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## Article

# Major Obstacles to Public-Private Partnership (PPP)-Financed Infrastructure Development in China

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**Abstract:** Public-private partnership (PPP)-led infrastructure development has been crucial in China as it has in many other countries. However, several obstacles in the field tend to challenge its development. Based on survey responses from PPP *practitioners* and *professionals* in Hong Kong and mainland China, this study analyzes and ranks the key barriers to PPP projects. Our findings suggest that both groups classify the critical obstacles to PPP consistently, albeit with some divergences in ranking them. Reflecting mainly from the perspective of professionals, the study also proposes some suggestions for mitigating these obstacles, so it could contribute to the effective formulation of PPP and successful implementation of PPP-led infrastructure projects in China as well as elsewhere.

**Keywords:** PPP; obstacles; project failure; infrastructure; sustainable development; China



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## 1. Introduction

Public-private partnerships (PPPs) have become popular with the advancement of project financing mechanisms. The British government was the first to use the term in 1982, defining it as an agreement between the government and private enterprise on infrastructure finance, operation and management. In general terms, a PPP is an alternative finance method aimed at overcoming the limitations of the public sector, as well as a way of enhancing efficiency in construction, operation and service delivery [1,2]. This definition implies three main features—partnership, benefit sharing and risk sharing—to reduce the financial burden and other risks to the public sector through different models such as build, operate and transfer (BOT), build, transfer and operate (BTO), build, own and operate (BOO) and design, build, finance and operate (DBFO). These models are efficient in different ways in sustainable infrastructure development. Each one also incorporates an element to realize sustainable social change [3]. However, each model's effectiveness is also affected by the various obstacles that are encountered in practice [4,5]. The absence of clear contractual arrangements, resulting in weak governance, is one of many factors contributing to the failure of PPP projects [6].

PPPs have received a great deal of attention in research across academic disciplines, and academics have studied them from many different perspectives. Scholars have looked at the various obstacles to PPPs using their respective disciplinary perspectives, from financial risk assessment to construction project management [7,8]. A large part of the literature has focused on the financial risks arising from having weak contractual arrangements between stakeholders, including the uncertainty of long-term concessional periods which generate high risks for both government and private enterprises. This implies that a project's success is thus heavily dependent on having the right contractual arrangements in place and allocating risks in line with resources, institutional frameworks and use of institutional rules [6,9,10]. The literature has investigated these contractual arrangements and risks extensively, however, it is not well known how important these major obstacles are, so an investigation into them and their level of importance is needed. Written from the

perspectives of PPP *practitioners* and *professionals* in Hong Kong and mainland China, this study uses conventional mean score methods to rank the obstacles. PPP practitioners are those involved in PPP-led project construction and operation (e.g., people working in the industry), whereas PPP professionals are those academic or professional experts who have capacity to provide advisory services on PPP contracts. Moreover, the study employs the 'two-sample *t*-test' to estimate differences in perceptions between the two groups regarding each of the key obstacles, and the level of variance is estimated using the rank agreement factor (RAF). The estimates show divergence between the two groups concerning the main obstacles. The study also suggests a few mitigation measures that will potentially help overcome the obstacles to PPPs.

In Section 2, we review the literature. Section 3 discusses the study's methodology, and explains our field survey strategy and analytical methods. Section 4 presents the results, based on the estimates. In Section 5, we analyze the findings related to the major obstacles, their importance and policy measures to help overcome them. Finally, we draw conclusions, while outlining contributions made to the literature, this study's limitations and the direction we believe further research should take.

## 2. Relevant Literature

The concept of public–private partnerships is cross-disciplinary in nature. While public administration discipline focuses on public values safeguarding political ideology and interests, management focuses on improving the efficiency of service delivery through close monitoring of firms' performance. Collaborative governance focuses on improving interorganizational partnerships, built on trusted relationships and mutual negotiations. Engineering and environmental governance focuses on improving the use of expertise and ensuring sustainability; private enterprises take the most risks, and limited interactions take place between partners. Given due consideration to theoretical foundations, this paper looks at the issues of PPP obstacles through the perspective of management.

A number of articles have analyzed the factors affecting the success of PPP projects. Critical factors include the sharing of risk, the strength of the private enterprises involved, political will, public support and the transparency of the procurement process [11]. Liu and Wang have studied the characteristics of an efficient tender, including robustness of business case development, quality of the project brief, public sector capacity, governance structures, effective communication, balance between streamlining and competition and transparency of the bidding process [12]. Equally, studies have explored several difficulties associated with PPPs, such as finance model preparation and common errors in project development and management [12,13]. Major difficulties include high transaction costs and preconstruction delays, political/social obstacles and inefficient financial markets [1]. Contractual arrangements are often complicated, involving multiple stakeholders with different goals and requiring information sharing for bidding and negotiation, leading to high costs and lengthy procurement processes [12,14]. The professional services fee further increases the costs involved. Other factors, such as public attitude and investment of public funds, are functions of political economy [15]. Additionally, PPPs violate the free-market process by governments partnering with strong private enterprises via negotiation [16,17]. Major difficulties in PPP projects include high transaction costs and lengthy preconstruction periods, political motivation and inefficient capital markets (more details are supplied in Table 1).

