Causal Relationships of Risk Factors in PPP Waste-to-Energy Incineration Projects

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Abstract: Waste-to-energy (WTE) incineration has been adopted in many parts of the world as a means of waste disposal while at the same time generating alternative energy. Many WTE incineration projects have been built in the past five years in China. Various risk events frequently happen in WTE incineration projects developed through public-private partnership (PPP) arrangements in China due to lack of sufficient understanding of risks and poor management practices, causing financial, social and environment problems. Through a structured questionnaire survey and subsequent expert validation, the direct and indirect causal relationships of 21 important risk factors in PPP WTE incineration projects were first identified and then critically analyzed to generate a full picture of the risk transmission mechanisms between these risk factors, considering the unique characteristics of this type of projects and the common features of PPP arrangements. This improved understanding of risks would facilitate the establishment of effective risk response strategies toward sustainable delivery of WTE incineration projects. A systematic approach that combines the joint efforts of public and private sectors is necessary for managing these risks towards win-win outcomes as these risks are of multiple sources, involved in all stages of the PPP cycle, and have complicated causal relationships. In designing general policies and specific measures, the following aspects should be taken into consideration: clear public sector’s best value perspectives, selection of capable concessionaire with suitable procedures, methods and criteria, good engagement with the private sector, benchmarking against critical success factors, appropriate roles of the government, and practical and workable project governance and contracting strategies.

Keywords: Public private partnership, waste-to-energy, risk, causal relationship, project management

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1 INTRODUCTION

With rapid and massive urbanization, many developed and developing countries are facing the problem of huge amounts of municipal solid waste (MSW). Waste-to-energy (WTE) incineration is playing an increasingly important role in MSW management (Cheng and Hu 2010; Ecke et al. 2001; World Bank 2012), which has less environmental impact than some other disposal methods and also is a renewable source of alternative energy. For example, in China, WTE incineration is treated as an integral part of China’s energy conservation and emission reduction endeavor. 109 WTE incineration projects had been built in the period of 2014-2016 through public-private partnership (PPP) arrangements according to the statistics of China PPP Center.

Public-Private Partnership (PPP) is regarded as an effective mechanism to attract investment from the private sector, especially in emerging markets, for the provision of public works and services and for efficiency improvement (Castro et al. 2016; World Bank 2014). As complex contractual arrangements that normally involve a large construction cost and a long concession period, PPP projects are inherent with a large number of risks (Xu and Li 2008; Ouyang and Wu 2010; Hainz and Kleimeier 2012; Song et al. 2012; Wang and Zhang 2018). Figure 1 illustrates the typical contract structure of PPP WTE incineration projects in China.

Appropriate risk sharing and management is critical to the success of PPP projects (Zhang 2005b). Poor risk management may lead to serious problems (Soomro and Zhang 2016; Zhang and Soomro 2016). Many serious risk events or even project failures had emerged in PPP WTE incineration projects (Belevi and Moench 2000; Ménard et al. 2006; Mills et al. 2006). In China, although the overall external environment is conducive to the development of the WTE incineration industry, which is faced with good market prospects as evidenced by the average internal rate of return of 10.94% (Zhao et al. 2016a), serious risk events still happen from time to time in WTE incineration projects, causing financial, social and environment problems due to bad risk management prac-
This situation has hindered the sustainable development of WTE incineration projects, which prompted the authors to deeply investigate the risks and their features in PPP WTE incineration projects, with an aim to better develop and manage them toward sustainability. It is hoped that output of this study will facilitate decision makers to design general policies and specific strategies to effectively control risks to ensure the sustainability of WTE incineration projects.

