The following publication Bao, F., Chen, C., Chan, A.P.C., Martek, I. and Shrestha, A. (2019), "Dynamic framework transfer model for public–private partnerships: Lessons from a China water sector case study", Engineering, Construction and Architectural Management, Vol. 26 No. 7, pp. 1218-1239 is published by Emerald and is available at https://doi.org/10.1108/ECAM-01-2018-0028.

Dynamic framework transfer model for Public–Private Partnerships: Lessons from a China water sector case study

Fengyu Bao [a,b], Chuan Chen [c,*], Albert P.C. Chan [a], Igor Martek [d], Asheem Shrestha [d]

[a] *Department of Building and Real Estate, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China*

[b] *Institute for Disaster Management and Reconstruction, Sichuan University, Chengdu, Sichuan, China*

[c] *Business School, Sichuan University, Chengdu, Sichuan, China*

[d] *School of Architecture and Built Environment, Deakin University, Geelong, VIC 3220, Australia*

[*] *Corresponding author.*

Chuan Chen

Business School

Sichuan University

29 Jiuyanqiao Wangjiang Road,

Chengdu, China

Postal code: 610065

Tel.: (86) 18010636887

E-mail address: chenchuan.scu@qq.com

Abstract

Purpose – Public Private Partnerships (PPPs) have emerged in developing countries, such as China, as a ubiquitous means by which government procures needed infrastructure. In this regard, they have been much studied. However, due to their long concession period, running into decades, few have run their full course into the transfer phase (TP) in which the PPP concession reverts from the private entity back to the public. In China, this is about to change as many PPPs approach their TP. The purpose of this paper is hence to comprehensively investigate the TP of PPPs in China.

Design/methodology/approach – A three-part methodology was undertaken to achieve the research purpose. Extensive literature review was first conducted to analyse the status quo of the transfer management regime in China, followed by the identification of critical challenges and the exploration of solutions via studying the TP of the Chengdu No. 6 Water Plant B Project – the first PPP in China's water sector to reach the TP. Research procedures and outcomes were hierarchically visualized by using Integration DEFinition language 0 (IDEF0) method.

Findings – The current transfer management regime of PPPs in China's water sector is deficient in many aspects. Based on the insight into the practice, a generic transfer process model (GTPM) with hierarchical structure process and sub-processes serving as a dynamic framework transfer model with self-evolution nature, is developed to facilitate the successful transfer of the PPP utility.

Originality/value – To the authors' best knowledge, this is the first attempt to systematically probe the TP of PPPs. The findings of this paper are hopefully to instruct government and PPP practitioners alike on mechanisms for smoothing the TP of further PPP projects ending their concession period.

Keywords Public-private partnership; water sector; China; Transfer phase; Dynamic framework transfer; IDEF0; Process model; Case study

Paper type Case study

Introduction

Unlike traditional means of developing infrastructure projects, a public-private partnership (PPP) is characterized by a long-term (10 to 30 years in China) contractual relationship between government and private party. Its lifecycle can be generally divided into different phases that involve varying tasks and outcomes. For instance, at the project identification phase, a risk allocation strategy should be considered [Li et al., 2005, European Investment Bank (EIB), 2012] , while at the project procurement phase, the focus will shift to the selection of an appropriate concessionaire (Zhang, 2004a, El-Mashaleh and Minchin, 2014). For PPPs contracted on specific models such as build-operate-transfer (BOT), transfer-operate-transfer (TOT), etc., the last phase centers on the transfer of the project back to the government; the transfer phase (TP). Such kinds of PPPs are the majority, especially in China, where more than 80 percent of existing PPPs were developed on the BOT model (Cheng et al., 2016). Consequently, for these PPPs, projects will be transferred back to the government at the expiry date. Simply, for most PPPs in China, the transfer phase (TP) will inevitably occur at the end of the contract term.

According to World Bank (2016), the government and its private partner need to simultaneously manage a variety of complex tasks within the relatively short period of the TP.

They should consider, for instance, the selection scheme of the new operator, the resources required to manage the transfer, the condition of the project assets, along with the feasibility of the overhaul plan, etc. Moreover, the government must consider the performance management regime as the on-going long-term sustainability of the project will cease to be the concern of the private partner. Considerations include the transfer of intellectual property rights and technology, and the appropriateness of staffing. Yet most practitioners lack experience in handling the multiple tasks of the TP, which in turn results in a problematic and costly transfer process (World Bank, 2016). Thus, the continuity and quality of the product or service may not be guaranteed, which may escalate to public disquiet due to falling service quality and disruptions.

A further complication is that there is little guidance in the literature advising practitioners on how to deal with the TP. Although much PPP research has focused on distinct PPP phases – such as project identification (Heravi and Hajihosseini, 2012, Grimsey and Lewis, 2002), project preparation (Van Buiten and Hartmann, 2015, Shen et al., 2007), project procurement (El-Mashaleh and Minchin, 2014, Zhang, 2004b), and, procurement implementation (Ho, 2006, Verweij, 2015) – the TP remains an area neglected by academia (Bao et al., 2018). Nevertheless, governments and institutions alike have gradually come to realize the significance of the TP as a growing number of PPPs reach their concession expiry period. Indeed, in China, the Ministry of Finance (MoF) has recently specified in its official PPP guideline that "*the form of transfer, compensation mode, items of transfer and transfer standard etc. should be clearly stipulated in the contract*" (MoF, 2014). Some widely used PPP reference guides, such as World Bank (2016), World Bank (2014) and EIB (2012) etc., also propose suggestions on TP management. Nevertheless, these suggestions are frequently impractical, speaking broadly and theoretically, without accounting for specific regional realities.

