First Public-Private-Partnership Application in Taiwan's Wastewater Treatment Sector: Case Study of the Nanzih BOT Wastewater Treatment Project

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Abstract: Taiwan has been promoting public-private-partnership (PPP) projects in the wastewater treatment sector with the aim of improving its sustainable environment and increasing its wastewater treatment rate. The Nanzih Wastewater Treatment Project is the first PPP application in Taiwan's wastewater treatment sector. It provides important experiences and lessons for both the public and private sectors. This paper presents a detailed study of its tender process, concession agreement, financial structure, payment mechanism, and risk management. It explains the key features of the project and provides conclusive findings on the lessons learned. These observations should be useful for practitioners and academia who are interested in the development of future PPP wastewater treatment projects in Taiwan.

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Introduction

In recent years, public-private-partnership (PPP) has been promoted in the Asian region to develop infrastructures. The total PPP investment in the water and sewerage sector in low- and middle-income countries from 1990 to 2008 was U.S.$ 59,281 million, while East Asia and the Pacific had the largest share at U.S.$ 28,777 million, accounting for almost one-half of the total investment (The World Bank 2009). Compared with the power and transportation sectors, Asian concession projects in the water sector are limited but have huge potential for further development (Kwak 2002).

The benefits of PPP include the introduction of the private sector's financial sources, technical and managerial expertise and innovation, reduced lifecycle cost, proper risk allocation, improved quality of service and performance, and enhanced public management (European Commission 2003; Ministry of Finance 2004; The World Bank 1997). These benefits have encouraged various applications of PPP projects worldwide. However, some questions whether the expected benefits are realized in PPP practices. Value for money (VfM) is the concept for assessing those benefits accrued to the public sector. Morallos and Amekudzi (2008) reviewed VfM practices in different countries. Furthermore, Garvin and Bosso (2008) proposed an equilibrium framework to assess the effectiveness of PPP programs and projects. In order to guide practitioners to the best PPP practices, substantial guidelines were published by various multilateral agencies [Asian Development Bank 2008; European Commission 2003; The World Bank 1998; United Nations and Economic Commission for Europe 2000; United Nations Industrial Development Organization (UNIDO) 1996]. Given the extensive PPP researches carried out, it is essential to summarize past experiences and studies for a thorough understanding of the issue. Recently, Kwak et al. (2009) conducted a comprehensive review on the PPP infrastructure development research in the past 20 years, and summarized key findings on success factors and barriers, government roles, concessionaire selection, risks, and finance. Future PPP projects will benefit from the lessons learned.

Particularly for PPP procurement, government requirements must be understood and fulfilled through various PPP modes. Abdel-Aziz and Russell (2001) structured government requirements into three dimensions of rights, obligations, and liabilities. For delivery of successful PPPs, Abdel-Aziz (2007) also derived various implementation principles at program level. Zhang and Kumaraswamy (2001) concluded that suitable legal foundation, workable procurement process, coordinating and supportive authority, marketability and affordability, selection of most suitable concessionaire, and realignment of public mindsets are critical for PPP procurement improvements.

Evidently, the success of a PPP project also depends on a well-structured tendering procedure and the selection of the most suitable concessionaire. Tiong (1995a,b,c, 1996) conducted extensive research on tendering and negotiations of build-operate-transfer (BOT) projects, and he identified that the financial and technical strengths of the consortium are the most important critical success factors in a BOT tender. Zhang (2004, 2005) found that the net present value (NPV) method and multiattribute analy-

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sis are the two most commonly used competitive tender evaluation methods, and the financial criterion package is the most weighted package in evaluation. Furthermore, Kumaraswamy and Anvuur (2008) developed an integrated framework that unified technical, relational, and sustainability criteria for selecting sustainable PPP teams.

In PPP operational practices, risk allocation and management is a complex issue, and it is the key to ensure VfM outcomes. Various risk management frameworks and their allocation have also been studied (Akintoye et al. 2001; Grimsey and Lewis 2002; Li et al. 2005; Tiong et al. 1999; Wang et al. 2004). The underlying principle of allocation is that the risks need to be allocated to the party who is able to manage the risks efficiently.

The complexities of PPPs vary according to specific project and country conditions. A case study is an effective approach to investigate PPP applications to capture specific project features, gain detailed understanding of its implementation, and draw useful implications (Gomm et al. 2000). To date, very few Taiwan PPP cases have appeared in international publications, especially with regard to the wastewater treatment sector. Therefore, the case study of the first PPP application in Taiwan's wastewater treatment sector, the Nanzih BOT wastewater treatment project, can provide valuable insights for both PPP practitioners and academia at a time when at least 30 wastewater treatment projects are being planned for the PPP market in Taiwan.

Taiwan's PPP Act and Associated Regulations

Taiwan promulgated "the Act for Promotion of Private Participation in Infrastructure Projects" (PPP Act) in 2000. It plays a significant role in Taiwan's PPP development and guides the implementation by various relevant project parties. The Public Construction Commission under the Administrative Assembly or the Executive Yuan is the government body in charge of PPP projects.

The major PPP models defined by the PPP Act are BOT, build-transfer-operate (BTO), rehabilitate-operate-transfer (ROT), operate-transfer (OT), and build-own-operate (BOO). The wastewater treatment and sewerage system belongs to one of 13 categories of infrastructure development that are allowed to use PPP schemes for procurement. The PPP Act specifies two different approaches to procure PPP projects. Under Article 42, a PPP project can be initiated as a government-planned project to solicit proposals from the private sector, while under Article 46, a PPP project can be initiated by an unsolicited proposal from the private sector. When the unsolicited proposal is not approved, the government can adopt the idea and proceed through the solicited approach of government-planned PPP projects. The procurement procedure for unsolicited proposals where the government provides land is shown in Fig. 1 (Public Construction Commission 2008).

The main objective of the initial and second evaluations is to ensure that the project proposed by the private sector meets the government's needs. The two-stage preevaluation mechanism for unsolicited proposals is used to improve efficiency and reduce costs borne by the private sector. Only upon approval of the initial evaluation will the proponent be required to submit a detailed project proposal for further evaluation. The subsequent tender evaluation aims to select the best proposal among the original proponent and other competing private investors.

