of the economy, the construction waste generated by urban construction has increased year by year, causing many environmental and social problems. The introduction of the Public-Private Partnership model has become an important institutional arrangement for promoting China's new urbanization and strengthening urban infrastructure construction. The actual operation of the PPP model involves complex contractual relationships, in which the contractual relationship between the government and private enterprises is the most critical. This paper will take the government and private enterprises as the main body, establish a cooperative residual rights allocation model based on risk sharing and interest compensation factors, optimize the contractual relationship between the government and private enterprises, and propose optimization strategies.

1. Introduction

1.1. Research background and significance
Construction waste, also known as construction and demolition waste, refers to the muck, waste concrete, waste masonry and other wastes generated by construction, construction units or individuals in the construction activities of demolition, construction, decoration, repair and other construction industries. In recent years, due to the acceleration of industrialization and urbanization, China's construction industry has been at the peak of construction, and the amount of construction waste has increased dramatically. According to the incomplete statistics of China's yearbook, the amount of construction waste in China has accounted for 30%-40% of the total amount of urban waste. The annual total discharge of construction waste is between 2 billion tons and 3.5 billion tons, accounting for about 40% of urban waste, and the average annual growth rate is above 10%. According to the latest plan announced by the National Ministry of Housing and Construction, based on the standard of 500-600 tons / 10,000 square meters, by 2020, China will also increase the construction area by about 30 billion square meters, resulting in at least 5 billion tons of construction waste.

With the development of economy and society, the seriousness and urgency of the construction waste problem have attracted the attention of the government and society. However, relying solely on the unilateral power of the government can’t meet the urban development needs in terms of capital supply and operational efficiency. Therefore, it is an inevitable requirement for the construction waste treatment industry to use the PPP model for market operation. The PPP model refers to the mutual cooperation between the government and private enterprises or private funds based on a specific project, and determines the rights and obligations of the parties to the contract by contract. While providing the public with high-quality facilities and services, the private enterprise can also get a reasonable profit. In
In foreign countries, the PPP model has achieved many successful experiences and has received extensive attention. The use of PPP mode as a means of building construction and management of construction waste in China has a strong practical significance. On the one hand, using the PPP model can give full play to the advantages of private enterprises, improve the rate of urban domestic waste disposal, and reduce the burden on the government. On the other hand, the PPP model requires governments, businesses, and the public to work together and involve a wide range of stakeholders. Practice has proved that if the private sector is involved in public utilities, if it is not handled properly, it may cause many problems and adversely affect the reform of public utilities in China. The actual operation of the PPP model involves a complex contractual relationship. The contractual relationship between the government and the private enterprise is the most critical. The actual operation of PPP mode involves complex contractual relationship, among which the contractual relationship between the government and private enterprises is the most critical. Due to the difference of goal orientation and possible opportunistic behavior in PPP mode, serious contractual governance problems are highlighted. Therefore, in view of the actual situation of China's garbage disposal industry, it is of great practical significance to study how to effectively design the contract checks and balances between government and private enterprises.

1.2. Research Status
In essence, a PPP project is actually a collection of contracts that govern the relationship between PPP projects and their stakeholders through the role of mechanisms such as supervision constraints, goal incentives, benefit distribution, and risk sharing. At the same time, resolve conflicts and conflicts among stakeholders and promote cooperation among all parties. PPP project stakeholders including government departments, project companies, contractors and investors will form during the transaction. A series of contractual relationships with a certain life cycle, so these stakeholders are the subject of the contractual relationship. Fan Xinghua and others analyzed the PPP operation mode and benefit of the construction waste resource industry, and found that the PPP model is feasible in the construction waste resource industry project, and BOO is the most suitable model for the construction waste treatment industry project [1]. Liu Chengyi demonstrated the necessity and feasibility of applying PPP mode in the field of construction waste treatment [2]. He Tianxiang et al. demonstrated that compared with the traditional Shapely value method, the improved benefit distribution coefficient calculated by the Shapely value model can not only improve the satisfaction of stakeholders, but also increase the overall satisfaction, and can be adjusted according to the actual project [3]. Guasch and Stéphane Straub believe that PPP project participants are linked by contract, which can alleviate the government's administrative pressure and improve the efficiency of public services to a certain extent, but because of the conflict of interests between various stakeholders, the parties are behaving in a way. Different in the process, which restricts the way of contract governance [4]. Wang Junhao and Jin Huanxuan used the cooperative game model of rotating bids to demonstrate that the government should give private enterprises a larger proportion of equity to actively participate in urban infrastructure PPP projects. At the same time, it is necessary to form a mechanism of checks and balances between the government and private enterprises in order to improve the contract governance efficiency of urban infrastructure PPP projects [5].

