Risk identification for PPP waste-to-energy incineration projects in China

Jinbo Song a,*, Danrong Song a, Xueqing Zhang b, Yan Sun c

a Faculty of Management and Economics, Dalian University of Technology, Dalian, China
b Department of Civil and Environmental Engineering, The Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong
c Faculty of Humanities and social sciences, Dalian University of Technology, Dalian, China

HIGHLIGHTS
• We analyze MSW management practices, relevant legislations and policies in China.
• Through case study on PPP WTE incineration projects, ten key risks are identified.
• Response strategies for key risks are developed.

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ABSTRACT
Municipal solid waste (MSW) is regarded as a renewable energy source. In China, the sharp increase of MSW has precipitated the rapid growth of waste-to-energy (WTE) incineration plants. Private capital has been getting into the WTE incineration industry through the public-private partnership (PPP) arrangement. Due to the large construction cost and the long concession period commonly associated with this arrangement, a number of failures have emerged in PPP WTE incineration projects. The aim of this paper is to investigate the key risks of PPP WTE incineration projects in China and study the strategies for managing these risks by drawing experience and learning lessons from these projects. First, we analyzed the MSW management practices, relevant legislations and policies, and the development of PPP WTE incineration projects in China. Second, we identified ten key risks through interviews, surveys and visits to some selected projects, and provided detailed analysis of these risks. Lastly, we developed response strategies for these risks from the perspectives of both public and private sectors.

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1. Introduction

There are growing support schemes worldwide to promote power generation from renewable energy sources (Commission of the European Community, 2008; Martins et al., 2011) because of the diminishing conventional sources of energy, frequent energy security issues, and increasing public environmental awareness. Municipal solid waste (MSW) is a renewable energy source. In many cities worldwide, there are huge amounts of MSW. The waste-to-energy (WTE) industry has developed quickly in China and many other countries in order to produce electricity as well as deal with the serious environmental problems caused by the huge amounts of MSW.

A number of WTE power plants have been developed in China through public-private partnership (PPP) arrangement, which is regarded as an effective means to attract funds from the private sector to provide public works and services and to improve efficiency (example, shorter construction time, lower construction cost, and lower operation and maintenance cost) in the delivery of such works and services. PPP projects are quite common in many developed and developing countries. The PPP arrangement is particularly attractive in developing countries as it enables the earlier availability of the needed products and services to the public by utilizing private capital (Chang et al., 2003). In China, the private sector has played a significant role in financing and providing public works and services (Chan et al., 2010; Chen et al., 2010; Ke et al., 2010).

However, it is inherent in a variety of risks and uncertainties due to the large construction cost and the long concession period commonly associated with PPP arrangement. Reliable risk identification and allocation of risks between the public and private sectors are essential to the success of PPP projects (Jin and Doloj, 2008; Li et al., 2005; Zhang, 2005a). Some categories of risks are identified, such as
(i) political risk (Wang et al., 2000b) containing government corruption (Maslyukivska and Sohail, 2007), government's breach of contract (Chan et al., 2011), and poor government decision making (Li et al., 2005); (ii) financial risk containing foreign exchange fluctuation (Wang et al., 2000a), interest rate fluctuation (Kumaraswamy and Zhang, 2001), and inflation (Estache et al., 2007); (iii) legal effectiveness issues (Zhang, 2005b); (iv) operation risk containing operation cost overrun (Grimsey and Lewis, 2002), tariff/toll change (Ng and Loosmore, 2007), and expense payment risk (Shen et al., 2006); (v) market demand change (Ke et al., 2010); and (vi) environment risk (Darrin and Mervyn, 2002). The process of risk allocation is complex and flexible (Xu et al., 2011), and it is necessary that the mechanism of risk allocation is equitable (Jin, 2010).

As to PPP WTE incineration projects, environmental problems (Chen and Lin, 2008; Mills et al., 2006) and technological shortcomings (Menard et al., 2006; Belevi and Moench, 2000) are mostly focused on. For example, redundant coal usage for MSW incinerating or lack control of emission may worsen national, regional, or even global environment badly (Asian Development Bank, 2007), poor operational efficiency and low technological level are severe obstruction to the project (Asian Development Bank, 2009), and the composition of MSW in China is questionable of its appropriateness for incinerating (Asian Development Bank, 2010).