Under this procedure, several measures are put in place to protect the original unsolicited proponent such as paying for its

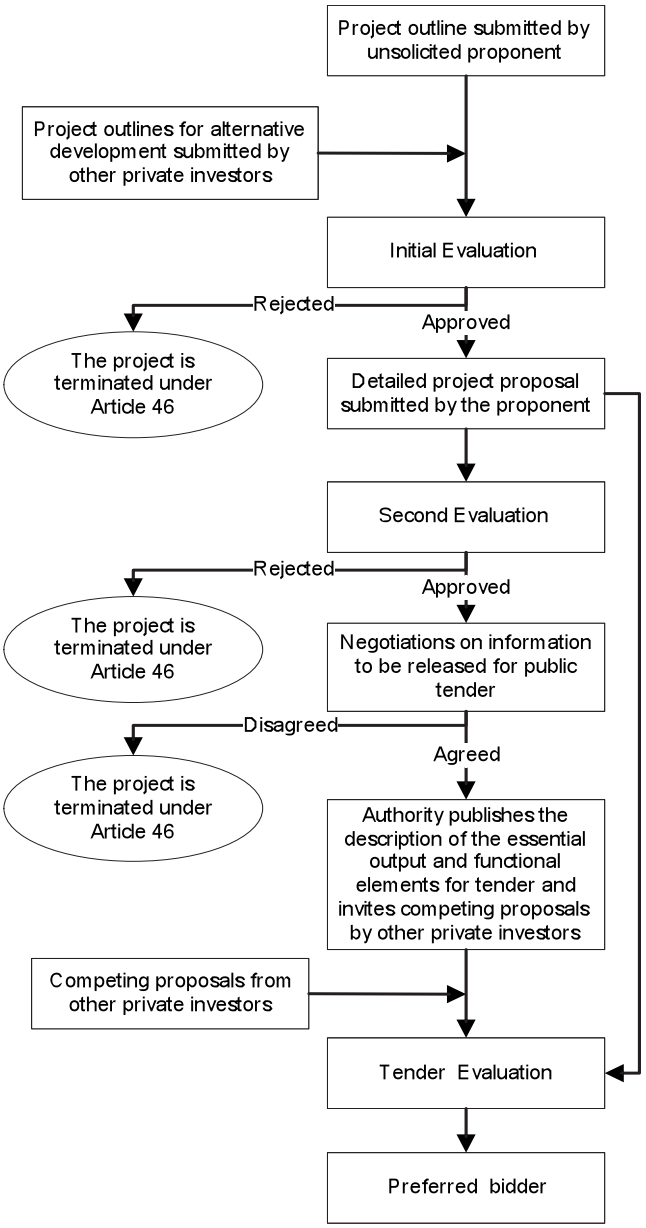

Fig. 1. Procurement procedure for unsolicited proposals where the government provides land (adapted from Public Construction Commission)

intellectual proprietary rights and providing the extra credits for tender evaluation or the right to match. On the other hand, the 45-day period for inviting other competing proposals specified in the procedure is an implicit protection measure. It might be difficult for other private investors to prepare a comparable proposal in such a short time and this enhances the original proponent's position of advantage. However, those protection measures favoring the original proponent can discourage competition in the tender process. Meanwhile, the original proponent bears significant risks in terms of the costs of preparing the business outline and detailed proposal. Those costs are not reimbursed and there is no guarantee of the project being awarded. The balance of the improved competition and the efficient protection for unsolicited proponents is important. In South Korea, a fraction of tendering costs (up to 30%) is reimbursed to qualified losers in unsolicited project tendering, while some bonus points might be awarded to

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the original proponent (PIMAC 2007). Taiwan could consider this approach to improve tender competition and also to provide moderate protection to proponents.

Taiwan's PPP Act provides various incentives to stimulate private participation in PPP projects. Like South Korea and Germany, certain taxes in Taiwan can be reduced or exempted for PPP projects. In addition, the Taiwan government can provide loans to private investors for financing PPP projects. Such loans are not restricted to qualified private companies involving foreign investments. There are two types of governmental loans, namely, medium/long-term loans and concessional loans, which can be obtained from the Council for Economic Planning and Development (CEPD) (The Council for Economic Planning and Development 2002, 2004). The CEPD medium/long-term loan is charged at a benchmark rate plus a credit margin of no more than 2%. The benchmark rate is the medium/long-term capital cost of Chunhwa Post, which is a government-owned post and banking services provider. In the early PPP market, this governmental loan played an important role to help drive and finance large-scale PPP projects. For instance, the Taiwan High Speed Rail PPP project secured NT$ 210 billion from the CEPD medium/long-term loan out of NT$ 280 billion total lending (Huang et al. 2003). It helped reduce the capital costs of PPP projects when the market was still immature with reluctant investors or higher alternative financing costs. The CEPD concessional loan is another governmental loan for private investors, but can only be used for certain capital expenditures. The lending amount from the CEPD is matched as 1:2 to the bank loan with a cap of NT$ 0.2 billion or NT$ 0.5 billion matching a syndicated bank loan. The loan is charged at a benchmark of the 2-year deposit rate of postal saving with a credit margin of no more than 2.25%, and has a maximum maturity of 10 years. This is more suitable for small-scale PPP projects. Both types of government loans provide alternative financing sources with comparably lower costs against private lending. It can help reduce the capital cost of PPP projects and thereby improve the potential overall VfM outcomes. This mechanism is similar to the U.K.'s credit guarantee finance (CGF) scheme, which uses public debt capital for private sectors to finance private finance initiative (PFI) projects. The main financial benefits of CGF are the potential savings arising from the funding premium accrued to the public sector and the potentially lower transaction costs of funds (HM Treasury 2003a,b). The effective use of the U.K.'s CGF scheme relies on the government's ability to secure funds more cost-effectively; however, this would expose the government to certain credit risks. The use of Taiwan's CEPD loans is mainly used as a means of incentive to encourage private participation and to provide supportive funds to the private sector, especially while Taiwan's PPP market is still developing.

PPP Development in the Taiwan Wastewater Treatment Sector

In the late 1980s, the percentage of the population served by the public sewer system was about 3%. From 1988 to 1997, several development plans were announced to facilitate the construction of wastewater treatment plants and sewerage systems including the "Wastewater Treatment and Sewerage System Development Plan" in 1988, the "Wastewater Treatment and Sewerage System Construction Plan Phase I (1992–1997)" in 1991, and the "Wastewater Treatment and Sewerage System Construction Plan Phase II (1998–2003)" in 1997. However, the development of the wastewater treatment sector was still slow, and the lack of a government fiscal budget was one of the reasons. By 2000, the figure was still below 8% (Ministry of the Interior 2005).

Table 1. Budget for Construction of Wastewater Treatment Plants and Sewerage Systems in Taiwan

	Traditional public procurement	PPP scheme
Number of wastewater treatment plants with sewer networks	53	36
Taiwan government budget	NT$ 45,850.7 million	NT$ 9,022 million
Local government budget	NT$ 27,443.9 million	NT$ 266 million
Private investment	0	NT$ 55,109 million

Note: Source: Ministry of the Interior (2005).

