The Development Research on the Construction Waste Resource Industry in PPP Pattern

Shiyu Lu
Nanjing Agricultural University, Nanjing 210000
gxyzyt@njau.edu.cn

Abstract: This paper first describes the development of construction waste recycling industry and PPP pattern, then discusses the related technologies of construction waste recycling industry, and summarizes the related risks of the combination of the two. Finally, it puts forward some corresponding policy suggestions.

1. Introduction
As the statistics released by the National Statistics Bureau, as of 2019, the urbanization rate of China had reached 60.60%. Amidst urbanization, a lot of construction waste is produced, taking a large proportion among all waste produced. Construction waste is like misplaced gold, and illegal disposal of construction waste will not only contaminate the living environment and cause damages to the ecology, but lead to a waste of the valuable land resources. Recycling of construction waste can partly resolve the problem of illegal disposal and reduce waste of resources.

In 2017, Ministry of Housing and Urban-Rural Development of P.R.C released the 13th Five-Year Plan for construction energy saving and green building development. One major task of the plan is to improve the utilization of resources, with a focus on disposal and recycling of construction waste. Besides, it encourages the PPP mode and other investment & operation modes.

Previous scholars maintained that the PPP mode played a positive role in converting construction waste into resources [1]. To address problems as insufficient funding and heavy government burdens in disposal of construction waste, some scholars proposed combining the PPP mode with industries and introducing civil funds into disposal of construction waste and boost industrial and economic development. Previous studies have probed into the necessity of these two measures, and analyzed the feasibility of applying the PPP mode to the construction waste recycling industry from technical, economic and policy perspectives [2] [3]. Pang et al. also confirmed feasibility from the financing and practical perspectives [4].

That being said, the risks of combining the PPP mode with the construction waste recycling industry remain. Hou analyzed the risks in the program of introducing the PPP mode to construction waste recycling in Zhengzhou by using the grey correlation degree method [5]. To reduce or eliminate the risks, relevant policies are required. There have been studies that probed into the policy recommendations according to features of industries, but few proposed policy recommendations in light of latent risks. This study will probe into the development of the construction waste recycling industry and PPP mode, discuss advanced technologies for construction waste recycling, analyze the risks of combining the two, and propose policy recommendations accordingly.
2. Development of the construction waste recycling industry and the PPP mode

2.1. Development of the construction waste recycling industry
The construction waste recycling industry in China started late and developed slowly, facing such problems as neglect of on-site classification and disposal, backward recycling and re-production technologies, insufficient funding, defective system of laws and policies, etc. [6] Thanks to efforts of researchers and experts, this industry has gained considerable development, and in particular, the utilization of recycled aggregates has increased. There are study cases for recycling of construction waste. For instance, to restore the damaged concrete road of Hening Highway, waste concrete was used as the raw material to produce new concrete, which considerably saved raw concrete and achieved good effect. For the time being, China has techniques and equipment for recycling of construction waste, and has made much headway in terms of standards, specifications, use demonstrations, and product quality; major cities have also released local policies for different steps for recycling and utilization of construction waste [7].

| Recycled aggregate | Cinder soil | Organic debris | Scrap metal |
|--------------------|-------------|----------------|-------------|
| 88.0%              | 9.1%        | 2.8%           | 0.1%        |

2.2 Development of the PPP mode
Cheng et al. found that since 1984, the PPP mode in China has undergone four stages and PPP projects have been increasing, with ups and downs. PPP projects are unevenly distributed in China, with those in the east outnumbering those in central and western China [8].

The PPP mode is also seeing wider adoption in more than 20 fields, including urbanization, civil aviation, health care, garbage disposal, the Belt and Road Initiative, Internet finance [9]. The scope of theoretical studies in this regard have been fleshed out, leading to a system that covers the nature of PPP, classification of project risks, risk distribution, project management, government supervision and management mechanism. However, problems of PPP projects, such as defective management systems and difficulties in financing, remains [10].

| Cut-off time | End of March 2018 | End of March 2019 | End of May 2020 |
|-------------|--------------------|--------------------|-----------------|
| Cumulative items / items | 7420               | 8843               | 9575            |
| Total investment in treasury projects / RMB trillion | 11.5               | 13.4               | 14.7            |
| Cumulative landing items / items | 3324               | 5541               | 6500            |
| Amount of investment on-site projects / trillion yuan | 5.5                | 8.4                | 10.2            |
| Landing Rate /% | 67.9               | 62.7               | 44.8            |
| Cumulative number of projects / projects commenced | 1375               | 3322               | 3879            |
| Operating Rate /% | 41.4               | 60.0               | 59.7            |
In these years, the number of PPP projects has surged. As the Table shows, from March 2018 to March 2019, the cumulative increase rate of projects included into the database reached 19.18%; and the rate was 8.28% from March 2019 to May 2020.