2 RESEARCH APPROACH

2.1 Overall Research Methodology

This study had taken a comprehensive research approach that combines literature review, case study, questionnaire survey, statistical analysis, expert validation, and path analysis. First, through a comprehensive review of literature and international practices, a big number of risk factors associated with PPP projects (including WTE waste incineration projects and other types of projects) were identified. Second, through case study and field investigation of 22 PPP WTE projects in China, risk factors were shortlisted to a small number of 21 with respect to PPP WTE projects. After that, a structured questionnaire survey of experts and practitioners was conducted on the relative significance of the 21 risk factors and the causal relationships between them. Then, the responses to the survey were statistically analyzed to evaluate the significance of these risk factors and initially identify the causal relationships between them. Next, the initially identified causal relationships were screened and those remained passed to three carefully selected experts to further examine, validate and confirm. Significant causal relationships were finalized through this expert validation process. Finally, the causal relationships of risk factors pair by pair were pieced together through path analysis and a consolidated map of causal relationships of all 21 risk factors was derived.

2.2 Literature Review

A large number of previous studies had focused on various issues related to risks in PPP projects, including risk identification, sharing and control, failure mechanisms, renegotiation, compensation for early termination, and concession period determination and adjustment (Hainz and Kleimeier 2012; Shan et al. 2010; Wang et al. 2000; Cheung and Chan 2011; Zhang 2011; Xiong and Zhang 2014; Zhang and Xieng 2015; Soomro and Zhang 2011; Soomro and Zhang 2013; Soomro and Zhang 2015; Castro et al. 2016; Song et al. 2016).

Regarding PPP in waste management and incineration, Belevi and Moench (2000) discussed the factors that determine the element behavior in municipal solid waste incinerators, Rand et al. (2000) provided a decision maker’s guide, Millset al. (2006) analyzed the financial and performance risks in energy savings projects, Kleis and Dalager (2004) discussed waste incineration practices in Denmark, Xu et al. (2006), Xu and Li (2008), Ouyang and Wu (2010), examined the problems in PPP WTE incineration projects and recommended countermeasures, the World Bank (2012) initiated a global review of solid waste management, Song et al. (2012), Song et al. (2013) identified key risks in PPP WTE incineration projects in China, Li and Zhang (2013) and Li et al. (2016) developed quantitative construction waste estimation systems, and Zhao et al. (2016b) analyzed the political, economic, social and technological factors that influence the external environment of the WTE incineration industry in China.

Researchers also explored the causal relationships of risk factors. Iyer and Sagheer (2010) identified 17 risk factors in Indian PPP road projects and developed a hierarchical structure of PPP risk factors using interpretative structural modeling. Rebeiz (2011) investigated the risk factors in build-own-operate-transfer projects in emerging markets, and mentioned the causal relationships between some risk factors. For example, force majeure may cause construction cost overrun, and technical risk or variation in design may lead to construction
delay. Song et al. (2013) identified a number of risk factors in PPP WTE incineration projects in China and discussed their interrelationships. For example, mistakes in government decision-making may lead to improper project location, which consequently worsens the surrounding environment and causes severe public opposition.

2.3 Case Studies of PPP WTE Projects

22 PPP WTE projects in China had been investigated, focusing on the risk events that had happened in each project, their consequences, timing and the response strategies and measures. The 22 projects are:

1. Beijing Liulitun
2. Tianjin Shuanggang
3. Shandong Heze
4. Shandong Zaozhuang
5. Jiangsu Wujiang
6. Ningbo Fenglin
7. Shenzhen Pinghu
8. Shenzhen NanShan
9. Shenzhen Yantian
10. Guangzhou Panyu
11. Guangzhou Likeng
12. Zhongshan Zhongxinzutuan
13. Zhengzhou Xingjin
14. Xuchang Tianjian
15. Wuhan Hankoubei
16. Anhui Wulu
17. Chongqing Tongxin
18. Kunming Wuhua
19. Guangdong Huizhou
20. Shijiazhuang Qili
21. Shanghai Jiangqiao
22. Shanghai Yuqiao

2.4 Risk Factors Identified

In the process of literature review and cases studies, 21 risk factors associated with PPP WTE incineration projects had been identified and they are coded as $S_1$ to $S_{21}$:

$S_1$: Technical risk
$S_2$: Construction cost overrun
$S_3$: Delay in completion
$S_4$: Design/construction/commissioning performance risk
$S_5$: Operating cost overrun
$S_6$: Operational performance risk
$S_7$: MSW supply risk
$S_8$: Revenue risk
$S_9$: Unwillingness to pay
$S_{10}$: Government decision-making risk
$S_{11}$: Government credit risk
$S_{12}$: Land acquisition and administration approval risk
$S_{13}$: Private sector decision-making risk
$S_{14}$: Private sector credit risk
$S_{15}$: Environmental pollution
$S_{16}$: Public opposition
$S_{17}$: Interest rate risk
$S_{18}$: Currency exchange risk
$S_{19}$: Inflation risk
$S_{20}$: Incompleteness of law/Change in law
$S_{21}$: Force majeure

2.5 Questionnaire Survey

To examine the relative significance of the 21 risk factors, in the questionnaire, respondents are requested to rate each of them on a scale of 1-5, with “1” being “not important,” “2” being “fairly important,” “3” being “important,” “4” being “very important,” and “5” being “extremely important”.

Regarding causal relationships, the 21 risk factors can potentially form a maximum number of 420 ($21 \times 20$) pairs of causal relationships. In the questionnaire, respondents are asked to give opinions on the causal relationships of these risk factors. For example, if an expert agrees that technical risk would likely lead to construction cost overrun and operational performance risk, he/she shall mark the risk factors of construction cost overrun and operational performance risk in the row of technical risk (Table 1) to indicate the causal relationships of the three risk factors.

3 ANALYSIS OF CASUAL RELATIONSHIPS

3.1 Questionnaire Responses

121 questionnaires were sent out and 62 respondents returned complete questionnaires. 49 respondents came from the industry (government organizations, investors, lenders, consultants, and legal advisers) and 13 respondents were from the academia (universities and research institutions). Most of the respondents have substantial research and working experience with actual PPP projects in general and WTE incineration projects in particular.

3.2 Significance of Risk Factors

Wang and Zhang (2017) provided a detailed analysis of the relative significance of the 21 risk factors. Based on all responses (i.e., including all industry and academic respondents), except for the five risk factors of “unwillingness to pay”, “interest rate risk”, “force majeure”, “inflation risk”, and “currency exchange risk” that have a significance index of 2.66, 2.60, 2.55, 2.45 and 2.19, all other risk factors have a significance index above 3.0 and range from 3.05 to 4.11. This means that except for the five factors that are (more than) “fairly important”, all other risk factors are (more than) “important” or “very important”. Wang and Zhang (2017) also examined the level of agreement between respondents from industry and those from academia in the rating of the significance of the 21 risk factors. Their Mann Whitney U test indicated that there is a general agreement between industry and academia respondents as there are only 2 (i.e., “construction cost overrun” and “unwillingness to pay”) out of the 21 risk factors that are statistically different in terms of mean significance at the 95% level of confidence.
### Table 1. Sample of the questionnaire survey

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Very likely leading to the risk factors as follows (you could select more than one choices)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical Risk</td>
<td>☐ Design/Construction/Commissioning Performance Risk  ☐ Delay in Completion</td>
</tr>
<tr>
<td></td>
<td>☐ MSW Supply Risk  ☐ Operating Cost Overrun  ☐ Government Decision-making Risk</td>
</tr>
<tr>
<td></td>
<td>☐ Government Credit Risk  ☐ Revenue Risk  ☐ Private Sector Decision-making Risk</td>
</tr>
<tr>
<td></td>
<td>☐ Private Sector Credit Risk  ☐ Interest Rate Risk  ☐ Public Opposition</td>
</tr>
<tr>
<td></td>
<td>☐ Inflation Risk  ☐ Incompleteness of Law or Change in Law</td>
</tr>
</tbody>
</table>