The objective of this paper is thus to identify main problems in an actual TP, as well as to recommend practical solutions, on the basis of a comprehensive description of the steps undertaken in the TP. The research outcomes aim at answering the following questions:

(1) What is the status quo of the transfer process of China's water PPPs?
(2) What are the deficiencies of the current transfer system in China?
(3) How can these deficiencies be addressed in order to better manage future transfer?

This paper uses an Integration DEFinition language 0 (IDEF0) method to build a generic transfer process model (GTPM), able to visualize the entire process of the TP. The model has a hierarchical structure in which critical transfer steps, factors, as well as information and material flows, are identified, along with connections to other phases and processes of the PPP delivery system. The case used is the Chengdu No. 6 Water Plant B Project (hereinafter referred to as the Chengdu Project), located in South-west China. As such, the research outcomes are specifically pertinent to the Chinese context, especially to China's water PPPs, which make up the largest portion of all existing PPPs in China (Cheng et al., 2016).

The findings of this paper contribute to the body of knowledge in the PPP field, and offer insights into the smooth transfer of water PPPs in China. The modeling approach used in this paper may also be duplicated by researchers focusing on other developing localities as a means to understand and address similar issues in the long-term PPP lifecycle.

The following sections contain: (1) methodology; (2) status quo of transfer: the "as-is" model; (3) optimizing transfer: the "to-be" model; (4) dynamic management framework for transfer. The final section summarizes the main conclusions.

Methodology

Research Process

The research follows three steps: (1) designing the "as-is" model; (2) identifying challenges; and (3) designing the "to-be" model (see Figure 1). The methodology is three part, utilizing literature review, IDEF0, and case study.

As a foundation to this study, the status quo of TP in China was analysed and visualized in an "as-is" model. To reflect the transfer status quo as accurately and completely as possible, data from various sources were collected. The national PPP guideline of China [i.e. MoF (2014)] was adopted to identify the basic elements of the as-is model. Other sources such as government documents and circulars, industry reports, literature, were also consulted to complement the data needed for modeling. Those elements were then processed using IDEF0 which was selected as the modeling tool, and which is explained more fully in following sub-sections.

[Please insert figure 1 around here]

The second step was to identify critical challenges of the current transfer system in China via a case study. Utilizing case study to test the IDEF0 model is validated by many researchers; e.g., Bevilacqua et al. (2012) remodeled the emergency management process, and Sugiyama et al. (2006) designed a chemical recycling process. Following this established precedent, this paper observed the transfer of the Chengdu Project, in order to identify deficiencies of the as-is model. The Chengdu Project lies in Chengdu city, Sichuan province, China, and was launched in 1996 under a "National Experimental BOT Program" initiated by the central government. Subsequent to an international bidding process, the Chengdu Génénerale des Eaux-Marubeni Waterworks Co., Ltd. (CGMW) was established as the special purpose vehicle (SPV) in 1999 and immediately embarked on the project implementation. The concession period was 18 years, including 2.5 years for construction and 17.5 years for operation. Its treated water was off-taken by Chengdu Waterworks General Company (CWGC), a local state-owned utility company. The TP of the Chengdu project started in August 2015, when the transfer committee was established, and officially ended on 10th August 2017, when the plant was transferred back to the Chengdu municipal government (CMG). Table 1 shows key project details.

[Please insert table 1 around here]

The Chengdu Project was an ideal case for research given that this project is the first, and to date, only water PPP that has been transferred back to the government. Moreover, previous authors have been actively monitoring this project since its inception phase, resulting in a comprehensive body of published work on the project regarding its pre-TP performance (Chen, 2009, Chen and Doloi, 2008, Chan et al., 2005, Chan et al., 2015). Apart from the data presented in earlier studies, the concession agreement, minutes of transfer committee meetings, and other documents pertinent to the project, were thoroughly scrutinized in order to capture any possible information in connection with the transfer. Additionally, during the TP, on-site and telephone interviews were carried out over five occasions (3 August 2015, 20 February 2016, 9 May 2016,

9 May 2017 and 15 September 2017) to elicit points of view from key management members representing both the public and private sectors. In total, nine interviewees participated in the study, including two officials from the public authorities, two senior management members form CWGC, one from Veolia, and four from CGMW. They all had been personally involved in and kept long connection to the Chengdu Project, possessing a deep familiarity and understanding of it, based on their own roles. By comparing the status quo of transfer management in China (represented by the as-is model) with the data collected from the real transfer process (as seen from the case study), the challenges of the current transfer management were revealed. Then, by observing the measures taken in the Chengdu Project, in combination with the opinions extracted from the expert interviewees, a series of possible solutions focusing on the challenges were proposed.

In the third step, findings from the prior steps were translated into IDEF0 elements to create the "to-be" model (i.e. the GTPM). The actions taken to upgrade the as-is model into the GTPM includes removing inappropriate steps and factors, redefining unclear steps, and adding new steps and factors needed. The preliminary version of the GTPM model was sent back to the interviewees for comments on the model's effectiveness, with a view to further improving the current transfer system. Additionally, the resulting GTPM was as also evaluated by three experts in both IDEF0 and PPP areas, with their opinions further informing the final version of the GTPM.