2. Contract type and problem analysis
2.1. Specific contractual form in PPP mode
We can describe the operation process of PPP project for municipal waste disposal as follows: the government determines the winner of the project through public bidding, and the winning enterprise obtains the franchise of PPP project for a certain period of time, and clarifies the rights, responsibilities and interests of both parties in the process of project operation, and signs a series of contracts which have already been binding. Then a PPP project company with the winning bidder as the core is set up, which is responsible for the financing, design, construction and operation of the project and provides public goods or services. From this, we can see that in the process of PPP project operation, different
stakeholders form a contract network, and there are different forms and different degrees of interaction between them. At present, the common PPP models of municipal solid waste disposal are mainly divided into the following types, as shown in Table 1.

Table 1. Several common PPP modes and their control rights configuration.

| ABBREVIATION | CONTRACT FORM | CONTROL CONFIGURATION |
|--------------|---------------|-----------------------|
| BTO          | Construction-transfer-operation | The company is responsible for the financing and construction of the infrastructure and transfers it to the government after completion. The government leases to the company, which is responsible for its operations and obtains commercial profits. |
| BOT          | Construction-operation-transfer | The government provides a concession agreement, and the enterprise as the investor and operator of the project is responsible for financing, development, and construction projects, and obtains profits during the period; after the expiration, the enterprise transfers its ownership and management rights to the government without compensation. |
| BBO          | Purchase-build-operate | The government sells the existing infrastructure to private enterprises, which are responsible for the reform, expansion, and permanent management rights. |
| BOOT         | Construction-ownership-operation | The company is responsible for the financing and construction of the infrastructure and owns the facility for permanent operations. |

Generally, these contracts can be divided into three categories: first, concession contracts signed by government departments and private sectors; second, debt financing contracts signed by private sectors and investors (banks or financial institutions); and third, project management contracts signed by project governments and social capital and contractors. These contracts are all formed with the project company as the center, focusing on the construction and operation of the project, and realizing the contractual relationship and governance between the two main bodies of resource allocation and integration through the contractual relationship.

2.2. Governance of PPP contract

However, in the PPP practice process, the governance problems highlighted by the pursuit of inconsistent goals are very complicated, and the reasons can be mainly divided into three categories:

1. There is a difference between the government and private enterprises in their goal orientation.

Because of the basic, externality and public welfare characteristics of urban infrastructure in urban construction and development, it has an important impact on urban economic development and the improvement of residents' quality of life. Therefore, the government tends to take social and public interest objectives into account when implementing PPP projects of urban infrastructure. And the main goal of private enterprises to run PPP projects of urban infrastructure is to maximize profits, with the help of the long-term and stable market demand for urban infrastructure, in order to obtain stable investment returns. Because of the difference of goal orientation between government and private enterprises in PPP of urban infrastructure, both sides may adopt a series of opportunistic behaviors, which will inevitably lead to conflicts of interest, thus resulting in contractual governance problems.
2. The government may have opportunistic behaviour.

The problems of government departments in the specific practice of PPP projects are mainly about performance credit. When government departments bid for public utilities to alleviate financial pressure and attract private enterprises to bid, they often promise various preferential conditions. However, due to the replacement of local leaders, the adjustment of functions of government agencies and other objective reasons, it is difficult to fulfill the original promised conditions, which leads to the problem of dishonesty in performance. For example, compensation mechanism can’t be fulfilled, contract clauses are canceled without reason, deliberate procrastination in the process of performance, lack of access to supporting land and so on. In addition, objectively, due to the defects of compensation and guarantee mechanism in franchise contract, the government will also have the problem of dishonesty in performance. Secondly, the ethical construction of administrative staff in government departments is inadequate, the supervision and management system of public departments is imperfect, public power will be alienated, corruption, privilege monopoly and other acts will occur, and the signing of PPP contracts may be transformed into the process of power-money transactions. This leads to the adverse selection problem when the government chooses the successful PPP enterprises, and also the moral hazard problem in the actual operation process. This further aggravates the contractual governance problem caused by the government.