### Table 2. Causal relationships between technical risk and other risks

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Risk factors very likely to be caused</th>
<th>Agreement of respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical Risk</td>
<td>Construction Cost Overrun 87%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Delay in Completion 81%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Design/Construction/Commissioning Performance Risk 81%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operating Cost Overrun 81%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operational Performance Risk 77%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Municipal Solid Waste Supply Risk 3%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Revenue Risk 55%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unwillingness to Pay 0%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Government Decision-making Risk 16%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Government Credit Risk 6%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Land Acquisition and Administration Approval Risk 6%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Private Sector Decision-making Risk 16%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Private Sector Credit Risk 6%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Environmental Pollution 68%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Public Opposition 39%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Interest Rate Risk 0%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Currency Exchange Risk 0%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inflation Risk 0%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Incompleteness of Law or Change in Law 6%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Force Majeure 6%</td>
<td></td>
</tr>
</tbody>
</table>

#### 3.3 Significance of Causal Relationships

The percentage of respondents in the questionnaire survey who agree there is a causal relationship between two risk factors is used to indicate whether the causal relationship is strong or not. A higher percentage means a stronger causal relationship and vice versa. This percentage is calculated for each of the 21 risk factors. For example, the percentages of agreement for the causal relationships between technical risk and other 20 risk factors are shown in Table 2, from which it is seen that 87% of the respondents agree that technical risk is very likely to lead to construction cost overrun, which means a very strong causal relationship; whereas no respondent agrees technical risk is very likely to cause interest risk, currency exchange risk or inflation risk, which means there is no causal relationship.

Causal relationships that have a percentage of agreement larger than 50% were regarded as “significant” and were retained for further expert validation and confirmation in the next stage and others as “not significant” and discarded.

#### 3.4 Expert Validation and Confirmation

Three experts were selected, each having deep PPP knowledge and rich working experience in more than 20 PPP projects, of which at least three are WTE incineration projects. These experts were provided the statistics of the questionnaire responses regarding causal relationships so that they could very carefully reexamine, reconsider and validate the causal relationships of the risk factors. A causal relationship was remained if all three experts agreed there is significant causal link between the two risk factors involved; otherwise, it would be discarded.