The establishment of the PPP Act in 2000 gives more administrative power to government officials and provides additional private financing channels for the wastewater treatment and sewerage sector. In 2002, the blueprint "Challenge 2008 Development Plan" specified a development target for this sector. It aimed to increase the total wastewater treatment rate and the percentage of the population served by the public sewer system to 30.1% and 20.3%, respectively, by 2007 (Executive Yuan 2003). Shortly afterward, the "New Ten-Development Plan" in 2003 and the "Wastewater Treatment and Sewerage System Construction Plan Phase III (2003–2007)" in 2005 explicitly planned the use of PPP schemes to carry out wastewater treatment and sewerage projects (Zeng 2006). The latter proposed the construction of 53 wastewater treatment plants by traditional public procurement and 36 wastewater treatment plants by PPP schemes. Sewerage construction was also included in the target. The budget for these projects is shown in Table 1.

From the consecutive and extensive national plans released by the Taiwan government, it seems that the Taiwan government planned to accelerate the development of wastewater treatment and sewerage systems, but was constrained by a shortfall of funds. The PPP schemes can help solve this problem by introducing private funding sources. However, the government did not have a VfM assessment on the comparison between a PPP scheme and traditional government procurement at the policy making and project planning stages. The government decided on an allocation of 53 wastewater treatment projects to traditional procurement and 36 projects to PPP schemes. In general, the government believed that PPP projects would have faster development and lower overall costs. Over the past 10 years, the government has developed about 10 new wastewater treatment plants under traditional procurement, and majority of them did not begin operation on schedule (Taiwan Institute of Economic Research 2005). For instance, the Keya, Fengshanxi, and Liukuaicuo projects took more than 10 years for development and construction. The reasons for such delays were complicated and may have involved government inefficiency, difficulties in land acquisition, and delays in design. However, the interest in the overall cost saving has grown recently. The government started to focus more on the efficient use of PPP schemes from a VfM perspective. Some studies were carried out by the government with the aim of incorporating the VfM system into the current appraisal framework.

The Nanzih BOT project was the first application in Taiwan's wastewater sector. It served as an important milestone in Taiwan's PPP development and provided valuable lessons and experiences for subsequent PPP wastewater treatment projects. A summary of some PPP wastewater treatment projects in Taiwan is shown in Table 2 (Huang and Ke 2007).

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Table 2. Summary of Some PPP Wastewater Treatment Projects in Taiwan

Project name	Contract signed	Capacity (m^3/day)	Concession (years)	Total capital cost (NT$ thousands)	Service charge (NT$/$m^3$)
Nanzih BOT wastewater treatment project	October 2004	75,000	35	3,916,572	25.66
Danshui BOT wastewater treatment project	May 2005	56,000	35	3,551,757	29.84[a]
Luodong BOT wastewater treatment project	December 2005	45,000	35	3,251,453	34.04[a]
Sanying BOT wastewater treatment project	In the pipeline	52,000	35	4,579,689	36.56[a]
Puding BOT wastewater treatment project	In the pipeline	15,000	35	1,566,784	35.86[b]
Zhunantoufen BOT wastewater treatment project	In the pipeline	46,500	35	3,827,082	34.17[b]
Zhanghua BOT wastewater treatment	In the pipeline	60,000	35	4,791,000	32.89[b]
Taibao BOT wastewater treatment project	In the pipeline	11,000	35	1,457,645	32.54[b]
Taiwan BOT wastewater treatment project	In the pipeline	93,000	35	6,931,446	28.8[b]
Taidong BOT wastewater treatment project	In the pipeline	15,500	35	1,565,544	34.84[b]

Note: Source: Ministry of the Interior (2007).

[a]Price cap of service charge.

[b]Expected average service charge calculated in the project preliminary plan.

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In Taiwan's PPP wastewater treatment sector, the benchmark concession period is 35 years, and it usually starts after the private sector obtains the rights for superficies. Currently, the service charge for PPP wastewater treatment services in Taiwan ranges from NT$ 25.66 to NT$ 38.15 per cubic meter (m^3), while domestic households are only required to pay NT$ 5 per cubic meter (m^3) (Yu 2006). Thus, the government needs to subsidize the remaining balance to cover the full PPP service charge. The credit worthiness and subsidies of the Taiwan government are two crucial factors that ensure the success of the PPP wastewater treatment projects in Taiwan.

Nanzih BOT Wastewater Treatment Project Background

The Nanzih BOT wastewater treatment project is the first BOT project in Taiwan's wastewater sector. The information on this project was collected from various sources such as the Kaohsiung Municipal Government (2004a,b, 2008), Ministry of the Interior (2005), Public Construction Commission (2007), and Rich Development (2004). Some relevant parties in the project need to be kept anonymous.

This project is located in the Nanzih district in Kaohsiung, the special municipality in southwestern Taiwan. Similar to other areas in Taiwan, Kaohsiung had a very low wastewater treatment rate. In 1995, the percentage of its population served by the public sewer system was only 0.54%. This had increased to 15% by 2000 (Ministry of the Interior 2005). In July 2000, the "Kaohsiung's Municipal Sewerage System Planning" was conducted, and it grouped the Kaohsiung municipal sewerage system into the four districts of Nanzih, Kaohsiung, Linhai, and Gaoping for further progressive development. Due to the limited government fiscal budget and the huge initial capital investment, the municipal sewerage system was planned to be constructed in phases. In 2002, the Ministry of the Interior and the CEPD explicitly addressed the possibility of using PPP schemes to finance, construct, and operate wastewater treatment plants and sewerage systems. Nanzih, one of the four planned districts, is located in the North of Kaohsiung and has a total area of $3,394$ km^2. The population in this area was approximately 160,000 in 2004. It is expected to increase to 360,000 by 2038. Led by central government policies, the Kaohsiung Municipal Government (KMG) and the Nanzih project company signed the first BOT wastewater treatment contract in October 2004. The Nanzih project company was established with equity contribution solely from its parent company, a local private construction and development company.