**Table 1.** Obstacles to global public-private partnership (PPP) projects.

| Group               | Sub-Group   | Variable                                     | Literature Source   |
|---------------------|---|--|---|
| <i>Difficulties</i> | High transaction costs and lengthy project period | 1 High transaction costs                     | Whiteside 2019; Robert and Albert 2015                                  |
|                     |   | 2 High bidding costs                         | Protap and Chakrabarti 2018   |
|                     |   | 3 Lengthy bidding/negotiation process        | Osei-Kyei et al., 2017; Cruz and Marques 2013                           |
|                     |   | 4 Lack of competition                        | Cui et al., 2018; Whiteside 2019  |
|                     |   | 5 Public opposition                          | Boyer and Van Slyk, 2019  |
|                     | Sociopolitical obstacles                          | 6 Lack of flexibility                        | Liu and Wang 2016; Protap and Chakrabarti 2018                          |
|                     |   | 7 High service charge to end users           | Robert and Albert 2015; Liu and Wang 2016;                              |
|                     | Non-conductive capital market                     | 8 Difficulties in finding financial partners | Robert and Albert 2015; Cruz and Marques 2013                           |
| <i>Risks</i>        | Unfair allocation of risks                        | 9 Allocation of risks                        | Gunnigan and Eaton 2006; Carbonara et al., 2018; Hurk and Verhoest 2016 |
|                     | Political risks                                   | 10 Government investment in similar projects | Hurk and Verhoest 2016  |
|                     |   | 11 General legislative change                | Carbonara et al., 2018; Hurk and Verhoest 2016                          |
|                     | Financial risks                                   | 12 Planning permission delay                 | Chen et al., 2018; Carbonara et al., 2018                               |
|                     |   | 13 Cost overruns                             | Osei-Kyei and Chan 2017   |
|                     | Legal and contractual risks                       | 14 Trust variation                           | Hurk and Verhoest 2016  |
|                     |   | 15 Consultation delays                       | Ozdoganm and Birgonul 2000  |
|                     | Environmental conditions                          | 16 Weather/environmental conditions          | Chen et al., 2018   |
| Management risks    | 17 Time overrun                                   | Kang-Wook et al., 2016;                      |   |
| <i>Errors</i>       | Private sector failure                            | 18 Procedural delay                          | Osei-Kyei and Chan 2017; Chen et al., 2018;                             |
|                     |   | 19 Lack of innovation                        | Zhang and Tariq 2020  |
|                     |   | 20 Lack of appropriate skills/experience     | Ye and Tiong 2003; Zhang and Tariq 2020;                                |
|                     | Lack of well-established legal framework          | 21 Wrong expected return                     | Ye and Tiong 2003   |
|                     |   | 22 Absence of sound legal framework          | Siagian 2017; Grimsey and Lewis 2004                                    |
|                     |   | 23 Indirect control of standards             | Ye and Tiong 2003   |

PPP projects involve various risks associated with finance, legal framework, institutional strength and sociopolitical context [18,19]. Those risks must be shared equally between the government and stakeholders (concessionaires), who will bring differential perceptions, capacities and goals [11,20]. Risk sharing between the public sector and private enterprise is critical if the desired outcomes are to be achieved [21]. Some studies have also highlighted the political risks associated with legislative change and delays in obtaining planning permission [22]. A study of financial portfolio management has also evaluated the risks associated with exchange rates, inflation rates and cost overruns [23]. Risks are associated with ‘misallocation of risks’, ‘legislative change and planning permission delays’, ‘budget overspends’, ‘legal and contractual risks from trust variation and consultation delay’, ‘risks from the weather/environmental context’, and ‘time overruns and procedural delays’.

Errors occur when contracting out PPP projects, arising from failures in estimating outcomes and the capacity of the private sector. Where there is a lack of expertise and experience among private enterprises and the public sector, this can lead to implementation delays and project failure [24–26]. In most cases, there is an absence of an established framework for PPPs, in which the traditional needs and control models are in place. Within this type of context, a poorly defined framework poses a risk when projects are contracted out and implemented, and they are often fraught with disputes among the parties involved [17,27]. Thus, it can be seen that errors arise from both the public sector and private enterprise. Public sector errors are linked with the absence of a relevant, established legal framework and quality control. Private sector errors are associated with a lack of design innovation, expertise and experience.

Comparing the tender documents with public finance initiatives (PFI), we see that the allocation of risks is associated with a poorly thought-out tender process. Though the process may initially save on procurement time, it favors private enterprise at the time of bargaining, against the procuring entity. This reflects private enterprise’s political influence over the public sector, which will typically disfavor the procuring authority. Globally, unsuccessful PPP projects provides some insight into the obstacles encountered. We can take the Hangzhou Bay Bridge in China (14 November 2003) and the Channel Tunnel in

Europe (1 December 1987) as examples of failing PPP projects (see Appendix A). In total, we identified 23 obstacles from the literature and international evidence, and these can be divided into three broad categories—difficulties, risks and errors (see Table 1).