#### 4 SIGNIFICANT CAUDAL RELATIONSHIPS

##### 4.1 Consolidated Caudal Relationships

Through initial respondent percentage agreement analysis and further expert validation and confirmation, significant causal relationships between the 21 risk factors were identified and summarized in Table 3 and Figure 2. These causal relationships pair by pair were pieced together through path analysis, and finally a consolidated map of the significant causal relationships was derived, which is shown in Figure 3. It is seen that each risk factor may directly cause a number of other risk factors and each of these other risk factors may consequently cause some other risk factors and so on through sequential causal relationships.
<table>
<thead>
<tr>
<th>No.</th>
<th>Risk factor</th>
<th>Risk factors very likely to be caused</th>
<th>Agreement of respondents in first round</th>
<th>Whether confirmed by all three experts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Technical risk</td>
<td>Construction cost overrun, Delay in completion, Design/ construction/ commissioning performance risk, Operating cost overrun, Operational performance risk, Environmental pollution</td>
<td>87%, 81%, 81%, 81%, 77%, 68%</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>Construction cost overrun</td>
<td>Revenue risk</td>
<td>77%</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>Delay in completion</td>
<td>Revenue risk</td>
<td>58%</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>Design/ construction/ commissioning performance risk</td>
<td>Operating cost overrun, Operational performance risk, Environmental pollution</td>
<td>65%, 77%, 55%</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>Operating cost overrun</td>
<td>Operational performance risk, Revenue risk</td>
<td>58%, 77%</td>
<td>Yes</td>
</tr>
<tr>
<td>6</td>
<td>Operational performance risk</td>
<td>Operating cost overrun, Revenue risk, Environmental pollution, Public opposition</td>
<td>52%, 77%, 74%, 55%</td>
<td>Yes</td>
</tr>
<tr>
<td>7</td>
<td>Municipal solid waste supply risk</td>
<td>Revenue risk</td>
<td>94%</td>
<td>Yes</td>
</tr>
<tr>
<td>8</td>
<td>Revenue risk</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>9</td>
<td>Unwillingness to pay</td>
<td>Government credit risk</td>
<td>65%</td>
<td>Yes</td>
</tr>
<tr>
<td>10</td>
<td>Government decision-making risk</td>
<td>Municipal solid waste supply risk, Government credit risk, Land acquisition and administration approval risk, Public opposition</td>
<td>52%, 58%, 58%, 68%</td>
<td>Yes</td>
</tr>
<tr>
<td>11</td>
<td>Government credit risk</td>
<td>Revenue risk</td>
<td>74%</td>
<td>Yes</td>
</tr>
<tr>
<td>12</td>
<td>Land acquisition and administration approval risk</td>
<td>Environmental pollution</td>
<td>58%</td>
<td>Yes</td>
</tr>
<tr>
<td>13</td>
<td>Private sector decision-making risk</td>
<td>Technical risk, Construction cost overrun, Delay in completion, Design/ construction/ commissioning performance risk, Operational performance risk, Environmental pollution</td>
<td>61%, 74%, 77%, 71%, 74%, 52%</td>
<td>Yes</td>
</tr>
<tr>
<td>14</td>
<td>Private sector credit risk</td>
<td>Environmental pollution, Public opposition</td>
<td>61%, 52%</td>
<td>Yes</td>
</tr>
<tr>
<td>15</td>
<td>Environmental pollution</td>
<td>Public opposition</td>
<td>87%</td>
<td>Yes</td>
</tr>
<tr>
<td>16</td>
<td>Public opposition</td>
<td>Unwillingness to pay</td>
<td>87%</td>
<td>Yes</td>
</tr>
<tr>
<td>17</td>
<td>Interest rate risk</td>
<td>Operating cost overrun, Revenue risk</td>
<td>52%, 74%</td>
<td>Yes</td>
</tr>
<tr>
<td>18</td>
<td>Currency exchange risk</td>
<td>Revenue risk</td>
<td>74%</td>
<td>Yes</td>
</tr>
<tr>
<td>19</td>
<td>Inflation risk</td>
<td>Construction cost overrun, Operating cost overrun, Revenue risk</td>
<td>58%, 65%, 81%</td>
<td>Yes</td>
</tr>
<tr>
<td>20</td>
<td>Incompleteness of law or change in law</td>
<td>Revenue risk</td>
<td>58%</td>
<td>Yes</td>
</tr>
<tr>
<td>21</td>
<td>Force majeure</td>
<td>Construction cost overrun, Delay in completion, Operational performance risk, Revenue risk, Environmental pollution</td>
<td>58%, 74%, 61%, 71%, 55%</td>
<td>Yes</td>
</tr>
</tbody>
</table>
4.2 Direct and Indirect Causal Relationships

Let $S = \{S_1, S_2, \ldots, S_{21}\}$ be the set of the 21 risk factors, then, the causal relationships of these risk factors can be described by directed lines or links. For example, “technical risk ($S_1$)” likely causes “operational performance risk ($S_6$),” which may consequently lead to “revenue risk ($S_8$).” This series of causal relationships of the three risk factors can be described as “technical risk $\rightarrow$ operational performance risk $\rightarrow$ revenue risk” or “$S_1 \rightarrow S_6 \rightarrow S_8$.”

Causal relationships can be classified into two categories, direct and indirect. If risk factor A itself can result in risk factor B, the causal relationship between A and B is called direct causal relationship. If risk factor A causes other risk factor(s) which lead(s) to risk factor B, the causal relationship between A and B is called indirect causal relationship. For example, in the relationships of “$S_1 \rightarrow S_6 \rightarrow S_8$”, “$S_1 \rightarrow S_6$” and “$S_6 \rightarrow S_8$” are direct causal relationships; “$S_1 \rightarrow S_8$” is indirect causal relationships.
relationship. For example, as shown in Figure 4, the risk factor of incompleteness of law/change in law can directly cause other 9 risk factors, which are operating cost overrun, revenue risk, government decision-making risk, government credit risk, land acquisition and administration approval risk, private sector decision-making risk, public opposition, interest rate risk, and currency exchange risk.