3. Opportunistic behaviour that may exist in private enterprises.

The opportunistic behaviors that private enterprises take into account in their own interests are mainly characterized by impure motives and insufficient strength, resulting in agency costs. At present, due to the uneven development of the market, the ability and qualifications of many enterprises involved in bidding for public utilities are uneven, and the government cannot know the true qualifications of the target enterprises. This has led some companies to use information asymmetry to appear malicious competition in the bidding process. What's more, some large companies use government credit to make money in the capital market, but there is no substantial progress on the project. On the other hand, due to the long concession period of PPP projects, private enterprises can generally recover investment costs within a certain period of time and obtain a certain return. At this time, private enterprises will weigh the cost of continuing operation and the opportunity cost of default. In order to maintain the smooth flow of cash, they will stop purchasing corresponding equipment. In addition, in the actual project operation process, private enterprises may find that they do not pay the effort level and maintenance cost promised before signing the contract, and can still meet the economic profit during the franchise period, which will result in low quality and longevity after the handover of the facility. The shortening of the period and other conditions will indirectly increase the government's annual operation and maintenance costs and reduce the government's cooperation surplus. This has led to the problem of contract governance caused by private enterprises.

3. Contract relationship optimization model

Governments and private enterprises have different interests when participating in urban infrastructure PPP projects. In the pursuit of their own interests, conflicts and contradictions inevitably occur. Among them, the government pursues the normal operation of public facilities, the quantity and quality of public goods, and the risks that the government may bear. Private enterprises pursue issues such as project profits, policy stability, business risks, and government guarantees. The contradiction and conflict between the government and the enterprise in the garbage disposal PPP project are mainly balanced by the mutual checks and balances mechanism under the influence of risk sharing and interest compensation factors based on the equity structure. Therefore, although the game between the government and private enterprises around the share of PPP project is very fierce, but the two sides can gradually achieve their own interests balance through continuous bargaining game. Among them, the risk and benefit compensation of each party become the important conditions to be considered in the game between them, and the size of equity share will ultimately reflect the distribution of the remaining cooperation. In this paper, we will start from the game between the contracting parties, and study the impact of share control
rights on the residual allocation of cooperation under the consideration of risk sharing and benefit compensation mechanism.

3.1. Precondition hypothesis

It is assumed that all the contents involved in the franchise contract can be quantified into the cooperative surplus of PPP project for urban construction waste treatment, and the cooperative surplus is allocated according to the share of equity between the government and private enterprises, and the government and private enterprises negotiate the share of equity of PPP project several times, in terms of project compensation and operational risk, etc.

It is assumed that the government and private enterprises mainly play a rotating game for their respective equity ratios \( a_1 \) and \( a_2 (a_1+a_2=1) \), and the risk expected benefits that the risk can bring to the project are \( R \), and the risk ratio of government departments and private enterprises are \( d_1 \) and \( d_2 \) respectively \((d_1+d_2=1, \text{ subject to a uniform distribution over the } [0,1] \text{ interval})\). In addition, taking into account the risk management and risk-sharing objectives of both parties, the private enterprise will be encouraged to share the risk, and the part of the multi-bearing will be compensated for, and the parameter \( \lambda (\lambda \geq 1) \) will be introduced to indicate the shared risk. The compensation coefficient, introduced by the discount factor \( \zeta (0<\zeta<1) \), indicates that due to factors such as negotiation costs, time delays and interest losses, the interests of both parties will suffer certain losses at every stage of the negotiation.

3.2. Three-stage game

At the first stage, the government first proposed the relevant regulations for the garbage disposal PPP project franchise contract, and finally reflected in the remaining of the cooperation \( R \). At the same time, the government bids for the equity ratio as \( a_1 \), \( a_1 \in [0,1] \), and the total surplus of the government's cooperation is \( r_1=R\alpha_1d_1\lambda \), while the cooperative surplus obtained by the private enterprise under the contractual clause proposed by the government is \((1-\lambda d_1\alpha_1)R-Rr_1\). In the first round of bidding, private companies may choose to reject or accept government terms. If the private enterprise refuses to accept the government's proposal, it will enter the next round of bidding. Otherwise the game is over.

At the second stage, the private enterprise rejects the government's contractual clause, proposes the revised franchise clause and the share of the shareholding \((1-a_2)\), then the government's shareholding ratio is \( \alpha_2 \), and the gain is \( r_2=R\alpha_2d_1\lambda \). The remaining cooperation of the enterprise is \((1-\alpha_2d_2)\). In the second round of bidding, the government can choose to accept or reject the proposal of private enterprises. The hypothesis discount factor is \( \zeta (0<\zeta<1) \). If the government accepts the private enterprise proposal, the equity ratio of the government and the private enterprise is \((a_2;1-a_2)\), and the cooperative surplus is \((\tilde{\zeta}_2\tilde{R}-\tilde{r}_2)\). The game process ends; otherwise, the next round of bids.