### 3. Research Methodology

This study uses cross-sectional survey data, collected from PPP practitioners and professionals based in Hong Kong and mainland China. The survey was administered in 2016 using a semi-structured questionnaire format outlining the 23 obstacles. Using sampling techniques, we invited 60 PPP firms (e.g., DaYue Consulting Co Ltd., Beijing, China) and contractors (e.g., CCC Shipping Engineering Co Ltd., Hong Kong) to complete the online questionnaire. Around 50% of the questionnaires were completed and returned to us within two months. Additionally, we contacted a similar number of professionals online, based on their research profiles. However, we received responses only from 10 professionals, two from South China University of Technology, three from Dongbei University of Finance and Economics, two from the University of Hong Kong, two from City University of Hong Kong and one from MTR Corporation Ltd. They were asked to respond using a *five-point Likert scale*, on which 1 represents the lowest importance and 5 represents the highest importance. They were also asked about other obstacles that they think are important. We piloted the questionnaire before sending it to the respondents. In addition, we interviewed two reputed PPP professionals—Senior Practitioner (expert 1) and University Professor (expert 2)—who provided us with an in-depth insight into the mitigation measures needed to overcome 10 key obstacles to PPPs. Both participants hold Ph.D.s in construction management and have more than 10 years' experience of PPP project handling. Nine open-ended (qualitative) questions were asked to capture their expert opinions and perspectives on mitigation measures. They recommended some additional measures, irrespective of the ten major obstacles identified, for achieving desired outcomes from the PPP-led infrastructure development projects, with a particular focus on China and Hong Kong.

The study followed a mixed-method approach using literature, case studies, online survey on practitioners and professionals and face-to-face interviews with the professionals. Such an approach allows us to identify potential obstacles to PPP-led infrastructure development in the context of China and Hong Kong, and analyze those in depth. Based on the responses, we estimated the average mean scores of 23 potential obstacles to PPPs identified from the literature, and ranked the top 10 obstacles among them. Given due consideration to the differences and similarities in perception of obstacles between the two study groups—practitioners and professionals—average scores were then used to estimate relative ranking using the analytical methods described below.

A mean score ( $MS$ ) was used to compare relative importance of the obstacles:

$$\text{Mean score, } MS = \frac{\sum(f \times s)}{N}, \quad 1 \ll MS \leq 5,$$

where 's' is the given score for each obstacle,  $f$  is the frequency and  $N$  is the total number of responses, assuming that two samples are normally distributed, and the population has common variance. We further estimate the mean differences between the groups using an independent two-sample  $t$ -test:

$$t = \frac{(x_1 - x_2) - (u_1 - u_2)}{\sqrt{s \times s \left( \frac{1}{n_1} + \frac{1}{n_2} \right)}}$$

$$S \times S = \frac{(n_1 - 1)S_1 \times S_1 + (n_2 - 1)S_2 \times S_2}{n_1 + n_2 - 2}$$

where  $n_1$  and  $n_2$  are the number of responses from practitioners and professionals;  $x_1$  and  $x_2$  correspond to the respective means.  $S_1$  and  $S_2$  are population means and  $u_1$  and  $u_2$  are sample variances.

We evaluated the uniformity of ranking between the two study groups using the rank agreement factor (*RAF*), percentage rank agreement factor (*PA*) and rank agreement disagreement factor (*PD*):

Percentage rank agreement,  $PA = 100 - PD$

Percentage rank disagreement,  $PD = 100 \times \frac{\sum_{i=1}^N |R_{i1} - R_{i2}|}{\sum_{i=1}^N D_{\max i}}$

$D_{\max} = |R_{x1} - R_{y2}|$  is the *PD*.  $i = 1, 2, \dots, N$ .  $x$  and  $y$  represent the mean scores of ranks of the obstacles, respectively, of the two groups—practitioners and professionals.

Rank agreement factor,

$$RAF = \frac{\sum_{i=1}^N |R_{i1} - R_{i2}|}{N}$$

where the rankings of the obstacles of practitioners and professionals are  $R_{i1}$  and  $R_{i2}$ .

The difference is  $Di = |R_{i1} - R_{i2}|$ ,  $i = 1, 2, \dots, N$ . An *RAF* value of zero indicates perfect agreement [28].

## 4. Results

### 4.1. Major Obstacles

According to the estimation of survey data, the mean scores of the obstacles the practitioners ranked varied from 3.47 to 4.2. They identified ‘wrong expected return’ as the most critical obstacle, and indeed this is common in PPP-led infrastructure development in mainland China and Hong Kong. The mean score of this obstacle was 4.2, followed by the obstacle ‘cost overrun’ (3.97) and ‘absence of a well-established legal framework’ (3.93). See Table 2 for all 10 major obstacles and their mean scores.