Procurement Process

Phase One: Unsolicited Proposal under Article 46 of the PPP Act

In March 2002, an international water and environmental company, submitted an unsolicited project outline to the KMG to construct and operate the Nanzih wastewater treatment plant and sewerage system. According to Article 46, the KMG made a public announcement and invited competing project outlines for alternative development. However, no other private investor submitted a competing project outline. The initial evaluation by the KMG then approved the project outline as it met the development policy needs, and the international company was required to submit a detailed proposal by February 2003 for the second evaluation. In August 2003, the second evaluation was conducted and asked the international company to supplement the required documents specified by the PPP Act as its proposal submission did not conform to the requirement. The required submission should include a land utilization plan, a construction plan, an operation plan, a financial plan, and a letter of intent for financing issued by the financial institution. However, in September 2003, the KMG rejected the final proposal. The main disagreements between the international company and the KMG were on the service charge and project scope. The service charge quoted by the international company was about NT$ 47 per cubic meter (m^3), while the KMG's expected budget was only about NT$ 25 per cubic meter (m^3). The KMG perceived the service charge higher than expected as not meeting public interests. The second disagreement was that the international company insisted on constructing only one phase of the sewer network, but the KMG expected three phases of the sewer pipeline construction. In addition, the final supplementation by the international company did not have a land utilization plan and was inadequate on the construction and operation plans. Finally, the unsolicited proposal was terminated during the preevaluation stage before a public tender could be conducted to invite other private investors for competing proposals. However, the KMG adopted the project

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idea which could meet government needs and public interests, and proceeded through the solicited approach of a government-planned PPP project under Article 42.

Phase Two: Solicited Approach under Article 42 of the PPP Act

In August 2003, the KMG was considering the government-planned BOT approach for the Nanzih project and submitted its feasibility study and preliminary plan to the Administrative Assembly, or Executive Yuan, for approval. It was unclear why the KMG did this before it rejected the unsolicited proposal in September. It could be that there were certain terms and conditions that the KMG and the international company were unable to agree on, but the discussions still carried on. In December 2003, the approval was obtained, and subsequently the first public tender notice was announced during the same month to solicit private sector proposals with a tender period of 61 days. Seventeen interested bidders purchased the tender document; however, none of the bidders submitted a proposal by the deadline of February 16, 2004. The second public tender notice was announced in March 2004 with a tender period of 62 days. Nineteen interested bidders purchased the tender document, while only one bidder, a local private construction and development company, submitted a proposal by the deadline of May 10, 2004. The following could be some of the main reasons why the tender did not attract interested bidders for the proposal submission. First of all, the price cap of service charge set by the government was perceived to be too low by the bidders. Second, the increase in steel price at the beginning of that year increased investment risk and bidders realized that it could be more difficult to recover the construction costs for the sewer pipeline network. These two reasons made the BOT project financially unattractive to investors. Third, the first tender period was actually less than 2 months after the 10-day Chinese New Year holidays. Thus, interested bidders might not have had sufficient time to prepare their tender proposal for this first BOT wastewater project. Fourth, although this was the first BOT project implemented in the Taiwan wastewater treatment sector, another BOT wastewater treatment project in Danshui released preliminary investment information earlier than the Nanzih project. The Danshui project was perceived to have higher service charges by bidders, thus attracting away some of the potential bidders. Fifth, there were concerns over the fairness and transparency of the evaluation and selection procedures. Some bidders perceived that the KMG already had a preferred bidder. After the first tender period, no bidder was awarded the contract. This eliminated the earlier speculation that the government favored a certain bidder. Finally, risks such as the quality of wastewater intake, environmental risk, land acquisition, and payment adjustment mechanisms in the first tender documents were unclear or undesirable from the bidders' perspective. They were amended accordingly in the second tender document to prevent future misunderstanding.

The tender evaluation was carried out in May 2004. The second evaluation committee meeting conducted a qualification of the bidder to review their financial capacity and relevant legal documents and agreements. The local company was nominated as the qualified bidder. Compared to prequalification before tendering, there was an inherent risk for bidders in this procedure that bidder qualification was conducted after the submission of the detailed project proposal. The local company could be disqualified before the evaluation of its detailed proposal proceeded. The third evaluation committee meeting evaluated the local company's proposal and awarded it as the preferred bidder. The tender evaluation criteria are shown in Table 3.

Table 3. Tender Evaluation Criteria

Evaluation criteria	Weights (%)
Financial plan	25
Service charges	20
Land utilization and construction plans	20
Operation plan	15
Project company organizational structure	12
Sustainability and innovation	8

The financial plan is the most important criterion followed by the service charges and the land utilization and construction plans. The local company reduced the required equity return from 10 to 8.5% and thereby offered relatively lower service charges compared to other subsequent BOT wastewater treatment projects. This could partially explain why the local company was able to meet the KMG's needs.

Thereafter in September 2004, the local company established the Nanzih project company which signed the BOT contract with the KMG in October 2004. The concession period started in April 2006 when the Nanzih project company obtained the right of superficies from the KMG. The construction of the Nanzih BOT wastewater treatment plant was completed in June 2009, which was slightly later than the expected month of April. The major milestones of the procurement process are summarized in Fig. 2.

Comparison

Compared to the Danshui project which was undertaken somewhat later, the Nanzih project took much longer procurement time, apparently contributed by the nonsuccess of the unsolicited proposal. Under the solicited approach, both projects followed the standard procurement procedure; however, the Danshui project was able to attract investors during the first public tender period while the Nanzih project could not. The economic attractiveness of the Danshui project was preferred by the private sector. The procurement schedules of the two projects are shown in Fig. 3. The subsequent government-planned PPP wastewater treatment projects will be only initiated by solicited proposals. Currently, the Nanzih project is the only PPP wastewater project initiated as an unsolicited proposal. Although it was terminated under Article 46, it provides useful learning opportunities to Taiwan's limited experiences on unsolicited projects.

Furthermore, the whole procurement process of the Nanzih project under both unsolicited and solicited approaches did not have a VfM assessment in the comparison between the BOT model and the traditional public procurement before the BOT model could proceed. In 2006, the Ministry of the Interior commissioned the Taiwan Institute of Economic Research to conduct a comparative study that reviewed the Nazih BOT project against three other traditional government-procured wastewater projects (Huang et al. 2006). The three other projects are the Shilongxi, Keya, and Miaoli wastewater treatment projects. This study used 35-year life cycle costs, which were adjusted by risk allocation and standardized by the wastewater treatment capacity of each plant for comparison. As Fig. 4 shows, the Nanzih BOT project is the cheapest based on the total risk-adjusted costs per unit of