In this paper, we will identify key risks in the development, operation and management of PPP WTE incineration projects in China and formulate corresponding strategies for each risk in order to foster the power generation from renewable energy sources progressively.

2. MSW management in China

2.1. The issue of MSW

The quantity of MSW has tremendously grown in the world since 1980s, especially in China with the continuous economic vitality and upgrading of life quality. Statistical data shows that China recently surpassed the USA to be the largest MSW producer (Cointreau, 2007). More than 150 million tons MSW are produced annually in China (Asian Development Bank, 2009), with an annual increasing rate of 8–10% (Asian Development Bank, 2010; Nie, 2008). It is predicted that the annual MSW generation will increase to at least 480 million tons by 2030 (Dan, 2005). In contrast to the huge amount of MSW generated each year, the waste management facilities in China are not sufficient and the waste collection and treatment systems in many cities are inefficient. It is reported that around 30% of the MSW is not collected (Zhang et al., 2010) and more than 200 cities are surrounded by waste in China (Asian Development Bank, 2007).

In general, there are three main MSW treatment methods:

1. Landfilling: It is a traditional waste management method that buries wastes materials. Landfills occupy land. It is predicted that there is a need of additional 1400 landfills over the next 25 years in China (Dan, 2005).
2. Incineration: It is a process that combusts organic materials and converts them into ash, flue gases, particulates and heat, which can in turn be used to generate electricity (Knox, 2005).
3. Composting: It is a process in which solid organic materials are broken down by micro-organisms in the presence of oxygen and a rich, soil-like product is generated (Australian and New Zealand Biosolids Partnership, 2010).

2.2. MSW treatment facilities in China

The three waste treatment methods have been in use in China. Fig. 1 shows the number of landfill sites, incineration plants and compost sites in China between 2001 and 2009. Fig. 2 shows the waste treatment capacities of these facilities in the same period. A trend can be observed from the two figures: the number of incineration plants increases, and so do their treatment capacities; the number of compost sites decreases, and so do their treatment capacities; the number of landfill sites decreases, but their treatment capabilities increase.

3. PPP waste-to-energy incineration projects in China

3.1. Development of WTE incineration plants

WTE incineration is recognized as an effective way to treat MSW (World Bank, 2000) and has been widely applied in many countries (Ecke et al., 2001). For example, in Japan, about 80% of MSW is treated by incineration (Jung et al., 2004), and in Denmark, incineration becomes the officially prescribed method (Heron et al., 2007). WTE incineration plants can reduce the original MSW volume by 90% or even 95% if modern incinerators are used (Belevi and Moench, 2000; Wikipedia, 2001), and steadily generate power and heat.

A number of WTE incineration plants have been built in China. According to a common geographical division of China, five regions are shown in Fig. 3. The quantity and capacity of the plants in each region are as follows. Upto 2010, there are four in Northwest China with a treatment capacity of 3300 tons/day, six in Southwest China with a treatment capacity of 6100 tons/day, seven in Northeast China with a treatment capacity of 4900 tons/day, nine in Central China with a treatment capacity of 7200 tons/day, and 56 in East China with a treatment capacity of 45,100 tons/day (not including Hong Kong, Macao and Taiwan). It can be seen that most of the plants are located in the coastal areas in East China.
3.2. Legislations and policies relevant to WTE incineration projects in China

A series of central legislations and policies has been enacted in China in order to effectively manage MSW, promote its utilization as a source of energy, and protect the environment. These include:

1. The technical policy on municipal solid waste management and pollution prevention (2000).
2. Notice on establishing the levying system for MSW fee and promoting the industrial production of MSW management (2002).
3. Opinion about promoting the industrial production of municipal waste water and solid waste management (2002).
5. Trial guidelines on renewable power generation price and expense (2006).
7. Method to recognize and manage the national encouraged resource with comprehensive use (2006).
10. Notice on improving the price policies of the municipal solid waste incineration for power generation (2012).