**Table 2.** Comparative ranking of the top 10 potential obstacles.

| Potential Obstacles                                  | Mean Scores from Practitioners | Rank | Mean Scores from Professionals | Rank |
|--|--------------------------------|------|--------------------------------|------|
| Wrong expected return                                | 4.20                           | 1    | 4.10                           | 3    |
| Cost overruns  | 3.97                           | 2    | 4.00                           | 4    |
| Absence of a well-established legal framework        | 3.93                           | 3    | 3.70                           | 6    |
| Private sector failure/lack of skills and experience | 3.90                           | 4    | 3.10                           | 10   |
| Trust variation                                      | 3.80                           | 5    | 4.20                           | 2    |
| Misallocation of risk                                | 3.73                           | 6    | 4.30                           | 1    |
| High service charge to end users                     | 3.57                           | 7    | 3.50                           | 7    |
| Political/social obstacles/lack of flexibility       | 3.53                           | 8    | 3.30                           | 8    |
| Time overruns  | 3.50                           | 9    | 3.20                           | 9    |
| Procedural delays                                    | 3.47                           | 10   | 3.80                           | 5    |

On the other hand, the mean score (MS) of major obstacles given by the professionals varied between 3.1 and 4.3, showing little deviance from the practitioners’ perspective. For instances, the professionals ranked ‘misallocation of risk’ as the top obstacle to PPPs, with a mean score of 4.30, followed by ‘trust variation’ (4.20) and ‘wrong expected return’ (4.10). According to the professionals, these were the top three obstacles to PPP-led infrastructure projects in the study context, whereas the practitioners perceived them as the sixth (3.73), fifth (3.80) and third (4.20) most important obstacles to PPPs, respectively.

In general, a mean score greater than 3.00 demonstrates a high level of importance on a five-point scale. All key obstacles exceeded the benchmark level, exhibiting a considerable threat to PPP-led infrastructure projects in the study context. Both groups gave ‘wrong expected return, a mean score above 4.00, while the professionals gave ‘misallocation of risk’, trust variation’ and ‘cost overrun’ mean scores above 4.00. All these four obstacles were reportedly categorized as severe threats to PPP-led infrastructure development in China and Hong Kong. Other threats that the practitioners perceived very close to severe were ‘absence of a well-established legal framework’ and ‘private sector failure/lack of



skills and experience'. Similarly, the professionals perceived 'procedural delays' as a great threat to PPP-led infrastructure development.

#### 4.2. Perception Variation

The Levene *t*-test was used to estimate the difference in mean scores between the two study groups. A divergence between two groups was assumed to be present if the congeneric variance was homogenous in a group, then the estimation could be made. We ran such an estimation, and according to the estimation, we cannot reject the null hypothesis (at 95% confidence) that the two groups had equal variance. That means that no significant difference in variance was evident between the two groups across the 10 obstacles, except in the case of 'political/social obstacles/lack of flexibility'. The estimate of *F* was as large as 13.66 (see Table 3 for details of the estimates). Other estimates of *F* were lower than 1, except in the case of 'Trust variation'.

**Table 3.** The differences in perceptions of potential obstacles.

| Variables  | Equality of Variances |          |      |          |           | <i>t</i> -Test (Equality of Means) |                    |
|--|-----------------------|----------|------|----------|-----------|------------------------------------|--------------------|
|  | Equal Variances       | <i>F</i> | Sig. | <i>t</i> | <i>df</i> | Sig.(2-Tailed)                     | ( <i>p</i> -Value) |
| Wrong expected return                                | Assumed               | 0.06     | 0.81 | 0.35     | 38        | 0.73                               | 0.10               |
|  | Not assumed           |          |      | 0.36     | 16        | 0.72                               | 0.10               |
| Cost overruns  | Assumed               | 0.03     | 0.87 | 0.21     | 38        | 0.83                               | 0.07               |
|  | Not assumed           |          |      | 0.21     | 15        | 0.84                               | 0.07               |
| Absence of a well-established legal framework        | Assumed               | 0.14     | 0.71 | 0.75     | 38        | 0.46                               | 0.23               |
|  | Not assumed           |          |      | 0.77     | 16        | 0.46                               | 0.23               |
| Private sector failure/lack of skills and experience | Assumed               | 0.00     | 0.98 | 1.96     | 38        | 0.06                               | 0.80               |
|  | Not assumed           |          |      | 1.87     | 14        | 0.08                               | 0.80               |
| Trust variation                                      | Assumed               | 1.53     | 0.22 | −1.23    | 38        | 0.23                               | −0.40              |
|  | Not assumed           |          |      | −1.50    | 24        | 0.15                               | −0.40              |
| Misallocation of risk–high risk                      | Assumed               | 0.32     | 0.58 | −1.88    | 38        | 0.07                               | −0.57              |
|  | Not assumed           |          |      | −1.88    | 16        | 0.08                               | −0.57              |
| High service charge to end users                     | Assumed               | 0.00     | 0.98 | 0.19     | 38        | 0.85                               | 0.07               |
|  | Not assumed           |          |      | 0.19     | 15        | 0.85                               | 0.07               |
| Political/social obstacles/lack of flexibility       | Assumed               | 13.66    | 0.00 | 0.66     | 38        | 0.51                               | 0.23               |
|  | Not assumed           |          |      | 0.50     | 11        | 0.63                               | 0.23               |
| Time overruns  | Assumed               | 0.04     | 0.84 | 0.86     | 38        | 0.40                               | 0.30               |
|  | Not assumed           |          |      | 0.88     | 16        | 0.39                               | 0.30               |
| Procedural delays                                    | Assumed               | 0.40     | 0.53 | −0.98    | 38        | 0.33                               | −0.33              |
|  | Not assumed           |          |      | −0.99    | 16        | 0.34                               | −0.33              |