IDEF0 Method

Of various methods for modeling a process, Shen et al. (2004) concludes that IDEF0, IDEF3 and DFD (Data Flow Diagram) are the preferred tools under conditions of system development where data is open-ended and there is limited capability to capture it all. Comparing the three methods, IDEF0 is suitable for preliminary design to describe the entire process in a top-down structure, while the other two methods suit detailed discussion from a bottom-up perspective (Shen et al., 2004). This study aims to uncover the TP holistically, serving as the basis of a systematic research on the TP, videlicet, the study is with exploratory and preliminary nature. Considering the above analysis, IDEF0 was chosen as the appropriate modeling tool.

IDEF0 is a modeling technique to design, maintain, and promote systems or processes [National Institute of Standards and Technology (NIST), 1993]. Several unique merits made it popular in process modeling. To name a few, it is adept at describing complex processes by providing multiple levels of details, and in the meanwhile having a complete overview with the entire process (Sugiyama et al., 2006). It is also easy for users to learn the method and to interpret the model built (Sanvido and Medeiros, 1990). Moreover, it allows decision makers to systematically analyse the current situation of a process, with the purpose of identifying possible deficiencies in-between the process, and implementing improvements (Climent et al., 2009). From these points, IDEF0 is particularly suitable for the objectives of this study.

An IDEF0 model is composed mainly of hierarchical diagrams formed by boxes and arrows (Figure 2). A box denotes an activity in a specific process model. The arrows represent the interfaces that constrain when and how an activity is performed. The interfaces on the different sides of the box reflect the different roles of the arrows. The arrows that point to the left side of the box represent the inputs expended by an activity and transformed into outputs that are denoted by the arrows from the right side of the box. The inputs and outputs can be objects or data (Carnaghan, 2006). The controls, which are represented by the arrows pointing

to the top of the box, provide the conditions constraining the activity's generation of outputs. The arrows pointing to the bottom of the box represent the mechanisms, which are the supportive means, such as professionals, machines, time, software, and so on. For more knowledge of IDEF0, the readers can refer to NIST (1993).

[Please insert figure 2 around here]

The areas in which IDEF0 has been applied vary, ranging from manufacturing processes (Al-Ahmari and Ridgway, 1999, Bevilacqua et al., 2015, Chin et al., 2006), bank business processes (Climent et al., 2009), chemical processes design (Sugiyama et al., 2006), logistic processes (Kovács, 2016), to construction processes (Yung et al., 2014, Sanvido and Norton, 1994) and so on. Chan et al. (2005) introduced this method to the PPP field, developing China's BOT generic process model (CBGPM), through which interfaces of BOT projects were identified. These previous studies support the efficacy of this method and is therefore adopted as the model for the current study of the TP of water PPPs in China.

Status Quo of Transfer: the "As-is" Model

A two-level hierarchical structure was built to show the status quo of the transfer process. The first level is represented by a context diagram A-0, which shows the connection between the TP and its outside environment (Figure 3). The second level presents the TP in a more detailed way by breaking it down into several steps linked by 18 key factors, as shown in the A0 diagram (Figure 4). The sources of key factors are shown in Table 2.

[Please insert table 2 around here]

A-0 level

The most general description (NIST 1993) of the transfer process in China is represented by the A-0 diagram with only one box and some key factors connecting it to the outside (Figure 3). Inputs to the transfer are available resources (e.g., money, time, people, etc.) infrastructure, and technical documents. Outputs produced by the transfer are PPP performance information that feeds back to improve the PPP development process, transfer knowledge and transfer experience resulting from managing the TP, and project assets belonging to the public. The process of transfer is limited by four controls: contract system, transfer participants' constraints (such as manpower and workload for transfer), external constraints (such as weather, law, etc.), VfM (value for money) anticipated by the government. Mechanisms of transfer are supportive bodies, including SPV, government agency and transfer committee. Definitions of these factors can be seen later within this section.

[Please insert figure 3 around here]

A0 level

The second level (i.e. the A0 level) is the decomposition of transfer, consisting of four steps (MoF 2014) shown in Figure 4. These four steps are:

(1) **Prepare for transfer (A1)** includes all the activities needed to make relevant project assets ready for transfer. In China, this work begins normally one to two years before

the PPP contract expiry, via transfer committee meetings on which government agency and SPV negotiate over details of the transfer plan. Technical documents and current condition of infrastructure are main references to develop detailed transfer arrangement (e.g. the overhaul plan, transfer checklist, etc.), and subsequently, SPV embarks on the final thorough overhaul as arranged. Then the refurbished assets are outputted. Outputs also include knowledge and experience gained by involvers of this step. All these activities consume available resources such as time, money, etc.

(2) **Assess and test assets (A2)** encompasses all activities needed to examine whether or not the condition of the refurbished assets is acceptable to the government. Resembling the A1 step, this step is supported by government agency, SPV and transfer committee, and controlled by transfer participants' constraints, external constraints and contract system. What is more, the process of assets test is also under control of the transfer arrangement produced by the A1 step. Inputs include refurbished assets and available resources, and outputs are acceptable assets, knowledge and experience learnt in this step.

(3) **Perform assets transfer (A3)** contains all activities required to finalize the formal transfer of project assets. Major inputs thus are all acceptable assets and available resources consumed in this step. Likewise, contract system, transfer participants, external condition and transfer arrangement define restrictions from multiple aspects. Main mechanisms are still government agency, SPV and transfer committee. Normally, this step ends up with a formal transfer ceremony on which project assets are officially transferred. As a result, transferred assets along with knowledge and experience are produced through managing this step.