In the third stage, the government-owned private enterprises will propose a compromise plan for the results of the first two rounds of the game. They cannot unilaterally allow themselves to own a larger shareholding ratio and have obtained more cooperation surplus. Both parties need to consider each other's expected cooperation surplus. Therefore, in the third stage, the government proposes that the equity ratio is \( a \), and the cooperative surplus \( r=\alpha Rd_1\lambda \), then the equity ratio obtained by the enterprise is \( 1-a \), and the cooperative surplus obtained is \((1-\alpha\lambda d_1)\). At this time, if the private enterprise accepts, the game is over, and the remaining distribution of the cooperation between the two parties is \((\tilde{\zeta}^2R, \tilde{\zeta}(R-r))\). If the private enterprise refuses, the government's shareholding ratio \( a \) is the biggest concession condition, beyond which the government will choose not to cooperate with this enterprise, the game process is over, and the remaining cooperation between the two parties is 0.

3.3. Model Solution
Figure 1. Schematic diagram of model.

As shown in Figure 1. Since both parties know that every time they make one round, the benefits will be decreased. So it is not good for both sides to let the negotiations go too long. It is better to let the other party get the benefits they must get, so that their own benefits will worsen. Now using the inverse induction method, we can see that in the third stage of the game, because $0<1-\alpha<1$, $0<\xi<1$, $R>r$, the best game outcome for private enterprises is to accept the government proposal. In addition, the government knows beforehand that the final negotiation result will be acceptable, then its proposed share ratio $\alpha$ will not be too large. If $\alpha$ is too large, the government will share a larger surplus of cooperation, but at this time the enterprise will get too small $R-r$, even if $R-r$ is greater than 0, the enterprise will consider the opportunity cost and prefer to choose the game strategy of refusing cooperation.

In the second stage, if the private enterprise knows that the government will propose a shareholding ratio of $\alpha$ after entering the third stage, the government's return is $\xi^2Rd$, and its own return is $\xi^2R(1-\alpha d)$. In order to reduce the cost of bargaining, rational enterprises understand that if the $\alpha$ proposed in the second stage makes the government's income less than the third stage, the government will refuse the proposal, and the game will enter the third stage, so the private enterprise will avoid this phenomenon. The proportion of shares proposed by the government should make the government's cooperation surplus not less than the third stage of cooperation surplus, and at the same time make its own income more than the third stage, at this time $\alpha$ meets the interests of private enterprises. Therefore, the proportion of equity $\alpha$ that can satisfy the income demand of private enterprises without refusing the government should satisfy:

$$\xi^2Rd_{1}\geq\xi^2\alpha R_{d_{1}}$$

(1)

Bring (1) to $\xi R(1-\alpha d)$, the maximum cooperation surplus for private enterprises is:

$$\xi R(1-\alpha d_{1})$$

(2)

Comparing (2) with the residual $\xi^2R(1-\alpha d_{1})$ obtained by the private enterprise in the third stage, Since $0<\xi<1$, then $\xi R(1-\xi d_{1})>\xi^2R(1-\alpha d_{1})$ is the income of the private enterprise at this time is greater than the income from the third stage.

In the same way, if the government knows in the first stage that it will raise the equity ratio of the third stage of the game to $\alpha$ and the cooperation surplus to $\xi^2\alpha R_{d_{1}}$, it is also known that the private enterprise proposes a ratio of not less than $\xi\alpha$ to the government in the second stage, and The remaining cooperation in the second phase is also $\xi^2\alpha R_{d_{1}}$, and the private enterprise will satisfy its cooperative residual $\xi R(1-\xi d_{1})$. In order to reduce the cost of bargaining, the rational government will propose a suitable equity ratio in the first stage so that the income of the private enterprise is not less than $\xi^2R(1-\xi d_{1})$, at the same time, can obtain more cooperation than the third phase of the distribution, so

$$r_{1}=R-\xi R(1-\xi d_{1})=R-\xi^2R+\xi^2\alpha R_{d_{1}}$$

(3)

It can be seen from (3) that because $R>\xi R$, the cooperation surplus allocated by the government at this time is larger than that of the second stage and the third stage.

Therefore, from the analysis of the above game equilibrium, it can be seen that the only sub-game refined Nash equilibrium solution of the cooperative game between the government and the private enterprise is $(R-\xi R+\xi^2\alpha R_{d_{1}},\xi R-\xi^2\alpha R_{d_{1}})$. Similarly, for the shareholders of multiple project companies
existing in the PPP project, these shareholders can be divided into two categories: the government and the private enterprise. Then, in the private enterprises, the game between the private enterprises is based on the strength of strength, and there is also a balanced solution.