Moreover, we used the independent *t*-test for equality of means. Such a test verifies whether the two groups have the same mean. According to the survey responses, the perspectives of the two groups did not vary significantly across the obstacles because the absolute value of *p* was greater than 0.05. Though the Levene test for 'private sector failure/lack of skills and experience' demonstrated significant differences (*t*-value = 1.96), *p*-value (=0.80) in the independent *t*-test evidence was such that this difference in perception was insignificant across the two groups.

### 4.3. Rank Agreement Factor

The rank agreement factor (RAF) was used to reach a common agreement in the ranking of all the obstacles to PPPs, and the percentage rank agreement factor (PA) was used to measure the agreement in the importance of ranking. According to our estimation, the average RAF was 0.5, which demonstrates that a moderate degree of agreement over all the obstacles between the perceptions of two groups was evident (See Table 4). This implies that the two study groups had a level of similarity in their perspectives on obstacles to PPP-led infrastructure development in China and Hong Kong. Moreover, the percentage rank agreement factor (PA) was 67%, which demonstrates a higher agreement than disagreement on identifying the same obstacles, and recognizes that both groups identified two-thirds of the major obstacles. Both groups recognized most of the critical obstacles to PPP-led infrastructure development in the same way.

**Table 4.** Significance of the potential obstacles.

| Groups                          | Rank Agreement Factor (RAF) | Percentage Rank Agreement Factor (PA) | Percentage Rank Disagreement Factor (PD) |
|---------------------------------|-----------------------------|---------------------------------------|--|
| Practitioners and professionals | 0.5                         | 67%                                   | 33%                                      |

## 5. Discussion

The survey results reveals that there are 10 most critical obstacles that challenge the success of PPP-led infrastructure development in China and Hong Kong, including ‘wrong expected return’, ‘cost overruns’, ‘absence of an well-established legal framework’ for PPP formulation and contracts, ‘private sector failure due to lack of expertise or experience’, ‘trust variation’, ‘misallocation of risks’, ‘high service charge to the end users’, ‘political/social obstacles’, ‘time overruns’, and ‘procedural delays’, here given in order of their respective significance. According to the survey responses of both practitioners and professionals, these obstacles largely contribute to PPP-led infrastructure project failure in China. Arguably, the PPP-led Hangzhou Bay Bridge development in China failed due to several reasons, including overestimation of traffic flow which caused errors in decisions (‘wrong estimation and lack of expertise or experience of private enterprises’), increase of upfront costs (‘cost overruns’), opening of competing bridges (Shaoxing-Hangzhou Bay Bridge and Salt Bridge on Hangzhou Bay) and a national infrastructure development plan for Hangzhou Bay Sea-crossing Engineering, Qianjiang 3 Channel and Ningbo, and Zhoushan-Shanghai sea-crossing (‘misallocation of risk’) which affected the cost recovery period (‘time overruns’). Finally, local weather conditions influenced by typhoon/marine climate and tidal waves also contributed to increased costs (‘political/social obstacles/lack of flexibility’). The Hangzhou Bay Bridge development was challenged by all these obstacles (see Appendix A for details).

Similar obstacles are evident in the context of Europe. PPP-led infrastructure development projects such as the Channel Tunnel have encountered challenges from the wrong estimation of revenue, and alternative modes of transportation such as road transport (particularly the Eurostar), ferries and airlines have sparked price competition. Particularly, the cost of construction increased significantly due to changes in the initial design, which contributed to a cost overrun that was more than twofold. This happened due to the involvement of inexperienced enterprises. The installation of equipment and vehicles, management delays and security controls also contributed to the delays and cost overrun. The construction delay led to operational delays, and ultimately contributed to cash flow delays, creating a financial burden for the long term. This particular PPP-led infrastructure development project between the UK and France also faced huge political and social barriers in the cross-border contract and management.

The perspectives of the two groups may have varied a little; however, such variations are insignificant for most of the obstacles, except in the case of ‘wrong expected return’: both the practitioners and professionals ranked it as a severe obstacle. This particular obstacle



remains at the top of the list of major obstacles to PPP-led infrastructure development projects. Again, the practitioners rated 'cost overruns' as the second most important obstacle, yet they were ranked fourth by the professionals—so both groups perceived this obstacle as having considerable importance due to its negative effects on investment decisions. The practitioners rated the 'absence of a well-established legal framework' as the third most important obstacle to PPP-led infrastructure projects, while the professionals rated it as the sixth most important obstacle. PPP-led infrastructure development projects are at greater risk without a well-defined legal framework. Interestingly, the four least important obstacles were largely perceived as identical across both the practitioner and professional groups.