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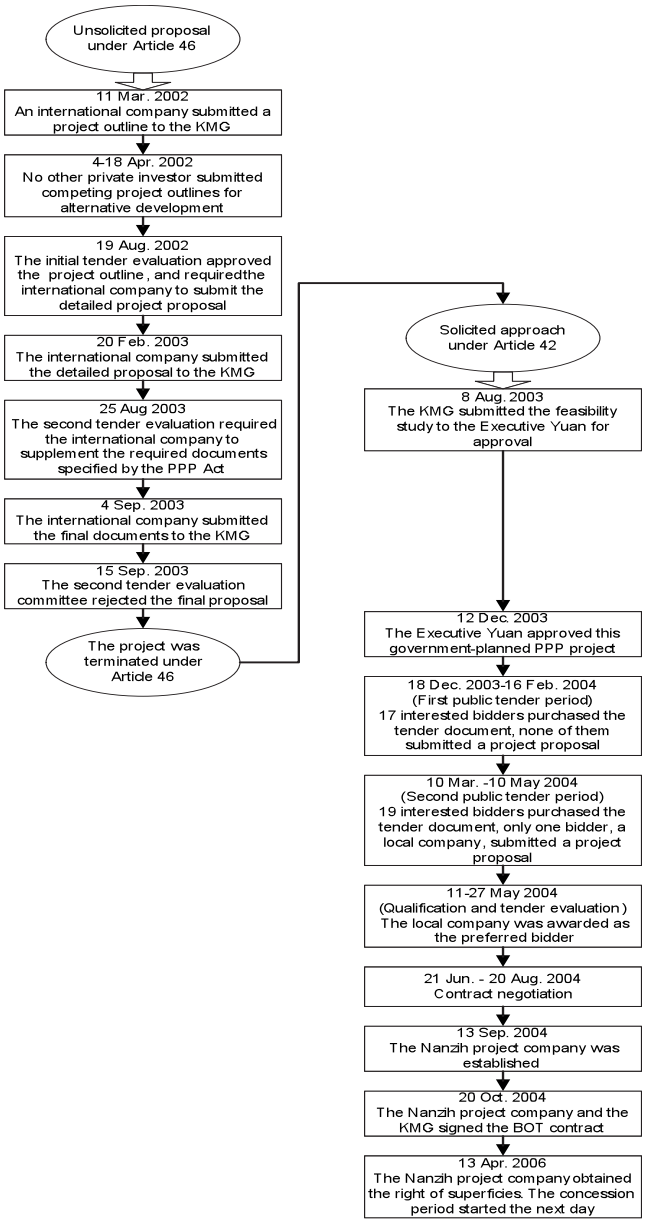

Fig. 2. Major milestones in procurement

treatment capacity. However, the differences in specific project conditions make the comparison difficult.

Concession Agreement

The Nanzih project company is responsible for financing, building, and operating the municipal wastewater treatment plant with

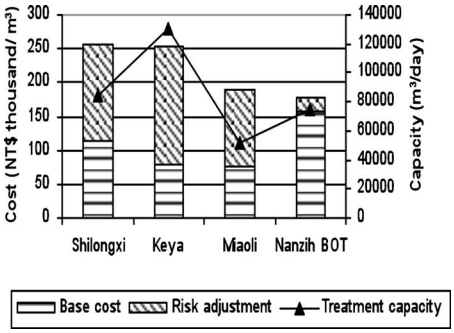

Fig. 4. Comparison of the Nanzih BOT project with three traditional government-procured wastewater projects. Source: Ministry of the Interior (2006).

the sewer pipeline network in the Nanzih district for a 35-year concession, and transferring it back at the end of the concession. The concession includes 3 years of construction and 32 years of operation. The Nanzih project company has priority to extend the contract before the end of the concession if its performance is satisfactory.

The plant is required to be a secondary wastewater treatment plant. The minimum capacity is required to be 75,000 m^3/day with a possible treatment capacity increase of 50,000 m^3/day. The plant will be located within a 15-km^3 area provided by the KMG between Yuanjhonggang Houjin Creek and Dianbao Creek.

The construction of the sewer network is required to be carried out in three phases as shown in Table 4. It has to be completed within 12 years, reaching the maximum length of 125 km. The service charge for the length beyond 125 km will be renegotiated by the KMG and the Nanzih project company.

The government is not only responsible for the specified service payment, but also the construction of the water diversion system, the installation of household connections to public sewers, and the acquisition of land for the wastewater treatment plant and sewer network.

Financial Structure

One of Taiwan's major local banks was the lead arranger who syndicated the NT$ 3.0 billion medium- and long-term loans from 17 local banks. At the same time, the Nanzih project company obtained about NT$ 2.2 billion equity contribution from its parent company. The financial structure of this BOT project is shown in Table 5.

The leverage is not aggressive, and the loan mainly relies on the local bank market with no foreign currency loan involved. The interest rate charged is not known; however, the two governmental financing sources may give some indicative figures. In

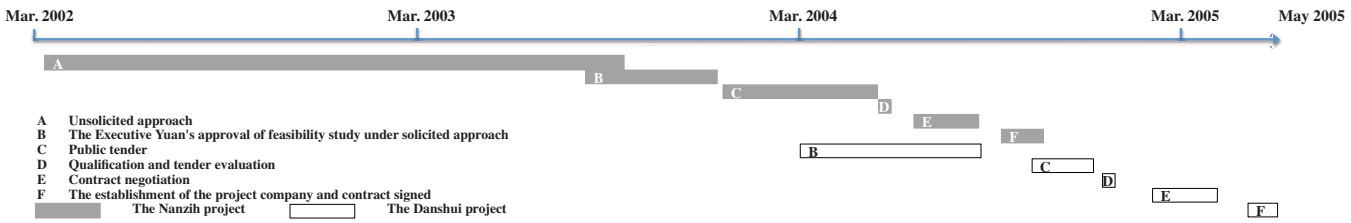

Fig. 3. Procurement schedules of the Nanzih project and the Danshui project. Source: Ministry of the Interior (2006).

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Table 4. Construction of Sewer Pipelines in the Nanzih BOT Wastewater Treatment Project

Phase	Schedule[a] (years)	Work scope
1	4	• Construction of sewer pipelines to achieve a minimum length of 79.5 km • Construction of sewer pipelines for the area around Kaohsiung University
2	9	• Construction of sewer pipelines to achieve a minimum length of 107.8 km
3	12	• Construction of other possible sewer pipelines

[a]Within the number of years after the Nanzih project company has obtained the right of superficies.

August 2004, the medium/long-term capital cost of Chunhwa Post and the 2-year deposit rate of postal saving were 1.83% and 1.55%, respectively, therefore, the after tax interest rate with allowable credit margins for CEPD medium/long-term loans and CEPD concessional loans were about 4.01% and 4.05%, respectively. This could serve as a floor for the bank-loan interest rate at that time. In addition, the KMG spent about NT$ 2.13 billion to construct the water diversion system, install the household connections to sewers, and overhaul the existing sewer pipelines.