(4) **Evaluate PPP performance (A4)** comprises all functions required to measure the lifecycle performance of the PPP project. The transferred assets (both tangible and intangible) are systematically evaluated in this step to generate lifecycle operation knowledge and experience. Meanwhile, as the government becomes the new responsible body for the post-transfer operation, transferred assets naturally become public property. Since at this step the private sector has seceded from the major contract responsibilities, evaluation can only be done by the responsible government agencies (e.g. finance department). Controls are transfer participants' and external constraints, as well as VfM requirement that is initially proposed by the government.

[Please insert figure 4 around here]

Analysis of key factors

There are 18 key factors connecting the four steps with the environment of the TP. Taking the precedent of Sanvido (1990) and Chan et al. (2005), this paper classifies these key factors into four groups according to the similarity of their roles within the model. That is, process control factors, product factors, feedback factors and constraint factors, as shown in the first column of Table 1, as well as represented by arrows in Figure 4. The definitions of the key factors are based on their sources (see Table 2), but necessarily rephrased to be in line with the characteristics of the TP.

Process control factors

The factors controlling the process of transfer are those which are indispensable for the entire transfer process, and should be well prepared in advance of the commencement of the TP. Nine factors shown in Table 2 belong to this category.

(1) Contract system refers to legal documents between parties defining the services to be carried out and role of each party in producing those services. It is the basis for developing as well as implementing the transfer arrangement. The most important contract is, of course, the concession agreement between the public and the private sectors, which, under ideal circumstance, specifies all details about the TP, such as transfer scope, transfer timeline, etc.

(2) Transfer committee is a kind of task force constituted by representatives from both the public and private parties, aiming to make the communication between the two parties smooth. Normally, the settings of the transfer committee are predefined in the concession agreement, and the function of the committee is activated when the TP begins. The key to the committee functioning efficiently is the competence of the selected representatives (Fischer et al., 2006).

(3) SPV regards the legal body undertaking the due contractual obligations (Department of Infrastructure and Regoinal Development, 2015). During ordinary operation, the SPV takes care of the project and offers products, and in so doing, gains reasonable and stable profit. However, when dealing with the TP, the SPV is expected to bear some more duties (e.g. final thorough overhaul, staff training, etc.) without extra profit.

(4) Government agency is required to share the risks and responsibilities throughout PPP lifecycle in order to create a conducive environment for the private party (Chan et al., 2005). Its active involvement is particularly essential for the TP in which the proactivity of SPV to fulfill the additional responsibilities is possibly insufficient due to the consideration of cost.

(5) Available resources include all resources dedicated by the involvers of the TP (e.g. time, money, tools, energy, intelligence, and work places, etc.). The National Audit Office (2001) suggests that all parties must entrust their best resources to ensure the success of PPP projects. Obviously, the success of the TP as well is influenced by the quality of the resources inputted.

(6) Infrastructure refers to the physical part of the project assets to be transferred in the TP. Considering the fact that the infrastructure has been unavoidably depreciated after decades of service (Yuan et al., 2015), it is critical for the government to request the SPV to conduct a thorough overhaul to the infrastructure. After the overhaul, all the related items should be tested to guarantee the acceptable condition.

(7) Technical documents refers to the data part of the project assets to be transferred, including critical data in construction, operation, maintenance and so forth (ADB, 2008). These documents provide the essential reference for transfer preparation as well as the PPP performance evaluation. They are important due to the feature of the construction industry where the products are normally of a one-off nature (Jin and Doloi, 2008).

(8) Transfer experience regards information and knowledge that comes from managing the TP. It is not that formally recorded by technical documents, but included in other

media, for instance, the reputation of the company, the memory of the transfer participants, etc. This can enhance the ability of the transfer participants to handle some unique uncertainties in the TP.

(9) VfM is the paramount objective and motivation of the government to adopt PPPs (Grimsey and Lewis, 2005). According to China's PPP policy, the VfM demonstration should be done during the project development phases, and also could be used to evaluate the lifecycle performance of PPPs. However, its application in China is at a very preliminary stage where criticism to its current operating way still exists.

Product factors

This group of factors refers to those produced by each step of the TP, and are utilized by other steps as inputs or controls (see Table 2 and Figure 4). They can be further grouped into two categories: physical products and informational products.

- ***Physical Products***

The physical products contain four categories of project assets. These four factors in fact refer to the same batch of assets being processed by successive steps of the TP.

(1) Refurbished assets mean that the assets have been thoroughly overhauled and their efficacy has been improved as expected. In other words, this factor is produced by step A1, prepare for transfer, and is used by step A2, assess and test assets (Figure 4). Likewise, the other three categories are defined below.

(2) Acceptable assets are those whose performance has been tested to be acceptable so that the transfer could be performed in the following step. This factor connects step A2 and step A3.

(3) Transferred assets regards those that have been formally transferred from the private party to the public party, and are going to be systematically evaluated and put into use after transfer. They come from step A3, and flow into step A4.

(4) Public assets indicate that the assets start to be used to provide products/services for the publics. They run through step A4 of the TP to the post-transfer life of the project.

- ***Informational Products***

Two informational products were identified in the TP, namely, transfer arrangements and transfer knowledge. They are used to facilitate the management of various transfer steps, as well as activities after the TP.

(1) Transfer arrangement refers to the agreed plan that defines all details about transfer, such as overhaul plan, assets checklist for transfer, and transfer schedule, etc. Ideally, it has to be well defined in the concession agreement, but more often, it depends on the negotiation process of the TP as relevant clauses of the concession agreement signed long time ago tends to be impractical to the practice of the transfer moment.