![Diagram](image)

**Figure 4.** Examples of direct causal relationships

5 IMPROVING WTE PPP PRACTICES

5.1 Multiple Sources of Risk Factors

PPP WTE incineration projects, like other type of PPP projects, have some common development stages, including feasibility study, design, construction, operation and maintenance. The analytical results discussed in the previous sections indicate that each and all stages involve some significant risk factors. Government decision-making risk, private sector decision-making risk, public opposition and technical risk may appear in the feasibility study stage; design/ construction/ commissioning performance risk, construction cost overrun, delay in completion, land acquisition and administration approval risk in the design and construction stage; and MSW supply risk, operating cost overrun, operational performance risk, revenue risk, unwillingness to pay, government credit risk, private sector credit risk, environmental pollution, interest rate risk, currency exchange risk, inflation risk, incompleteness of law/change in law and force majeure in the operation and maintenance stage. Some risk factors may happen in all stages or in more than one stage. For example, technical risk, government credit risk, private sector credit risk, and incompleteness of law/change in law may occur in any of these stages. Furthermore, some risk factors are due to the public sector (e.g., government credit risk and government decision-making risk), some to the private sector (e.g., delay in completion and construction cost overrun), whereas others are not caused by either sector (e.g., public opposition and force majeure).

5.2 Systematic Approach to Risk Management

The multiple sources of risk factors, each and all stages involving risk factors and the various significant causal relationships between them make effective risk management a challenging task, which necessitates a systematic approach and the joint efforts of public and private sectors. Researchers had studied how public and private sectors can collaborate towards win-win outcomes in PPP projects, for example, the public sector’s best value perspective (Zhang 2006a; Zhang 2006b; Hu et al. 2014), the way of good engagement with the private sector (Farquharson et al. 2011), organizational competencies and project performance (Omar and Fayek 2016; Fayek and Omar 2016; Elwakil 2016), critical success factors (Zhang 2005b; Xu et al. 2015), the role of the government (Kumaraswamy and Zhang 2001), how to pave the way for PPP projects (Zhang 2005a), concessionaire selection protocol, methods and criteria (Zhang 2004a; Zhang 2004b; Zhang 2005c), and project governance and contracting strategies (Weber and Allen 2010; Sha 2016; Wang et al. 2016; Li et al. 2017; Yan et al. 2017). Furthermore, Zhang and Chen (2013) development a systematic framework for infrastructure development through PPP and the World Bank (2014) published a PPP reference guide. In the process of designing general policies and specific measures for effective risk control to ensure the sustainability of WTE incineration projects, useful points should be drawn from these research outputs while taking into consideration of the particular characteristics of this type of projects, in particular, the complicated causal relationships of the 21 important risk factors.

6 CONCLUSIONS

WTE incineration has been adopted in many parts of the world to deal with the common MSW problem, significantly reducing environmental impact as well as creating alternative energy. Many WTE incineration projects have been built through PPP as part of China’s energy conservation and emission reduction endeavor. Although being regarded as an effective mechanism to attract private investment and improve efficiency, PPP projects are inherent with a large number of risks over a long concession period. Serious risk events have frequently occurred in PPP WTE incineration projects in China, causing financial, social and environment problems.

A clear understanding of the key risk factors associated with PPP WTE incineration projects is a prerequisite for effective risk management toward the success of this type of projects. Previous studies on risks of PPP projects normally analyze risks individually based on risk classification and statistical analysis, often neglecting their interrelationships. As a small step further, this study identified and analyzed the causal relationships of risk factors associated with PPP WTE incineration projects, generating a consolidated map of significant
causal relationships of 21 important risk factors.

A systematic approach that combines the joint efforts of public and private sectors is necessary for managing these risks towards win-win outcomes as these risks are of multiple sources, involved in all stages of the PPP cycle, and have complicated causal relationships. In designing general policies and specific measures, the following aspects should be taken into consideration: clear public sector’s best value perspectives, selection of capable concessionaire with suitable procedures, methods and criteria, good engagement with the private sector, benchmarking against critical success factors, appropriate roles of the government, and practical and workable project governance and contracting strategies.

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