3.3. PPP approach to the development of WTE incineration projects in China

The development of WTE incineration projects requires large amounts of money, including the initial construction cost and the operation and maintenance cost. This is a big challenge to the various levels of governments in China. Consequently, they turn to the private capital for the development of WTE incineration projects through a PPP approach. As of 2008, more than 70% of the WTE incineration projects have been developed through the PPP arrangement.
regarded as the grid-connected power; if $q_1$ is more than $q_2$, $q_2$ should be regarded as the grid-connected power.

However, nowadays, these legislations and policies are usually varied and not followed out at the local level (Wang and Tiong, 2000). So, many risks occurred, such as the poor decision making (Li et al., 2005), contract change (Shen et al., 2006) and public opposition (Chan et al., 2011).

4. Research objective and methodology

4.1. Research objective

The main objective of this research is to identify the key risks in the development, operation and management of WTE incineration projects in China, analyze these risks, and provide useful strategies for the effective management of these risks.

4.2. Overall research framework

The flow of the overall research framework is shown in Fig. 5. Case study is adopted as the primary approach for data collection. This method is favored because more useful answers about the events could be obtained when ‘how’ questions are asked (Xu et al., 2011; Yin, 2009).

4.3. Case selection

4.3.1. Selection criteria

The projects are selected according to the following criteria: (1) there existed serious problems no matter in which stage (construction, operation, or transfer) of the project that had caused grave consequences to the project; (2) the projects were broadly distributed in different areas of China and operated under different conditions; and (3) project participants were willing to provide detailed information relevant to this research.

4.3.2. Projects selected

Initially, more than 40 PPP WTE incineration projects were identified by exploring the WTE incineration projects that were listed in China’s Tenth Five-Year Plan (2001–2005). Then, six projects were chosen according to the criteria mentioned in the above. They are Project A in Heze, Shandong Province; Project B in Wujiang, Jiangsu Province; Project C in Xingjin, Xianan Province; Project D in Tongxing, Chongqing Municipality; Project E in Wuhua, Yunnan Province; and Project F in Nanhan, Guangdong Province. The locations of the selected projects are shown in Fig. 3, and other detailed information of these projects is summarized in Table 1. For the reason of confidentiality, the names of the projects are not provided here.

4.4. Data collection

4.4.1. Review of documents on WTE incineration projects

Various types of information on the six projects have been collected. These included internal talks, agendas and meeting minutes of the project management, and other non-public information; news and reports from multimedia; published books, reports, and articles.

4.4.2. Interviewees from contracting and non-contracting parties

To obtain unbiased information and opinions from multiple perspectives, critical stakeholders from both contracting parties and non-contracting parties of these projects were interviewed face-to-face. Interviewees from the contracting parties included project managers from the private sector and high or middle level administrators from local public agencies. For non-contracting parties, this study considered residents nearby the WTE incineration plants.

4.4.3. Design of semi-structured questionnaire

We developed two semi-structured questionnaires respectively for the interviews of contracting parties and non-contracting parties. Each questionnaire included some open-ended questions on key issues involved in PPP WTE incineration contracts and main concerns of different parties. Based on the two questionnaires, we interviewed face-to-face the major stakeholders of these projects. Appendixes A and B summarize the main questions asked in the interview.

4.4.4. Interview with contracting parties

A total of 34 interviews were accomplished with the contracting parties of the six projects, including six with the managers from the plants and 28 with the administrators from the local public agencies. For a majority of the interviews, it took 60–120 min while others took 30–60 min. These interviewees were very supportive and provided us with quite detailed information on the projects they had been involved. During interview, we took notes, and recorded the conversation by digital recorders. After interview, we transcribed the recording into text, of which there were a total of 256 A4 pages.

4.4.5. Interview with non-contracting parties

In our research, residents nearby the six projects were interviewed, and were asked only in a short time. Of the 60 interviews, 49 with critical information were helpful to our research.
4.4.6. Project visiting and observation

We visited four of the six projects, namely Projects A, D, E and F. In visiting each project, we made careful observation of the layout of the plant, the functions of the various components of the plant, management and maintenance of these components, the procedures in the normal operation, and the processes of MSW treatment and waste gas disposal. We also visited the surrounding areas of each project including the residential areas. We prepared detailed notes, photos, and videos of the many aspects that we had visited and observed.