(2) Transfer knowledge concerns documentation recording outcome information of each step of the TP. In a process, the operation knowledge of one function may facilitate the implementation of its downstream function (Chan et al., 2005). Likewise, the knowledge acquired from the TP can do good to the post-transfer operation of the project.

Feedback factor

This category of elements returns to the beginning of the development process to facilitate the TP by optimizing decisions made throughout the PPP lifecycle.

(1) PPP performance information appears as the only one factor turning back in the as-is model (see Figure 2). It is produced at the last step, A4, and serves as a valuable reference for improving the decisions of the development process of future PPPs.

Constraint factors

This category of factors is related to limitations constraining the TP. It is common sense that any business process is under certain constraints (e.g. schedule, manpower, budget, etc.), otherwise there is no need for conducting management activities. The TP is mainly influenced by limitations from two aspects:

(1) Transfer participants' constraints refers to limitations resulting from the staff assigned by both the public and private sectors to participate into the TP. As previously mentioned, the TP requires extra investment from both the public and private parties. Typically, the personnel are necessary and usually temporarily convened from other posts for this special purpose. Therefore, the number or capability of the assigned participants matters to the transfer efficiency.

(2) External constraints are environmental factors that may hinder or impact the transfer process. These factors may include weather, codes, culture, economy, political system, technology and so forth. One feature in common is that they are all beyond the control of the transfer involvers (Wang et al., 1999).

Optimizing Transfer: the "To-be" Model

The "as-is" model that comprises a two-level hierarchical structure (Figure 3 and Figure 4) is constructed using multiple materials pertinent to PPP transfer. It describes China's current transfer management procedures. The challenges were then examined and identified using the model to analyse the recently transferred case of the Chengdu Project. This section presents those challenges, and the solutions proposed, which are summarized in Table 3.

[Please insert table 3 around here]

Challenges for China's current TP management

Disordered transfer preparation process

As shown in Figure 4, the first step of the TP is to prepare for transfer. In this regard two products, the transfer arrangement and the refurbished assets, are necessary. Here transfer arrangement refers to the plan determined by both parties, while refurbished assets appears as the implementation of the plan carried out by the SPV. These two factors require different work procedures and different responsible parties. However, the basic principle defining the process is to put together activities with similar procedures, characteristics and outcomes (EIB, 2012). Consequently, clashes may occur when processes with different features are mixed into one step.

This worry has been observed in the transfer preparation of the Chengdu Project. Initially, the transfer preparation of the Chengdu Project seemed to progress smoothly when CGMW submitted the preliminary transfer plan to CMG before the first transfer committee meeting held as scheduled on 11th August 2015. However, it took an unexpectedly long time to reach an agreement on details of the transfer arrangement. The standoff between the two sides persisted until the scheduled start time of the final overhaul, without any substantive progress being reached regarding the arrangement. Considering the unclear division of responsibilities of the transfer preparation process, CGMW decided to embark on the overhaul unilaterally, while at the same time pursuing ongoing negotiation with CMG. As a result, CMG was compromised in bargaining with CGMW since it had to continue monitoring the overhaul process throughout the negotiations. This dysfunctional conflict further undermined the efficiency of the negotiation, at the same time putting the overhaul process at risk of poor supervision.

Problems in making overhaul plan

An important trait of water PPPs is that production relies heavily on a great number of facilities and equipment. This trait results in a relatively long list of items to be overhauled. As there is no universally accepted guideline or experience for overhauling water PPPs, the approval of the overhaul plan has to undergo a lengthy and intense negotiation process. That is to say, the longer the checklist is, the more problems may occur.

In the Chengdu Project, more than 180 items were related to the overhaul plan, making it a tough task to come to a quick consensus on the whole plan. To make things worse, the contract clauses referring to overhaul work offered little help, while generating ongoing controversy. For example, the concession agreement requires that the final thorough overhaul should include "*inspection and repair, crack detection, test and replacement of worn and defective parts*". However, there were no specifications in the contract defining the parameters for needing some repair, in contrast to needing replacement. Consequently, given the zero-sum conflict of interest, CGMW and CMG typically interpreted clauses to their own advantage. Even when agreement was reached in a matter, the dispute would then shift to further uncertainties, such as what brand a new part should be. What's more, an immature institutional environment, such as a lack of procedural rules for settling disputes, combined with no technique criteria for overhaul, exacerbated the drawn-out process.

Late determination of the transferee

Although the government is responsible for the transfer of a PPP, it is neither able nor allowed to run the project directly according to the law of China. Naturally, the real situation in China is that when transfer process is done, the project will be awarded to a transferee selected by certain means to play the responsible role in managing post-transfer operation. In this case, a transferee is certainly a close involver of the TP; however, its important role has not been displayed by the as-is model.

The neglect of the transferee has affected the transfer progress of the Chengdu Project. The nominated transferee of the Chengdu Project was the Xingrong Group, a big water enterprise in Chengdu city. But its name had not appeared in the transfer committee meeting record until 4th February 2017, when 18 months had passed since the beginning of the TP. The late determination of the transferee led to many disadvantages. Firstly, without the expertise of the transferee, CMG found difficulties in handling technological issues, which led to much

ineffective communication with CGMW. Also, without the confirmation of the transferee, many details about the transfer arrangement could not be settled at all. Consequently, the holistic efficiency of the transfer management had been decreased considerably.

Lacking emphasis to personnel settlement

During the TP, front-line employees have to make decisions of whether to stay or leave under a circumstance that is with uncertainty to their future career and life. The uncertainty stems from two aspects. On the one hand, this kind of decision could be very hard for the one who has worked for so many years in a place where his/her family has been established and rather accommodated to the life style. On the other hand, the government normally reserves its authority to keep or refuse any original employee after the transfer.