2.3 Development of the Construction Waste Recycling Industry under the PPP Mode
The PPP mode construction waste recycling projects have been implemented in cities along the upper and lower reaches of Yangtze River, cities in the Beijing-Tianjin-Tangshan area as well as transport hubs in southwestern China. In early August in 2015, the PPP construction waste recycling demonstration project was started in Haining, Jiaxing, Zhejiang province; later in October of the same year, the municipal government of Zhengzhou, Henan signed with partner enterprises the approval protocol for the construction waste disposal project in the PPP industrial technology development zone; also in October, the municipal government of Tianjin entered into cooperation with a company in Hunan and signed a cooperation agreement for the PPP waste landfill project. Similar PPP projects have also been or are being implemented in Zhejiang, Hubei and other provinces across China.

3. Current Research Situation regarding the combination of the PPP mode and the Construction Waste Recycling Industry

3.1 Current research situation for construction waste recycling

3.1.1 Sorting technology
To improve the current construction waste sorting technologies and reduce the impurity rate of aggregates, some scholars invented a patent of removing impurities through recycling of construction waste, which could tackle the problem that conventional winnowing or human sorting could not completely remove the impurities. The patent included five steps — sorting, secondary shattering, magnet-based removal of metals, grain size-based screening, and winnowing — to achieve better quality aggregates.
3.1.2 Materials technology

Many studies have been devoted to recycling of construction waste. Shen et al. ground construction waste into brick powder, ore powder, fly ash and activators to produce construction waste composite powder materials (CWCPMs), and by experiments, they studied the small-scale concrete that was mixed with CWCPMs [11] [12] [13]. The study results show that the content of CWCPMs in the small-scale premade concrete components had little impact on the slump loss, but had large impacts on the compressive strength and the flexural strength. When 30% CWCPMs were added, the pore structure of the concrete was finer, the pore distribution became more reasonable, and the internal and surface structure became more intense; the anti-freezing performance of the C30 concrete was improved, and it had better comprehensive strength than benchmark concrete in 28 days; addition of CWCPMs also enhanced the shrinkage of concrete, and as the amount of added CWCPMs increased, the shrinkage coefficient first decreased and then rose. The components of CWCPM are easily and widely accessible; using it to replace cement to prepare prefabricated concrete could save cement, reduce power consumption and protect the environment, thus having a great prospect for application.

Sapienza University of Rome, by processing the residue of refuse derived fuel (RDF), obtained the base ash (BA) — a special construction material used for base engineering of roads, which provided a feasible solution for multiple on-site construction projects [14]. Polytechnic University of Milan, through comparative tests, replaced the raw fillers with stable bottom ashes (SBAs) and electric-arc furnace steel slags (EAFSSs), and studied its impact on the compressive performance, volume performance and mechanical performance of asphalt mixtures. The research result shows that it is feasible to replace the raw fillers of the asphalt mixtures with recycled aggregates;
compared with asphalt mixtures obtained by standard (calcium) fillers, the mixture obtained by recycled aggregates had similar or better comprehensive performance, volume performance and mechanical performance [15].

3.1.3 Other technologies
Many scholars have probed into advanced technologies for construction waste recycling. Aside from the abovementioned technologies, there are many other efficient processing technologies, material preparation technologies. For instance, the intelligent construction waste detection and robot sorting technologies, Internet + waste sorting and recycling digital platform technologies.

3.2 Current research situation of the PPP mode
Yao and Li summarized the merits of the PPP mode — it reduces the debt-liability ratio, increases the capital for projects, reduces public investment, and improves the initiative of private enterprises [16]. However, it also has many risks, as shown in the following.

3.2.1 Low prices of the products and services leading to losses
If the quality of products or services that private enterprises provide is poor, the demand for price reduction and quality improvement increases; meanwhile, because the public have no correct perception of the products, or lack of promotion leads to a small market demand, the enterprises will reduce the price to expand the demand, which will lead to losses.

3.2.2 Lack of authority or change of laws and policies leading to termination of the projects
Currently, China has not released specific laws about the PPP mode, and relevant regulations, rules, management methods lack authority and stability. When the central and local governments adjust PPP-related laws and policies, the projects will face uncertainties and are very likely to end up in termination.

3.2.3 Lack of confidence in the government leading to losses
Some local governments, when making promises to reduce or remove part or all taxes and provide grants for PPP projects, do not measure their financial conditions, and consequently, they are under debt burdens and fail to fulfill the promises [17]. In some other cases, the government neglect or even breach the contracts, leading the projects to losses and failure.