PPPs' success depends on quality, cost, schedule timescales and governments' capacity to overcome constraints. The professionals also provided us with some insight into other associated obstacles. Firstly, another obstacle to PPP-led infrastructure development projects was identified as the lack of government credibility arising from competitive projects taken on by the government. Such evidence is available particularly in transportation infrastructure schemes in China and Europe. The schemes affected expected revenue, diverting the flow of traffic to alternative directions (see Appendix A). A second additional obstacle was seen as the absence of policy and governance in collaborative projects involving central and local government particularly in the context of China. Thirdly, the failure of PPP projects was associated with malicious bidding practices, inefficient management and non-compliance in contract negotiations. Other macroeconomic structural obstacles to successful PPP-led infrastructure development were interest rates, inflation, re/financing problems, salvage value issues, banks' lending policies, public opposition, distribution of responsibilities, estimation of future cash flow, a lack of appropriate standards and oversight mechanisms, government control and policy changes from new governments. PPP-led infrastructure development projects are very influenced by contextual factors, including socioeconomic, legal, legislative and financial system [29].

The differences in perception between the two groups were not statistically significant at the 95% level of confidence, except for on 'private sector failure of skills and experience'. The *t*-value for 'trust variation' and 'misallocation of risks' was greater than 1, demonstrating a certain variation in perception between the two groups, but the average percentage of agreement was higher than that of disagreement. So the perspectives of the two groups were more uniform than divergent. Moreover, the rank agreement factor (RAF) of 0.5 and percentage rank agreement factor (PA) of 67% show an agreement between the two groups, and the divergence between two groups was lower than the uniformity.

As for the two professionals who were sought to give their perspectives on the mitigation measures, financial managers are crucial in financial planning and estimating revenue and overcoming major obstacles in PPPs. A special purpose vehicle (SPV) structure, for example, would see an experienced company commissioned for construction through a competitive bidding process. Such a mechanism would include provisions for a concessional agreement for raising income (if needed), extending the operational period or raising fare/ticket prices. It would also keep extra funds aside in case construction became more expensive than planned. Moreover, a precise description of roles and division of responsibilities should be clearly outlined in the contract. This should also specify the power and accountability of all stakeholders involved, and there should be terms in the contract allowing for compensation claims from the accountable party for any losses. Clarity in PPP arrangements could help overcome obstacles and achieve the desired outcomes in the infrastructure development in China and Hong Kong. Details of the expert suggestions that were obtained through the face-to-face interviews can be found in Appendix B.

## 6. Conclusions

This study has analyzed 23 potential obstacles to PPP-led infrastructure development in the context of mainland China and Hong Kong, from the perspectives of practitioners and professionals. It identified the top most important 10 obstacles, including 'wrong

expected return', 'cost overruns' and 'absence of a well-established legal framework', with some divergence in their order of importance. It has identified two obstacles, 'competitive projects' and 'absence of governance', in the case of collaborative projects involving central government and local government, that are critical to the success of PPP-financed infrastructure development in the study context. This study has also suggested a few mitigation measures based on the experience of professionals. These include appropriate revenue estimation, construction design and management, and accurate project timescales. PPP formulation should carefully consider these aspects to achieve desired outcomes and sustainable growth.

In the absence of the right experience and expertise, a government's control over PPP-led infrastructure projects can be ineffective, particularly with schemes implemented in collaboration with local government. A lack of expertise from the sponsoring government will contribute to project failure. The efficiency of private enterprise is also critical to the success of PPP-led infrastructure development projects. Both government and private enterprises must have technical expertise and financial stability to achieve the desired outcomes. Moreover, sociopolitical, weather and cultural factors, which create barriers to progress, must be taken into consideration in PPP formulation to optimize expected outcomes.

PPP-led infrastructure development projects should address all these critical obstacles to achieve the economic, social and environmental efficiency that could lead to the growth of the industry. Further, new policies that incorporate business opportunities such as carbon trading will enhance sustainability [30]. Overcoming the key obstacles will help achieve sustainability, and a sustainability-led project evaluation would facilitate efficiency in PPP-led infrastructure development, together bringing better outcomes and greater sustainability.

This study contributes to the existing literature on PPP-led infrastructure development in China as well as in the European context by identifying major obstacles and their significance. Such information is crucial in developing legal frameworks for PPPs, overcoming barriers and exploiting the benefits of PPPs. The study provides an insight into the order of significance of the major obstacles which can influence a PPP-led infrastructure development project. Relevant stakeholders of the industry can use this information to take the necessary steps at the early stage of PPP project formulation once they are aware of these critical obstacles. Moreover, the study also offers a few policy measures which can be used to potentially mitigate the obstacles' effects and contribute to the development of a best practice framework in PPP projects in China and Hong Kong, and potentially in other similar countries across the globe. However, the ranking of the obstacles and their mitigation measures are contingent upon the context, and as such may not be universal. Future studies would increase the sample sizes of both the practitioners and professionals to increase the reliability of the findings and their implications.