Since the price cap of the service charge set by the government in the tender was perceived to be low by the private sector, the equity return could not reach the expected 10%, which is the common required equity return of subsequent BOT wastewater treatment projects in Taiwan. However, the Nanzih project company finally compromised and settled at 8.5% equity return. This is to charge the KMG at the price cap level.

Payment Mechanism

The wastewater treatment services payment to the Nanzih project company consists of capacity payment and output payment. The capacity payment is based on the designed capacity, including capital recovery charges and fixed operation and maintenance (O&M) charges. The output payment is based on the actual quantity of wastewater treated, including variable O&M charges. The payment formula is as shown below

$$\text{Service payment} = \text{DQ} \times (\text{CC} + \text{FC}) \times T + \text{VC} \times Q$$

where DQ=designed capacity, 75,000 m^3/day; CC=capital recovery charge with a price cap of NT$ 19.5/m^3 (NT$/$m^3$); FC=fixed O&M charge with a price cap of NT $ 4.05/m^3 (NT$/$m^3$); VC=variable O&M charge with a price cap of NT$ 2.11/m^3 (NT$/$m^3$); Q= actual quantity of wastewater treated (m^3); and T=number of operating days (days). If construction completion of the wastewater treatment plant takes less than 3 years after obtaining the right of superficies, the service payment between the early operation date and contracted operation date would be

Table 5. Financial Structure

Fund	Amount (NT$ billion)	Percentage (%)
Equity	2.2	42.3
Debt	3.0	57.7
Total	5.2	100

$$\text{Service payment} = Q \times (\text{FC} + \text{VC})$$

where FC=fixed O&M charge with a price cap of NT$ 4.05/m^3 (NT$/$m^3$); VC=variable O&M charge with a price cap of NT$ 2.11/m^3 (NT$/$m^3$); and Q=actual quantity of wastewater treated (m^3). The variable and fixed O&M charges will be adjusted annually by the previous year's Taiwan consumer price index (CPI), therefore, a 1-year lag remains between inflation adjustment and O&M charges. If a change in law or tax causes any adverse impact, the service charge will be adjusted accordingly. However, the adjustment due to a change in law is not clearly defined. In principle, the service payment will be adjusted back to the equivalent level as contracted; however, the absence of a clear definition could lead to potential disputes on what constitutes the equivalent level. In addition, the water pollution control charge paid by the Nanzih project company to the Taiwan Environmental Protection Agency can be claimed back from the KMG.

The payment structure in the Nanzih project has some significant differences compared to the Danshui project. As the Nanzih project company was not responsible for installing household connections to public sewers, there is no relevant charge in the payment structure; while the Danshui project company was responsible for such installations, an additional payment component, the household connection charge, is included in the service payment to recover the installation costs. Furthermore, the fixed O&M charge in the Nanzih project is based on the designed capacity, while the Danshui project's O&M charge is based on the actual quantity. The latter introduces additional uncertainty to the Danshui project company; however, it provides incentives to facilitate household connections that could significantly affect the amount of wastewater to be treated and thereby the project company's revenue. The Nanzih project's base service charge is fixed at NT$ 25.66/m^3 while the base service charge in the Danshui project is adjusted according to the capital investment scale due to multiple-phase construction, but it cannot exceed a price cap of NT$ 29.84/m^3.

The payment of the Nanzih BOT project is not affected by various pollutant loading and volumetric bands. Instead, The Nanzih BOT project specified a certain pollutant loading threshold that eased the project company's obligation to treat wastewater to the required discharge standard if the intake pollutant loading is above that threshold. The Danshui project adopted a volumetric-band payment structure which requires output payments only without a capacity payment for a volume of wastewater above a certain threshold (Ministry of the Interior 2007). The volumetric- and/or pollutant loading-band payment structure is advantageous by linking the treatment cost directly; however, it involves a more complex procedure for implementation and monitoring.

In addition, when nonperformance caused by the Nanzih project company occurs, if the project company does not remedy the default within a specified period, 0.05–0.1% of the performance bond will be deducted. If the nonperformance is severe, the service payment will be suspended. However, the contract does not specify what constitutes severe situations. This could lead to potential disputes during future operations. The Nanzih project has started commercial operation, therefore, continuous performance monitoring will be useful.

Risk Management

The risk allocation for the Nanzih BOT wastewater treatment project is summarized in Table 6. The Nanzih project company

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Table 6. Risk Allocation

Risk category	Risk allocation	
	Public	Private
1. Legal risks		
Change in law or regulation	x	
Increase in tax	x	
2. Financial risks		
Interest rate		x
Foreign exchange		x
Inflation	x	
Failure to raise fund	x	x
3. Construction risks		
Land acquisition	x	
Delay in completion		x
Construction cost overrun		x
4. Operating risks		
Operating cost overrun		x
Quality of wastewater intake	x	
Performance failure		x
Operation interruption	x	x
Labor dispute		x
5. Market and revenue risks		
Competition from other wastewater treatment plant	x	
Insufficient wastewater volume	x	
Insufficient revenue from ancillary facilities		x
Change in wastewater treatment charge	x	x
6. Force majeure risk		
Natural force majeure (earthquake, flood etc.)	x	x
War, riot	x	x
7. Environmental risks		
Change of environmental standard	x	x
Environmental damage	x	x
Payment of water pollution control fee by project company to Taiwan Environmental Protection Agency	x	
8. Asset transfer risks		
Asset transfer by early termination		x

assumed most of the financial, construction, and operating risks, while the KMG assumed most of the legal risks. Most of the force majeure and environmental risks were shared, since they are difficult to foresee. The land acquisition risk was allocated to the KMG as it was more suited to manage this risk using its administrative power. This allocation is commonly applied in Taiwan's PPP wastewater treatment projects. The government and the project company also shared the failure to raise fund risk, as the government could provide necessary assistance or funds on financing. Some international practices provide the full allocation of the funding risk to the private sector, while Taiwan provides incentives to promote private participation in infrastructure development with a view to develop the PPP market.

The Nanzih project has significant lower market and revenue risks compared to the Danshui project. First of all, the capacity payment including the fixed O&M charge is based on the designed capacity that can serve as the minimum operating revenue while the Danshui project's fixed O&M is based on the actual quantity of wastewater treated. Second, the wastewater intake in the Nanzih project includes not only wastewater from the public sewer system, but also water from Houjin Creek with the aim of improving its water quality and ecosystem. Therefore, the insufficient wastewater volume is not as critical as the Danshui project, which fully depends on wastewater from the sewer system. This could partially explain why the installation of household connections to the public sewer system was allocated to the KMG as the Nanzih project company had relatively less incentive to accelerate household connections. Contrarily, the Danshui project company was allocated for household connections. In terms of project effectiveness, the Nanzih project showed much slower household connections when compared with the Danshui and Luodong projects, the two subsequent BOT wastewater projects. The Luodong project also allocated the installment of the household connections to the private sector. The Nanzih experience shows that it would be more effective for the private sector to install household connections with the necessary assistance from the government, and manage the revenue risks by itself.