4.4.7. Data processing and analysis

Data collected in different means were thoroughly analyzed from the perspective of how to effectively manage the key risks involved in PPP WTE incineration projects in China. It contains a systematic analytic process of three steps, identification of key risks, analysis of key risks identified, and determination of appropriate response strategies to the key risks. The three steps are expounded in the following sections.

5. Identification of key risks

In this step of key risks identification, risk events that had caused serious problems in the development, operation and management of each selected WTE incineration project were summarized. From these events, key risks were identified. Table 2 presents the process of key risks identification. For example, five risk events had occurred in Project A. The first risk event (RE-A1) was the immature technology of the incinerator used, which did not fit for the kinds of MSW generated locally. RE-A1 resulted in an accumulative operational loss of about 15 million RMB within 4 years of operation. RE-A1 is identified as technical risk in this research. The second risk event (RE-A2) was the use of coal in the plant at a level higher than that nationally restricted. RE-A2 led to the discharge of more greenhouse gases. RE-A2 is identified as environment risk. The third risk event (RE-A3) was the breach of contract by the local public agency which did not keep the promise to provide the project with subsidy. RE-A3 caused the project could not get real help from the government when it faced heavy economic burden. RE-A3 is identified as government credit risk. The fourth risk event (RE-A4) was a lack of legislations and policies to deal with the breaching behavior of government. RE-A4 is identified as legal and policy risk. The fifth risk event (RE-A5) was the change in the project contract that the private contractor withdrew from this project. RE-A5 resulted in the operation of the project broken off. RE-A5 is identified as contract change risk.

Through statistical analysis on key risks of the six projects encountered (Table 3), in total, 10 key risks identified, including (1) government decision-making risk, (2) government credit risk, (3) legal and policy risk, (4) technical risk, (5) contract change risk, (6) environment risk, (7) public opposition risk, (8) MSW supply risk, (9) payment risk, and (10) revenue risk. These risks are analyzed in the following section.

6. Analysis on the key risks

6.1. Government decision-making risk

The bureaucracy, corruption, incompetence, inadequate preparation, or lack of experience of public officials often causes problems in the decision making on some key issues of PPP WTE incineration projects. These problems include unreasonable project planning, improper project location, incomplete technical feasibility analysis, and unreasonable investment return rate. These problems may consequently cause change of contract, government credit issue, or even termination of the project. For example, the problem of improper project location occurred in Projects B and C. In Project B, it was approved by the Provincial Development and Reform Committee, and an environmental impact assessment report was approved by the National Environmental Protection Bureau. However, the public had raised the issue of possible environment pollution, which led to an investigation of the local government. The result of investigation showed that the plant was inappropriately located. This project was eventually suspended.

Besides, some projects were approved to be constructed in the villages in order to protect the environment and economic growth in areas of dense populations. However, because of inefficiency or bureaucracy, it often took a long time for project approval. With rapid urbanization, many residential areas had been under development in the period when the projects were waiting for approval. The locations of the projects would have been already surrounded by several newly built residential areas when they were eventually approved. These residential areas would suffer from emissions of these projects and conflicts would ensue.

6.2. Government credit risk

Public agencies failing to fulfill their obligations in the concession contract can negatively affect the project directly or indirectly. In PPP WTE incineration projects, good government credit is a critical factor to maintain the project in a long term operation. However, it was reported that the probability of local public agencies to breach contract was relatively high in China (Li, 2007). There were some cases that were not successful due to such a reason. For example, Projects A and D failed because relevant public agencies had not fully undertaken their duties of paying for MSW treatment and supplying MSW in sufficient quantities.