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## Appendix A. Two PPP-Led Infrastructure Development Projects that Faced Several Obstacles

<sup>®</sup>The Hangzhou Bay Bridge (HBB) is a cross-sea bridge across the Hangzhou Bay in China, which is the world's third-longest bridge. Such infrastructure required huge investment, and the Chinese authority adopted the PPP model. Based on the traffic flow, the internal rate of return (IRR) and payback period were estimated to be 8.03%~10.1% and 14.2 years, respectively. Such estimations attracted 17 private enterprises and financial institutions, and a state foundation (HBB Development Co Ltd., Hangzhou, China) was formed to facilitate the BOT. Later, the corporation transferred 80% shares to the local government. The bridge opened five years later than the estimated date and the finance gap finally reached RMB 850 millions in 2013 due to the revenue deficit of 200 million. If this continues, the principal amount would not be recovered in the next 30 years.

As a failing case, HBB is meaningful in analyzing obstacles to PPPs. The failure of HBB was caused by errors in estimation of expected return. *Firstly*, the feasibility study predicted that by 2010 the traffic flow would reach 18.67 million vehicles, but the figure was actually 30% less (11.12 million). The misjudgment caused severe errors in decision-making. *Secondly*, the project required additional investment—the estimated amount of 6.4 billion increased to 13.6 billion in 2011. The upfront investment by the joint-stock corporation continued to increase. *Thirdly*, within two years of starting, a competitive Shaoxing-Hangzhou Bay Bridge opened for traffic, which is only 50 kilometers away. Moreover, the opening of Salt Bridge on Hangzhou Bay in 2013 made the situation worse. In addition, the national plan for Hangzhou Bay Sea-crossing Engineering, Qianjiang 3 Channel and the Hangzhou Bay Bridge and Ningbo Zhoushan-Shanghai sea-crossing projects will affect the cost recovery period. *Finally*, the local weather conditions, including typhoons and marine climate, and the hydrology, e.g., tidal and stormy waves, also contributed to high costs.

<sup>®</sup>The 50 km Channel Tunnel (CT) across the strait of Britain and France was the largest infrastructure project of its kind. In 1981, the two countries agreed to construct and operate the tunnel with the help of the private sector. In 1986, the two governments formed a consortium and signed a concessional agreement with the British Channel Tunnel Group (CTG) and France Manche (FM) to construct and operate the tunnel for 55 years (including construction period of 7 years). The two government also agreed not to build any competitive tunnel before 2020. The initial budget was £6.023 billion with £1.023 billion equity funds—79% from CTG and 21% from FM. CTG and FM under the TransMancheLink (TML) were the major players in the project and responsible for construction, installation and operation.

The CT encountered several challenges. *Firstly*, the revenue estimation was based on the income from the shuttle train tickets, royalties and ancillary revenues under the terms of contract. However, the consortium failed to estimate effects of the ferry and airline services that later sparked price competition. Moreover, when Eurostar began operation half a year later, the rail communication further decreased. *Secondly*, the initial cost of £4.8 billion increased to £10.5 billion due to higher construction costs, which contributed to a 65% higher cost of construction (£5.8 billion). The underlying reason was linked to design changes and the cost overruns related to equipment installation and train vehicles. Moreover, the initial company cost of £642 million increased to £1.128 billion in 1994 due to cost overruns caused by management delays and security controls. *Thirdly*, time and cost overruns were caused by adding security and environmental measures. Moreover, the construction delays led to operational delays, which caused cash flows delays, creating a financial burden for the long term. Apart from these issues, this project faced political risks, management risks, legal and contract risks and misallocation of risks.

## Appendix B. Interview with the Two Experts (Professionals): Mr. Pau and Dr. Koh

Nine research questions were asked on how to mitigate the key obstacles in PPPs.

Q1. There is always a feasibility study in the period prior to PPP projects when stakeholders would do the expected revenue calculations for the post-stage operation. However, from the results of the questionnaires, we can see that most failed PPP projects have a problem that the actual revenue in the post-stage operation is much lower than the expected income. How can we solve the problem of wrong expected returns?

*Expert 1: "This problem raises the ticket price in the operation stage. A policy might be to extend the operation time on the concession agreement. The private enterprise then would be able to reduce fares for the services. Secondly, the policy could support raising the price of a single ticket; the PPP project should go in the market to increase competition. The later strategy would increase the actual income of the private sector. Besides, a provision for subsidy should be retained for the concessional agreement if the actual income is less than the estimated one; similarly, the government has the right to get dividends".*

Q2. The stakeholder will estimate the cost in the feasibility period and know how much they will need to construct such a PPP project. However, a problem may possibly occur that cost overruns are much more serious, for example, if the PPP project needs to invest 100 million, but in the later period stakeholders have to pay additional investment which makes the private sector company collapse. How might the private enterprise be compensated if cost overruns happen?