The risk of wastewater intake quality is highly relevant to the treatment cost. The intake pollutant loading threshold was specified to be biochemical oxygen demand (BOD) 200 mg/L and suspended solids (SS) 200 mg/L. If the wastewater intake is above that threshold, the Nanzih project company has no obligation to treat the wastewater to the discharge standard. This eased the project company from assuming much of the intake quality risk, and also provided little incentive for the project company to treat highly polluted wastewater with best effort as there was no clear agreement to what extent highly polluted wastewater should be treated.

Lessons Learned

The Nanzih project is the first BOT wastewater treatment project in Taiwan. There was no prior experience with a project of this nature. This project has provided a learning platform for both public and private sectors for future wastewater treatment PPPs in Taiwan. Some main lessons and experiences learned are highlighted below:

1. The Nanzih project is currently the only wastewater PPP project that was initiated by an unsolicited proposal in Taiwan, thereby it is the only wastewater project that has undergone both the solicited and unsolicited procurement approaches. The Nanzih experience showed that due care and diligence is needed during the transition between unsolicited and solicited approaches.
2. Under the unsolicited approach, the international company submitted a detailed proposal that did not conform to the requirements specified by the PPP Act. This resulted in a resubmission of tender documents with supplements, which still did not fully conform to the requirements. To facilitate the tender process, it is important for the government to define clearly the full documents required including the land utilization plan, the construction plan, the operation plan, the financial plan, and the letter of intent for financing issued by the financial institution. At the same time, it is important for the private sector to understand Taiwan's relevant PPP laws and requirements so that the tender can be prepared accordingly without missing out important information.
3. The first tender period under the solicited approach was too short for the first BOT wastewater treatment project. After deducting the 10-day Chinese New Year Holiday, the actual tender period was only 51 days. The private sector should be given more time to prepare and evaluate the PPP tender as there was no precedent in Taiwan's wastewater sector at that point of time. Shorter tender periods may increase the invest-

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ment risks for the private sector, which may ultimately result in higher service charges or deter investors away from bidding.

4. Only one bidder submitted the tender proposal, which meant that there was no competition in the tender process. The issue on how the government could introduce more competition in the tender process is essential to ensure the efficient use of PPP schemes and VfM. Viable project economy, reasonable tender procedure, transparent and fair tender evaluation, and strong government support could be factors to attract bidders and improve tender competition.
5. The price cap of service charges set by the KMG was perceived to be low by the private sector. The Nanzih project company finally compromised with a lower equity return of 8.5% instead of the expected 10%. The household connections and the water intake quality risk borne by the public sector and the relatively lower market risk could justify the lower equity return to some extent. However, as the first project, it would normally expect a higher return because of higher investment risks, which could arise due to initially uncertain PPP markets. Despite the fact that the benchmark equity return of 10% was established for the later PPP wastewater projects with the installment of household connections allocated to the private sector, a reasonable return should be justified on the basis of overall VfM outcome and the specific project risk profile to ensure the efficient use of the PPP scheme.
6. The Nanzih project is currently the only BOT wastewater project where the government is responsible for the household connections. The Nanzih experience shows that it would be more effective for the private sector to install household connections with the necessary assistance from the government. The subsequent BOT wastewater projects have learned and applied this and have showed much faster household connections. As the acceleration of household connections to public sewers is one of the primary national development targets, the government will utilize the private sector's efficiency introduced by the PPP model to facilitate the household connection rate. Thus, it is unlikely that the government will use the Nanzih model on the allocation of household connections for subsequent wastewater treatment PPP projects again, even though its service charge was the cheapest among all current BOT wastewater treatment projects due to there being no inclusion of connection fees with a lower equity return to the private sector.

Conclusions

The Nanzih BOT wastewater treatment project is the first PPP application in Taiwan's wastewater treatment sector. It is an important milestone in Taiwan's PPP development. Currently, a large number of PPP wastewater treatment projects have been planned by the Taiwan government and will be conducted in the near future by local authorities. The case study of the Nanzih BOT project can give valuable insights into project procurement, tendering, payment, and risk management for governments and potential investors to develop and invest in the Taiwan PPP wastewater treatment market.

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References

Abdel-Aziz, A. M. (2007). "Successful delivery of public-private partnerships for infrastructure development." *J. Constr. Eng. Manage.*, 133(12), 918–931.

Abdel-Aziz, A. M., and Russell, A. D. (2001). "A structure for government requirements in public-private partnerships." *Can. J. Civ. Eng.*, 28(6), 891–909.

Akintoye, A., Beck, M., Hardcastle, C., Chinyio, E., and Assenova, D. (2001). *Framework for risk assessment and management of private finance initiative projects*, Glasgow Caledonian University, Glasgow, U.K.

Asian Development Bank. (2008). *Public-private partnership handbook*, Asian Development Bank, Manila, Philippines.

The Council for Economic Planning and Development. (2002). *Directives on medium/long term loans for PPP projects*, Taipei, Taiwan (R.O.C.).

The Council for Economic Planning and Development. (2004). *Directives on concessional loans for PPP projects*, Taipei, Taiwan (R.O.C.).

European Commission. (2003). *Guidelines for successful public-private partnerships*, European Commission, Brussels.

Executive Yuan. (2003). *Challenge 2008 development plan (2002-2007)*, Executive Yuan, Taipei, Taiwan (R.O.C.) (in Chinese).

Garvin, M. J., and Bosso, B. (2008). "Assessing the effectiveness of infrastructure public-private partnership programs and projects." *Public Works Manage. Policy*, 13(2), 162–178.

Gomm, R., Hammersley, M., and Foster, P., eds. (2000). *Case study method: Key issues, key texts*, SAGE Publications, London.

Grimsey, D., and Lewis, M. K. (2002). "Evaluating the risks of public private partnerships for infrastructure projects." *Int. J. Proj. Manage.*, 20, 107–118.

HM Treasury. (2003a). *CGF technical note 1*, HM Treasury, London.

HM Treasury. (2003b). *PFI: Meeting the investment challenge*, HM Treasury, London.

Huang, C. Z., and Ke, J. W. (2007). *Budget and scheduling of BOT wastewater treatment and sewerage system projects*, Ministry of the Interior, Taipei, Taiwan (R.O.C.) (in Chinese).