4. Suggestions for combining the PPP mode and the construction waste industry

4.1 To establish uniform policies and reduce political risks
As there are no specific laws for the PPP mode, and the released regulations or policies are not consistent and lack authority, it is advisable that we conduct consistent planning of the PPP mode in light of the features of industries. China should establish specific laws for the PPP mode as soon as possible, so that the local governments can follow suit and establish local rules. Besides, we should avoid constant modification of the policies to reduce the political risks.

4.2 To release policies for subsidies and incentives
To resolve the problems including losses of enterprises, delay or failure of projects due to force majeure, the government can release subsidies to tide the enterprises over; to resolve the challenges including low product or service prices and small demands, the government can release incentive policies to strengthen publicity of products and services, and extend the market.

5. Conclusion
To sum up, development of the construction waste recycling industry is a focus of China and there are many advanced technologies in this regard. China has been promoting the PPP mode, but many PPP projects ended up in failure because of the complexity and the dynamic environment. To
combine the construction waste recycling industry with the PPP mode is feasible and can promote industrial growth, but the risks are worth attention. Therefore, it is necessary to release policies to ensure success of the combination. In this paper, we analyzed the development of the construction waste recycling industry and the PPP mode, introduced relevant technologies, recapped the risks, and proposed suggestions against the risks, such as releasing consistent policies, granting subsidies and incentive policies. This study is expected to contribute to the development of the construction waste recycling industry and the PPP mode, as well as to the environment protection initiatives.

References

[1] Fan Xinghua, Gao Jingjing, Xue Zhenhua. Research on construction waste recycling industry based on PPP mode [J]. Low temperature building technology, 2017,39 (03): 134-136
[2] Wang Kang, Zhao Yongsheng. Research on construction waste recycling based on PPP mode [J]. Shandong industrial technology, 2017 (10): 101
[3] Yang Ya. Application of PPP mode in construction waste treatment service [J]. Housing, 2019 (08): 122-123
[4] Pang Yongshi, Hua Zhaowen, Liu jingkuang. Study on industrial policy of construction waste recycling under PPP mode [J]. Construction technology, 2018,47 (16): 153-157
[5] Hou Yarong. Risk assessment of PPP project of Zhengzhou construction waste treatment industrialization [J]. Market research, 2017 (02): 30-32
[6] Zhang Caili, Yu Li, sun Yuzhou. Study on multistage recycling of construction waste [J]. Silicate bulletin, 2016,35 (07): 2149-2152
[7] Li Hao, Zhai Baohui. Research on the development of China's construction waste recycling industry [J]. Urban development research, 2015,22 (03): 119-124
[8] Cheng Zhe, Wei Xiaquan, Lin Jing, Cai Jianming. Spatial temporal pattern and influencing factors of PPP development in China from 1984 to 2013 [J]. Economic geography, 2018,38 (01): 20-27
[9] Zhao Ye. Review and Reflection on China's PPP model research since the reform and opening up -- An Empirical Analysis Based on the full text database of journals [J]. Local finance research, 2016 (08): 84-89 + 95
[10] Wu Mengjiao, Zhou Sen. research on several problems of PPP mode construction project management [J]. Jiangxi building materials, 2016 (15): 288-289
[11] Xue Cuizhen, Shen Aiqin, Guo Yinchuan, zhangjialong. Mix proportion optimization design of small concrete with cwpn based on orthogonal test [J]. Materials guide, 2016,30 (16): 115-119
[12] Xue Cuizhen, Shen Aiqin, Guo Yinchuan, Wan Chenguang, Zhang Jing. Influence of construction waste composite powder on concrete frost resistance [J]. Materials guide, 2016,30 (04): 121-125
[13] Xue Cuizhen, Shen Aiqin, Wan Chenguang, Guo Yinchuan, Li Hui. Effect of construction waste composite powder on shrinkage performance and microstructure of small concrete members [J]. Silicate bulletin, 2016,35 (02): 363-368
[14] Martina Di Gianfilippo, Iason Verginelli, Giulia Costa, Riccardo Spagnuolo, Renato Gavasci, Francesco Lombardi. A risk-based approach for assessing the recycling potential of an alkaline waste material as road sub-base filler material[J]. Waste Management,2018,71.
[15] Dario Topini, Emanuele Toraldo, Luca Andena, Edoardo Mariani. Use of recycled fillers in bituminous mixtures for road pavements[J]. Construction and Building Materials,2018,159.
[16] Yao Dongmin, Li Junlin. Efficiency difference under condition satisfaction: comparison between PPP mode and traditional mode [J]. Reform, 2015 (02): 34-42
[17] Wei Zhimin, Sun Yang. Analysis of constraints on private enterprises' participation in PPP projects [J]. Journal of Jiangsu University of administration, 2016 (03): 56-61