6.3. Legal and policy risk

Relevant national PPP legislations and policies may not be carried out or fully carried out. Some legislations and policies are difficult to effectively implement due to their incompleteness. In addition, there are changes of legislations and policies resulted from the change of administrators, or inconsistency between the central and local policies. These problems significantly affect project outcomes. For example, the State Development and Reform Commission, Ministry
of Finance, Ministry of Construction, and Environmental Protection Administration had promulgated legislations and policies regarding the charge system for MSW treatment. However, these legislations and policies were not fully followed in practice by some local public agencies, such as the cases in Projects A, D and E. To make it worse, these legislations and policies do not have specific clauses on the punishment for breaking them.

6.4. Technical risk

The selection of an inappropriate/immature technical scheme or the poor design of a technical scheme for a WTE incineration project can cause serious operational problems or even failure of the project. For example, the imported incinerators may be unsuitable for the MSW generated locally in China. One main issue is the composition of MSW. Unlike some other countries, MSW in China is usually dominated by components of high moisture and low energy. In Project A, the mismatch of the incinerating technology and the local MSW composition led to serious problems in the operation of the project, including very low MSW treatment capacity of the incinerator. Similarly, in Project E, the imported incinerators from the USA required sorting and separating the MSW before incinerating. However, this requirement could not be met in the local residential areas due to lack of sorting facilities and the habit of the local residents. This led to the operation problem of the project and the initial investor of private capital withdrew from this project.

Furthermore, some PPP WTE incineration projects in China experienced a technical dilemma. They modified and renovated existing old facilities into incinerators in order to save money. However, these incinerators of low technical level could not meet...
the various requirements in WTE incineration and consequently led to a great financial loss to the project.

6.5. Contract change risk

Some reasons may cause the change of contract, including imperfect project plan and design, changes in technical specifications, changes in stakeholders’ requirements, and the change of the franchisee. For example, the franchisees had been changed in Projects A and E. These changes led to the delay or suspension of services.

6.6. Environment risk

In the MSW incinerating process, it is inevitable that various kinds of contaminating materials are produced, including $SO_2$, $NO$, $H_2S$, $HCl$, heavy metal ashes (example, Pb, Hg, and Cd), and chlorides (example, polychlorinated dibenzo-p-dioxins and polychlorinated dibenzo-furans). Most of them are extremely poisonous and require stringent attention and prudent treatment. Excessive discharge of contaminating materials can seriously pollute the environment. For example, such environmental accidents had happened in Projects A, D and F. In Project A, the accident was due to human error, which added an excessive amount of coal in the incineration; in Projects D and F, the accidents were because of the mismatch of the incinerating technologies and the properties of local MSW.

6.7. Public opposition risk

Failing to protect the public interests in project development and operation often causes public opposition. Besides, the public opposition is resulted from a lack of environmental knowledge and information on WTE incineration projects. Nowadays, opposition from residents near the WTE incineration plants is a prominent problem in China. Although the local public agencies are eager to promote WTE incineration projects, pressure from the public is quite high. Such pressure can lead to the delay, suspension or termination of a WTE incineration project. Like Project B, there were many other WTE incineration projects in China that had encountered strong opposition from local residents. Common ways of opposition are mass disturbance or non-payment of MSW treatment.

6.8. MSW supply risk

This risk refers to that the quantity of MSW supply is significantly below the designed MSW treatment capacity of the incinerator and/or the quality of MSW is worse than that required for the incinerator. The worse the quality of MSW is, the lower the energy generated per unit of MSW treated and the higher the treatment cost per unit of MSW. Poor MSW quality may also cause various operational problems and even damage the incinerator. For example, when MSW is of large content of construction waste or hard materials such as iron and metal pieces, the incinerators would be stuck and this problem takes time and manpower to solve; when MSW contains large content of inorganic minerals like dust and stone, the designed heat standard would not be attained. In all cases, the financial benefits of the WTE incineration projects will be sacrificed. Moreover, in Project D, the designed MSW treatment capacity of the incinerator was 1200 tons/day. However, there was not sufficient supply of MSW due to lack of large capacity vehicles and high transportation cost. The grid-connected power produced with WTE incineration was even not enough to meet the requirement for the normal operation of the plant itself. A similar problem existed in Project C.