With the personnel settlement, the Chengdu Project was an extreme case. All of the front-line employees chose to stay with the plant, and CMG accepted them as their wish. As a result, issues about personnel settlement and new staff training were fortunately avoided. But, as mentioned by some interviewees, this perfect result mainly relied on the excellent condition of the project as well as the strong affordability of CMG; for PPPs that fail any of these two conditions, planning personnel placement could be very sensitive and complicated. Without appropriate settlement, project operation during the transition period may be put at risk by worried staff. However, the current transfer system in China seems lack enough emphasis on this critical factor.

Impracticality of evaluating PPP lifecycle performance

Performance evaluation is one of the significant activity in contract management of PPPs (EIB 2012). Nonetheless, most of the existing methods for performance evaluation are still arguable, even in those with mature PPP market (Liu et al., 2016). The main reason lies in the complexity in nature of PPPs. Therefore, it is easy to understand the impracticality of evaluating lifecycle performance within a short step at the end of the TP (i.e., the A4 step in Figure 4).

The Chengdu Project proved the abovementioned impracticality. According to the concession agreement, the TP of the Chengdu Project was from 2015 to 2017, covering the last two years of the concession period. On 11th August 2015, after 15.5 years of operation, the transfer committee of the Chengdu project was set up as scheduled in order to arrange the transfer work. Both sides took part in the transfer process actively. For example, less than one week after the first transfer committee meeting, CMG sent technical experts into the water plant to verify the overhaul plan. Although participants from CMG were fully dedicated, they admitted that it was not possible for them to conduct PPP performance evaluation in such a limited period. CGMW tried to employ consultant to evaluate the project performance, but it failed due to the difficulty in finding competent candidates. The impracticality has also been mentioned by Wen (2012) who investigated another renowned pilot PPP project in China, the Laibin B Power Plant, and concluded that it was hard to assess the lifecycle performance of the plant given the ups and downs of the partnership throughout 20 years.

Low quality of key factors in the as-is model

The key factors identified by a process model can be seen as possible critical success factors (CSFs) that, when utterly met, guarantees the successful completion of the process (Sanvido et al., 1992). In other words, the quality of the key factors matters to the success of a process. As

for the transfer process of the water PPPs in China, the low quality of some key factors in the as-is model has given rise to adverse ramifications, which can be viewed in the Chengdu Project.

Based on the analysis of the total 18 key factors (Table 2) of the Chengdu Project, some of the factors appeared with low quality. As an example, the contract system could be more instructive. The concession agreement of the Chengdu Project had a rather sketchy description of the transfer arrangement, which, as previously analyzed, arouse many debates between CGMW and CMG. Another imperfect factor was the transfer committee which comprised three representatives from the public sector and three the private. In particular, the public representatives were dominated by the ones from administrative departments of CMG. This bureaucratic configuration seemed not to be qualified enough to deal with issues requiring much expertise of water PPPs. The low quality of the factor transfer experience was not unexpected at all as by now very few PPPs all over the world have reached the TP. Instead, challenges caused by low quality of key factors could be more serious to numerous other PPP water projects which were developed and maintained not as well as the Chengdu Project.

Based on the above analysis, a conclusion can be drawn is that the main challenges observed from the case study were not caused by some rare, unique problems; indeed, they are closely linked to some generic drawbacks such as the immature PPP administration system, unreasonable procedure design etc., which can easily spread to the TP of any other water PPP. Therefore, these mutual challenges possibly faced by all water PPPs in China should be improved to better future transfer management.

The "to-be" model: GTPM

Compared to the as-is model, the GTPM includes a total of five steps and 23 key factors (Figure 5). Relevant steps and key factors that were involved in the model modification are summarized in Table 4, and the detailed discussion follows.

[Please insert figure 5 around here]

[Please insert table 4 around here]

Redefining original A1 step

In the GTPM, the original A1 step is divided into two steps: A1, prepare for transfer, and A2, overhaul assets. This alteration aims to separate the preparation of transfer from the overhaul of project assets, so the two processes could be more focused and ordered. The practitioners of transfer management could also be reminded that the primary task for the TP is to develop a holistic, workable plan for the TP. To do so, both parties should make full use of their resources and intelligence to reach an agreement on the arrangement efficiently. When the arrangement together with other details are set, overhaul could be conducted followingly by the SPV, while the government agency changes its focus into monitoring. Owing to the clear division between the planning process (A1 step) and the implementation of the plan (A2 step), the practitioners can be fully aware of their dynamic responsibilities and foci, carrying out rational adjustment to the allocation of their limited resources and efforts.

Decomposing new A1 step

Given the inefficiency of this step exposed by the case, it is necessary to build a more explicit roadmap showing the process of transfer preparation. As shown in Figure 6, this paper fulfilled this need by decomposing new A1 step into the third level, the A1 level, prepare for transfer, which encompasses three sub-activities (i.e., A11, A12 and A13), and a number of sub-factors (note that the controls from the outside of the A1 step are not displayed in Figure 6 for the sake of brevity). These sub-steps start with the government agency planning for the TP and post-transfer operation in advance. It is of great importance for the government to advance some work before the formal TP, as China's governments with little experience in PPP transfer need more time to decide proper transferee and acceptance condition which are crucial factors for following activities. In the meanwhile, the SPV should finalize the compilation of preliminary overhaul plan, personnel settlement plan, and transfer checklist. With clear cognition of each's duties and demands, the two parties then can meet together and make effective discussion on the details of transfer to justify the transfer arrangement and acceptance criteria.