*Expert 1: "When the private companies do a project, certainly not all the funds come from the companies themselves and some funds may come from the bank. The cost of a project is difficult to control, because constructing a project is complicated. The problem of cost overruns is usually due to two reasons. The first reason is trouble building so that there are many unexpected things. The second reason is the length of the construction period, for example, if you need 5 years to construct a project, but in Hong Kong, the construction period has to be compressed to 3.5 years".*

*Expert 2: "If the government is a stakeholder in the special purpose vehicle (SPV), private enterprise can possibly apply to the government for funding. If the government itself does not want to be a stakeholder, when the situation of cost overrun happens, the government will ignore it and let the private enterprise handle this problem completely. To avoid this problem, the private sector should not be too optimistic when they calculate the budget and the private sector should explore the potential change of the market. When they calculate the cost of the PPP projects, the private sector should add externalities into the overall cost so that the situation of cost overruns may be mitigated".*

*"In addition to this, SPVs can discuss the possible situation of the project with the World Bank, which is usually the economic activity around the project, and seek a provision from the bank. This provision may account for 20 percent of the total cost which might not be used, but if the situation of cost overruns happens, the private sector can use this part of the money. The application of this provision is a promise for SPVs and SPVs will not worry about having no money to go on to the next activities. After the project is over, money lenders have their own clearing form with the borrower such as enhancing the interest rate. Undoubtedly, the point is that the borrower should make sure the number of provision, that is to say, the financial manager should make a perfect financial analysis and plan".*

Q3. PPP project frameworks are not well-established in mainland China. How could the government prepare a sound legal framework?

*Expert 2: "Generally speaking, the charge standard and legal framework of each province are different, so there will be usually some ambiguities. For example, if a motorway spans A province to V province, maybe at the beginning this motorway is designed with the legal framework and financial situation of A province, but the motorway is completed and extends to V province and V province has another toll collection manner.*

*Many times this problem will appear frequently in mainland China, because the private sector may sign a contract with the central government or local government. To solve this issue, the contract needs to mix the legal framework of the central government with that of local government for the mode of operation or the government can draw up a new legal framework for the PPP project”.*

**Q4.** How could the private sector solve the inadequacy of skilled manpower?

*Expert 2: “This is the SPV’s internal problem. SPVs absolutely want to find some related experience companies to construct this project”.*

*Expert 1: “The way of choosing the construction unit is bidding or direct entrustment”.*

*Expert 2: “This depends on the nature of the project itself. If a similar project has been constructed by many companies, such as road projects, the SPV may select the way of open tendering and invite 8 to 10 companies to bid. On the other hand, some projects such as hydroelectric power have been done by few companies, so the SPV has to entrust a company to do this project. For example, only one or two companies around the world have done prison projects, and if the mainland China government wants to do a PPP prison project which will involve the issues of defense and national security, the government should cooperate with local companies and one or two experienced companies abroad”.*

**Q5.** How do we solve the issue of trust variation?

*Expert 2: “If government does not act as a stakeholder and just signs an implementation agreement with the private sector (the agreement means that the private sector only has 35 or 40 years to operate and after the operation period, this project has to be handed over by the government), the government will ignore the internal trust variation and let the SPV sort it out themselves. Under normal conditions, this problem might not happen if the SPV is very professional, but more common trust variation appears on the political risk. In some less politically stable countries such as Africa and South America countries, the emergence of a new regime may overturn the previous agreement signed with the last government. Besides, if estimation is too optimistic and the SPV cannot recover costs, the issue of trust variation also occurs”.*

**Q6.** How do we solve the misallocation of risks usually borne by the private sector?

*Expert 1: “If the question of misallocation of risk appears, the private sector companies can settle the dispute themselves, but they have to know they are at a loss because they used the most part of the money in the construction period. So that private sector companies can appropriately raise ticket prices in the operation period. However, sometimes private sector companies cannot resolve the dispute. At this time, the government can hand over the rest of this project to another tender”.*

**Q7.** How do we reduce the service charge to the end users?

*Expert 2: “Usually there will be a high price limit for these user reimbursement projects when the government calls for bids. The government signs the agreement with private sector companies and the agreement provides that prices cannot exceed a certain range such as metro ticket prices, water rates and travelling expenses”.*

**Q8.** How do we overcome the time overrun issue?

*Expert 1: “Generally speaking, the biggest influencing factor in time overruns is the extension of the construction period when a project does not get into the operational phase in accordance with the provisions of time. If this situation is caused by the government, the construction side could claim for reimbursed time and the operation period could be postponed. However, if this situation depends on the private sector itself, the private sector must pay money for this fault”.*

**Q9.** How do we solve the procedural delay issue?

*Expert 2: “The procedure includes the financing aspect, construction aspect and operation aspect. For the financing procedure delays, the stakeholder in charge of finance should be very familiar with the financing procedure and make a perfect financial plan. Before the start of the project, the stakeholder has to explain the financing procedure and possible problems to the finance company or bank. For the operation aspect, the delays are mainly caused by incomplete information transfer. To avoid these delays, the SPV should update the data regularly and keep the previous data for the operation party as a reference. For example, normally, the market in the operation period is different from the market in the feasibility study period. If the market environment in the operation period is good, the stakeholders will consider raising the ticket price appropriately according to the data renewal. Inversely, if some competitive items appear around this project, the SPV should talk over lowering the price to attract passenger flow volume”.*

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