3.4. Game conclusion

It can be seen from the above model that the cooperative game between the government and the private enterprise has the only sub-game refined Nash equilibrium solution, which reflects the size of the remaining cooperation between the government and the private enterprise. The government income is the total income minus the enterprise income, while the private enterprise’s income is the remaining

\[ R^b = -\xi \alpha R d_1 \lambda + \xi R \]  \hspace{1cm} (4)

Conclusion 1: Because:

\[ \frac{d(R^b)}{d(\xi)} = -2\xi \alpha R d_1 \lambda + R \]

When \( \xi \rightarrow 0 \), the remaining surplus of private enterprises is zero. When \( \xi = \frac{1}{2\alpha d_1 \lambda} \), the cooperative surplus of private enterprises reaches a maximum of \( \frac{R}{4\alpha d_1 \lambda} \). In addition, from the analysis of the discount factor, it is known that the larger the cooperation surplus of private enterprises, the appropriate reduction of the proportion of government equity; On the other hand, since \( \xi R - \xi^2 \alpha R d_1 \lambda = \xi R (1 - \xi \alpha d_1 \lambda) \), the smaller the \( \alpha \), the larger the surplus of the private enterprise.

According to the conclusion (1), when rational private enterprises negotiate with the government, they should reasonably control the negotiation process and reduce the negotiation costs. In addition, the model shows that the equity ratio \( \alpha \) is crucial for the final remaining distribution. To encourage private enterprises to actively participate in urban infrastructure PPP projects, the government should give private enterprises a large proportion of equity.

Conclusion 2: Because:

\[ \frac{d(d_1)}{d(\lambda)} = \frac{\xi R - R^b}{\xi^2 \alpha R \lambda^2} \]

Therefore, the risk-taking of private enterprises and the compensation coefficient \( \lambda \) are inversely proportional. That is to say, the larger the compensation coefficient, the smaller the proportion of risks shared by private enterprises.

According to the conclusion (2), under the condition that the expected risk return is positive, the introduction of the \( \lambda \) coefficient can’t positively stimulate the private enterprise to bear more risks. The pursuit of interest attributes drives government departments to take risks, but for some public sectors with low comprehensive strength and poor negotiation ability, the results are not practical. Because in the process of cooperation, private enterprises will take the initiative to share more risk proportions due to the consideration of the successful implementation of the project and the collective rationality of fair concern. Then, more compensation requirements will be put forward to the government instead, which does not conform to the model conclusion that risk is inversely proportional to compensation.

4. Conclusion

4.1. Reasonable distribution of controlling rights

According to the conclusion 1, in the contractual governance of urban infrastructure PPP projects, on the one hand, it is necessary to avoid excessive dispersion or over-concentration of equity, and on the other hand, in order to mobilize the enthusiasm of private enterprises, under the premise of ensuring the balance of government and private enterprise equity structure let private enterprises occupy a large share in the urban infrastructure PPP project and realize the ownership structure with private enterprises as the main body. This shareholding structure should be composed of a few major shareholders and most small and medium shareholders. The majority shareholder is not an absolute shareholder but a relative shareholder. This is conducive to changing the situation of excessive concentration of equity, rationally diversifying equity, effectively avoiding conflicts of interest and opportunistic behavior between
government and private enterprises, and improving the efficiency of contractual governance of urban infrastructure PPP projects.

4.2. Establish a reasonable risk sharing mechanism
According to the conclusion 2, the purpose of introducing PPP model in the field of construction waste disposal is not to transfer as many risks as possible to private enterprises, nor to blindly take taking greater risks as a means to obtain higher return on investment, but to assume corresponding risks according to ‘the most risk-controlling partners’. The principle of risk sharing mechanism is established to reduce the probability of risk occurrence and ensure that risk control can be completed at minimum cost.

4.3. Flexible choice of risk sharing compensation methods to expand more market access opportunities
In addition to the basic price compensation, the method of benefit compensation can also develop other compensation methods that are suitable for local conditions, such as ‘renewable resources for building materials’, market access preferences, construction opportunities for waste treatment plants, and deep cooperation with other projects. Diversified risk compensation methods can improve the perceived effect of enterprises to a certain extent, thereby improving the overall utility of risk sharing, ensuring the stability of the alliance and achieving sustainable development in the later stage of the project.

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