In addition, the problems caused by the vague definition of the TP in the concession agreement will tend to be common in practice, as most of the water PPP contracts were based on the contract of the Chengdu Project (Chen, 2009). Therefore, the two parties should also realize that constantly modifying the arrangement according to the feedback factor (i.e. arrangement modification information in Figure 6) may occur. In this case, trying to propose reasonable demands may be helpful for both sides to shorten the negotiation period. What is more, formulating workable rules of procedures beforehand could also reduce negotiation time consuming, especially under the circumstance that China's institutional environment for PPP is still developing.

[Please insert figure 6 around here]

Renaming new A4 step

The step *A3 perform assets transfer* in the as-is model is renamed as *A4 perform transfer procedures* in the GTPM. This change is to emphasize that transfer is not only with reference to the project assets but also need adequate attention to deal with possible issues related to front-line employees. Pre-communication should be carefully conducted by the SPV to capture the real thinking of the employees. And the transfer arrangement should be developed with full consideration of their reasonable requests. The government should also participate in the investigation to the employees earlier, by which they can carry out necessary evaluation to them and make proper decisions accordingly (World Bank, 2016). If transfer leads to staff leaving, make sure that their next placement is clearly told, and in the meantime, recruitment for vacant posts as well as necessary training for new staff are conducted timely.

Postponing original A4 step

Putting this step behind the TP is not to despise the significance of evaluating the PPP lifecycle performance. It is only because the TP is too short to systematically deal with a complicated evaluation. Besides, currently there is still an absence of a reliable and practical way to evaluate PPP performance in China, as existing methods failed to handle issues caused by China's uniqueness in many aspects, such as preliminary stage of PPP development, poor reservation of PPP data (Cheng et al., 2016), special economic and political systems, etc. Without solid approach, the reliability of the evaluation result could be uncertain. Therefore, to guarantee the

reference value of a lifecycle performance evaluation, this paper suggests the government assigns separate time and team to do it systematically after transfer, on the premise of a careful method selection and a comprehensive data collection.

Developing A5 step

Performing post-transfer procedures matters as the transfer of a PPP is not the end of the project's life but a transition of two different ways to run the project. The best situation is that this transition happens smoothly without any interruption of the product/service provision. This purpose requires that all post-transfer actions, such as to form new contractual partnership with succeeding operator, to put all relevant items (e.g. project assets, personnel, work instruction, contractor warranties, technology, knowhow, etc.) in place, are completely accomplished. With this step, several critical stakeholders referring to the post-transfer operation of the project, such as transferee, sponsor, and succeeding operator, which are not shown in the as-is model, are highlighted in the GTPM, and their definitions are summarized in Table 4.

Improving the quality of the key factors

A total of 23 key factors are finally identified in the GTPM (refer to Table 2 and 4 for detail). Analysis of the case showed that transfer success is closely related to the quality of these key factors. Note that the Chengdu Project was developed under a national BOT scheme of China, with outstanding performance in engineering and maintenance (Chen, 2009). However, it also suffered difficulties due to the low quality of some factors during the TP. For the majority of other existing water PPPs in China, their operation status are almost unknown to the publics because of the poor monitoring system of the government over the last two decades (Cheng et al., 2016). As a result, the possibility of their future transfer coming across similar challenges resulting from low-quality factors is likely to be high. In this context, the GTPM can contribute to the industry by revealing what factors need to be concerned for better transfer, and then corresponding measures could be taken in advance to maintain the good quality of those factors.

Dynamic management framework for transfer

Based on above analysis, a dynamic management framework for the transfer of China's water PPPs is shown as Figure 7. This framework displays how the proposed GTPM can facilitate the transfer management, and in the meanwhile, accomplish self-evolution by learning from the transfer process.

[Please insert figure 7 around here]

In general, the framework contains four steps to carry out efficient transfer management.

(1) The transfer phase starts with developing as-is model to reflect the project status. This step is crucial given that, when coming to the transfer phase, the conditions of different PPPs are not necessarily the same as shown by the Chengdu Project. Distinctions may be caused by multiple reasons, like the ability of management team, contract requirement, or different local PPP rules, etc. Through as-is model, the unique, actual situation of a PPP can be revealed so that deficiencies relating to transfer management can be further identified.

(2) The GTPM serves as benchmark to exam the specific deficiencies of the as-is model, such as key factors with low quality, missing steps, unclear step description, etc. According to the deficiencies identified, the measures to improve the as-is model are considered and tested by GTPM, and so on, until a satisfactory result appears. Note that the GTPM can be tailored as needed. For instance, any step of the GTPM (Figure 5) can be further decomposed into certain sub-level to be explanatory enough for the model users (NIST, 1993).

(3) Bearing the possible measures for satisfactory result in mind, transfer practitioners can begin to develop detailed transfer plan. To make a comprehensive plan may take time due to the involvement of multiple parties that are expected to get consensus on various items; however, the GTPM can help by offering a facilitating platform for communication between involvers (Bevilacqua et al., 2012). When making the plan, decision makers should be aware of the priorities of all key factors from their own perspective (i.e. the public or private perspective) so that management attention could be balanced (Chan et al., 2005).

(4) On the basis of the prior efforts, the TP could be efficiently managed. During the transfer process, more attention and effective measures should be placed on more critical factors and steps identified. The GTPM could be used as a real-time monitoring system under which management strategies and tools could be appropriately developed. On the other hand, by learning from the practice, the model can be constantly upgraded to better guide the practice in the future.