6.9. Payment risk

The delay, insufficient or non-payment of subsidies from the government can cause severe financial problems to the project, and may even cause the suspension or termination of the waste treatment service. Delay of payment had happened in Projects E and F.

Furthermore, the current practice in China is that power generated in WTE incineration project is usually sold to the national power grid. But the price of grid-connected power is different from city to city as these cities have different policies. In general, the price of grid-connected power and the MSW treatment subsidy of WTE incineration projects are relatively low. In this situation, the delay or inadequate payment for MSW treatment and electricity generation would easily cause deficit problem to the project.

6.10. Revenue risk

Several factors influence the cost and revenue of a WTE incineration project, including consumer price index, subsidy for MSW treatment, transportation cost, grid-connected power, price of grid-connected power, coal price, and operational standard. For example, in Project C, the transportation cost was a heavy burden on the project. The reduction of the transportation cost was not significant even after the local government built a new road for the project at a cost of 7 million RMB. In addition, the price of coal may fluctuate from 170 RMB/ton to 350 RMB/ton within a year. However, there was often no corresponding adjustment in the price of grid-connected power and in the subsidy for waste treatment.

7. Response strategies to the key risks

There are some internal relevancy and external causes for the key risks involved in the PPP WTE incineration projects. Firstly, despite various risks may emerge, key risks are generally concentrated on the ten categories discussed in the above. There are some correlations among these risks. For example, mistakes in government decision-making may lead to improper project location, which in turn may worsen surrounding environment and cause severe opposition from local residents. This may eventually bring contract change risk. Besides, when MSW supply risk, payment risk or technical risk occurs, the revenues of the project will change. As there is no political or regulatory guarantee to sustain the operation of the project, the project might modify the original contract.

Secondly, the composition of MSW in China is still a critical restriction to the development of WTE incineration projects. It directly results in technical risk, contract change risk, MSW supply risk and revenue risk. In China, the WTE incineration technologies are still far from perfect. Most modern equipments and machines are imported from abroad. Due to the Chinese life style and weak awareness of MSW household classification, the composition of MSW is a large obstacle. For most MSW, the moisture content is 50–55% and the heat value is usually 3000–5000 kJ/kg, which is much lower than that of the United States, the United Kingdom, Japan and Hong Kong.

Thirdly, there is a lack of professionals who have both technical expertise and management experience in WTE incineration projects in China. Even a limited number of professionals in the WTE incineration projects are mostly from the field of thermoelectric or conventional power generation. However, PPP WTE incineration projects are still in the initial stage, and a number of risks have been
encountered. The three causes discussed in the above deserve special attention because they lead to significant risks and hinder the development of PPP WTE incineration projects. Table 4 provides some response strategies to the key risks.

8. Conclusion

MSW has tremendously grown in many cities in China with the continuous economic vitality and upgrading of life quality. Incineration is one of the three major MSW treatment methods in China. There is growing support of power generation from MSW with increasing awareness about the adoption of renewable energy source. A series of legislations and policies has been enacted in China in order to effectively manage MSW, promote its utilization as a source of energy, and protect the environment. Consequently, a large number of WTE power projects have been developed through the PPP arrangement, which is regarded as an effective means to attract private funds and improve efficiency in the delivery of public works and services. However, many failures have emerged in PPP WTE incineration projects in China due to a variety of risks and uncertainties.

Through case study, we identified 10 key risks including (1) government decision-making risk, (2) government credit risk, (3) legal and policy risk, (4) technical risk, (5) contract change risk, (6) environment risk, (7) public opposition risk, (8) MSW supply risk, (9) payment risk, and (10) revenue risk. Some response strategies were provided for each of the key risks from the public and private sectors.