Huang, C. Z., Zheng, R. H., Lin, M. C., and Lai, Y. X. (2006). *Comparative study of the conventional government procurement and the BOT scheme for wastewater treatment projects*, Ministry of the Interior, Taipei, Taiwan (R.O.C.) (in Chinese).

Huang, S. Y., Huang, S. Z., and Gao, W. C. (2003). *Study on PPP financing risks*, Public Construction Commission, Taipei, Taiwan (R.O.C.) (in Chinese).

Kaohsiung Municipal Government. (2004a). *Contract of the Nanzih BOT wastewater treatment project (draft)*, Kaohsiung Municipal Government, Kaohsiung, Taiwan (R.O.C.) (in Chinese).

Kaohsiung Municipal Government. (2004b). *Invitation to tender (the second bulletin): The Nanzih BOT wastewater treatment project*, Kaohsiung Municipal Government, Kaohsiung, Taiwan (R.O.C.) (in Chinese).

Kaohsiung Municipal Government. (2008). "The Nanzih BOT wastewater treatment project (in Chinese)." ⟨http://pwbgis.kcg.gov.tw/nanzihsewerage/index.htm⟩ (Oct. 29, 2008).

Kumaraswamy, M. M., and Anvuur, A. M. (2008). "Selecting sustainable teams for PPP projects." *Build. Environ.*, 43, 237–252.

Kwak, Y. H. (2002). "Analyzing Asian infrastructure development privatization market." *J. Constr. Eng. Manage.*, 128(2), 110–116.

Kwak, Y. H., Chih, Y. Y., and Ibbs, C. W. (2009). "Towards a compre-

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hensive understanding of public private partnerships for infrastructure Development." *California Manage. Rev.*, 51(2), 51–78.
Li, B., Akintoye, A., Edwards, P. J., and Hardcastle, C. (2005). "The allocation of risk in PPP/PFI construction projects in the UK." *Int. J. Proj. Manage.*, 23, 25–35.
Ministry of Finance. (2004). *Public private partnership handbook*, Ministry of Finance, Singapore, Singapore.
Ministry of the Interior. (2005). "Wastewater treatment and sewerage system construction plan phase III (2003-2007)." Construction and Planning Agency, ed., Ministry of the Interior, Taipei, Taiwan (R.O.C.) [Executive-Yuan approved edition (in Chinese)].
Ministry of the Interior. (2006). *The forum on promoting the development of wastewater treatment and sewerage system*, Ministry of the Interior, Taipei, Taiwan (R.O.C.) (in Chinese).
Ministry of the Interior. (2007). *The feasibility study of Danshui BOT wastewater treatment project*, Ministry of the Interior, Taipei, Taiwan (R.O.C.) (in Chinese).
Morallos, D., and Amekudzi, A. (2008). "The state of the practice of value for money analysis in comparing public private partnerships to traditional procurements." *Public Works Manage. Policy*, 13(2), 114–125.
PIMAC. (2007). *Procurement process of PPP projects in Korea*, Korea Development Institute, Seoul, Korea.
Public Construction Commission. (2007). *List of contracted major PPP projects*, Public Construction Commission, Executive Yuan, Taipei, Taiwan (R.O.C.) (in Chinese).
Public Construction Commission. (2008). "Private participation in infrastructure projects." ⟨http://ppp.pcc.gov.tw/pcc_site/english/EN-2.cfm⟩ (Nov. 3, 2008).
Rich Development. (2004). *Investment plan for Nanzih BOT wastewater treatment project*, Sewerage Engineering Dept., Public Works Bureau, Kaohsiung Municipal Government, Kaohsiung, Taiwan (R.O.C.) (in Chinese).
Taiwan Institute of Economic Research. (2005). *Why we support BOT model for wastewater treatment projects*, Public Construction Commission, Taipei, Taiwan (R.O.C.) (in Chinese).
Tiong, R., Kiong, T. S., and Ashley, D. (1999). *Evaluation of risks in BOT projects*, School of Civil and Structural Engineering, Nanyang Technological Univ., Singapore, Singapore.
Tiong, R. L. K. (1995a). "Competitive advantage of equity in BOT tender." *J. Constr. Eng. Manage.*, 121(3), 282–289.
Tiong, R. L. K. (1995b). "Impact of financial package versus technical solution in a BOT tender." *J. Constr. Eng. Manage.*, 121(3), 304–311.
Tiong, R. L. K. (1995c). "Risks and guarantees in BOT tender." *J. Constr. Eng. Manage.*, 121(2), 183–188.
Tiong, R. L. K. (1996). "CSFs in competitive tendering and negotiation model for BOT projects." *J. Constr. Eng. Manage.*, 122(3), 205–211.
United Nations and Economic Commission for Europe. (2000). *Guidelines on private public partnerships for infrastructure development*, Geneva.
United Nations Industrial Development Organization (UNIDO). (1996). *Guidelines for infrastructure development through build-operate-transfer (BOT) projects*, United Nations, Vienna.
Wang, S. Q., Dulaimi, M. F., and Aguria, M. Y. (2004). "Risk management framework for construction projects in developing countries." *Constr. Manage. Econom.*, 22, 237–252.
The World Bank. (1997). *Toolkits for private participation in water and sanitation*, Washington, D.C.
The World Bank. (1998). *Concessions for infrastructure: A guide to their design and award*, Washington, D.C.
The World Bank. (2009). *Private participation in infrastructure database*, Washington, D.C.
Yu, F. Y. (2006). "Government needs to raise fund to promote the development of wastewater treatment and sewerage system." *Proc., Forum on Promotion and Development Strategies for Wastewater Treatment and Sewerage System*, Construction and Planning Agency, Ministry of the Interior, Taiwan, Taipei, Taiwan (R.O.C.) (in Chinese).
Zeng, S. G. (2006). "Evaluation of wastewater treatment and sewerage system construction plan." *Proc., Forum on Promotion and Development Strategies for Wastewater Treatment and Sewerage System*, Construction and Planning Agency, Ministry of the Interior, Taiwan, Taipei, Taiwan (R.O.C.) (in Chinese).
Zhang, X. Q. (2004). "Concessionaire selection: Methods and criteria." *J. Constr. Eng. Manage.*, 130(2), 235–244.
Zhang, X. Q. (2005). "Criteria for selecting the private-sector partner in public-private partnerships." *J. Constr. Eng. Manage.*, 131(6), 631–644.
Zhang, X. Q., and Kumaraswamy, M. M. (2001). "Procurement protocols for public-private partnered projects." *J. Constr. Eng. Manage.*, 127(5), 351–358.

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