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<th>Key risk</th>
<th>Public sector</th>
<th>Private sector</th>
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| Government decision-making risk | • Gain WTE incineration experience and improve capacity on decision-making for PPP WTE incineration project.  
• Emphasize project feasibility study.  
• Establish a clear accountability system for MSW treatment. | • Consider and evaluate carefully the results of the decisions made by public agency.  
• Plan remedial measures well beforehand, such as insurance from insurance company. |
| Government credit risk     | • Establish public monitoring mechanisms, and improve government credit and performance evaluation systems.  
• Avoid pursuing political gains for individuals. | • Obtain credit support from the government in written form, and look for guarantee from the government by defining the obligations and rights in the contract.  
• Keep in touch with public agency to have the latest information on relevant policies. |
| Legal and policy risk      | • Set up clear policy goals in order to avoid different public agencies making policies from their own perspectives. | • Specify influencing factors (example, replacement of the government officials, policy inconsistency between the central and local governments) of the risk in the contract to lessen the potential loss.  
• Include compensation clauses of raising concession price or extending concession period in contract. |
| Technical risk             | • Upgrade incineration standards to meet the most stringent international standards.  
• Adopt an effective bidding process to select qualified and experienced private participant.  
• Apply matured modern technologies. | • Analyze carefully the characteristics of local MSW, and adopt suitable technologies.  
• Promote research on WTE incineration technology.  
• Enhance personnel technical training.  
• Improve experience and capacity through the cooperation with research institutes. |
| Contract change risk       | • Stipulate in the contract that: (a) Public agency should be responsible for the costs increased and the time delayed due to his changes.  
• (b) Any changes by private sector should seek the approval of the related public agency; otherwise, the franchise of the private sector will be terminated.  
• (c) Deposit should be paid by the private sector to ensure that the project will be completed and the service will be provided as promised. | |
| Environment risk           | • Oversee the whole process of emissions strictly.  
• Treat the MSW classification prudently. | • Control emissions according to the legislations.  
• Report the contaminants discharged. |
| Public opposition risk     | • Investigate and evaluate problems caused by the project.  
• Consult the public and hold public hearings at the proper time.  
• Make appropriate compensations to residents close to the plant. | • Open the operational information to local residents.  
• Improve the transparency and publicity of the project during operation. |
| MSW supply risk            | • Set up a complete MSW classification system, and establish appropriate legislations and policies to restrict MSW dump.  
• Make more investment on the infrastructure to promote the quality of MSW sorting and classification.  
• Strengthen publicity, education, and demonstration activities. | • Reach an agreement of “take or pay” with public agency to ensure returns on the project.  
• Monitor and record the heat value of MSW for 24 h. |
| Payment risk              | • Make reasonable payment for MSW treatment to private sector.  
• Faithfully implement unified price policies of grid-connected power nationwide. | • Reach an agreement with public agency on surcharge for overdue payment. |
| Revenue risk              | • Use a flexible concession period mechanism (i.e., on condition that a reasonable profit is set, whatever the revenue change, the franchise will expire only when the actual profit arrives at the reasonable profit).  
• Include the formulas and conditions for adjusting the subsidy in the contract.  
• Include the distribution clauses of extra profit between the public and private sectors in the contract. | |
perspectives of both the public and the private sectors. It is believed that these strategies would facilitate both the sectors in the development, operation and management of PPP WTE incineration projects in the future, with enhanced risk assessment and management practices, improved public relationships, more efficient project operations, and better protected environment.

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Appendix A

Questions to contracting parties:

1. What technologies and equipments does the WTE incineration project employ?
2. Please discuss on the process of decision-making, construction and operation of the PPP WTE incineration project. Are there any obstructions?
3. Does the WTE incineration project have an influence on the surrounding environment? What are the residents’ response and attitude?
4. What is the composition of MSW treated by the PPP WTE incineration project? Is it suitable for the technologies and equipments of the project?
5. How much subsidy does the government pay to the private sector? What is the subsidy composed of?
6. What are the revenue and cost of the project?
7. Have any changes or risks happened to the PPP WTE incineration project?
8. Are there any effective legislations and policies pushed PPP WTE incineration projects forward?
9. Do you have any suggestions for improved implementation of PPP WTE incineration projects?

Appendix B

Questions to non-contracting parties:

1. How about environment in your living area?
2. How do you think the impact of the WTE incineration plant on your daily life?
3. Do you support the WTE incineration plant near your community? Please state your reasons.
4. Do you think the MSW treatment fees are appropriate? Please state your reasons.
5. Do you receive timely and clear information about the operation of the plant?

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