Conclusions

For numerous water PPPs in China, the final phase of the lifecycle is to transfer the project back to the government. Compared with other phases, the TP is little-known due mainly to the limited number of projects having reached this stage. Relevant knowledge and experience about the TP is rather limited, which has led to many challenges in transfer management. Hence, this paper aims to contribute to the body of knowledge on PPPs by proposing a complete transfer process model that hierarchically displays the detailed composition of the TP of water PPPs in China.

Three steps were followed to build the model. The first step was to summarize the status quo of the transfer management of water PPPs in Chinese context, with an IDEF0 method adopted to visualize the findings in an “as-is” model. Next, the Chengdu Project was selected as the case by which to identify the deficiencies existing in the as-is model, as well as to identify possible solutions for handling those deficiencies. Thirdly, the “to-be” model, known as GTPM, was proposed on the basis of the prior analysis; again, by using IDEF0. The model identified five steps and 23 key factors forming a number of material and data flows in the TP. These factors were further categorized into five groups according to their similarity of roles within the model. Moreover, a dynamic, self-evolving framework showing how to utilize the GTPM to facilitating transfer management was proposed.

To the best knowledge of the authors, to date, this research is the first to systematically describe the entire transfer process of China’s water PPPs. The findings of this research clearly reveal the status quo of China’s transfer management regime, and also point out existing deficiencies of the current transfer system. Based on this, plausible means by which to overcome these deficiencies are offered. In achieving these three aims, the research questions

pursued by this study are answered. Practitioners will benefit from the findings since the GTPM is able to inform better decision-making regarding TP of PPPs. Moreover, the model is also of value to PPP projects yet in the concession period, and earlier, since it will pre-alert practitioners of potential problem areas they will face at the TP. In so doing, it will allow them to remedy deficiencies in the contract structure and future transition phase, well ahead of time. For academic researchers, the process model here developed using IDEF0 methodology could be adapted to address similar TP issues in other localities.

Limited by both the literature and practical experience, the development of the GTPM relied on a specific case study. As the uniqueness of one specific case may not be wholly generalizable, the applicability of the conceptual model is limited. Hence, this research will be extended in further studies in which all the model elements will be evaluated by experts from China's water PPP area. Moreover, based on the findings of this paper, it is expected that other issues related to TP, such as transfer risks, transfer success criteria, etc. will also be further investigated.

References

ADB (2008), Public–Private Partnerships Handbook, Philippines.

Al-Ahmari, A. M. A. & Ridgway, K. (1999), "Integrated modelling method to support manufacturing systems analysis and design", *Computers in Industry,* 38**,** 225-238.

Bao, F., Chan, A. P. C., Chen, C. & Darko, A. (2018), "Review of Public-Private Partnership Literature – A Project Life Cycle Perspective (accepted)", *Journal of Infrastructure Systems*.

Bevilacqua, M., Ciarapica, F. E., Crosta, A., Mazzuto, G. & Paciarotti, C. (2015), "Implementation of a RFID system in a furniture industry involved in the fashion sector: A case study", *International Journal of RF Technologies: Research and Applications,* 6**,** 99-119.

Bevilacqua, M., Ciarapica, F. E. & Paciarotti, C. (2012), "Business Process Reengineering of emergency management procedures: A case study", *Safety Science,* 50**,** 1368-1376.

Carnaghan, C. (2006), "Business process modeling approaches in the context of process level audit risk assessment: An analysis and comparison", *International Journal of Accounting Information Systems,* 7**,** 170-204.

Chan, A. P. C., Lam, P. T. I., Wen, Y., Ameyaw, E. E., Wang, S. Q. & Ke, Y. J. (2015), "Cross-Sectional Analysis of Critical Risk Factors for PPP Water Projects in China", *Journal of Infrastructure Systems,* 21**,** 04014031.

Chan, W. T., Chen, C., Messner, J. I. & Chua, D. K. H. (2005), "Interface management for China's build-operate-transfer projects", *Journal of Construction Engineering and Management,* 131**,** 645-655.

Chen, C. (2009), "Can the pilot BOT Project provide a template for future projects? A case study of the Chengdu No. 6 Water Plant B Project", *International Journal of Project Management,* 27**,** 573-583.

Chen, C. & Doloi, H. (2008), "BOT application in China: Driving and impeding factors", *International Journal of Project Management,* 26**,** 388-398.

Cheng, Z., Ke, Y., Lin, J., Yang, Z. & Cai, J. (2016), "Spatio-temporal dynamics of public private partnership projects in China", *International Journal of Project Management,* 34**,** 1242-1251.

Chin, K. S., Zu, X., Mok, C. K. & Tam, H. Y. (2006), "Integrated integration definition language 0 (IDEF) and coloured Petri nets (CPN) modelling and simulation tool: A study on mould-making processes", *International Journal of Production Research,* 44**,** 3179-3205.

Climent, C., Mula, J. & Hernández, J. E. (2009), "Improving the business processes of a bank", *Business Process Management Journal,* 15**,** 201-224.

Department of Infrastructure and Regoinal Development (2015), "*National Public Private Partnership Guidelines "*, Australia, Available at: https://infrastructure.gov.au/infrastructure/ngpd/ (Accessed 7 September 2017).

EIB (2012), The guide to guidance: How to prepare, procure and deliver PPP projects*,* Luxembourg.

El-Mashaleh, M. S. & Minchin, R. E. (2014), "Concessionaire selection model based on data envelopment analysis", *Journal of Management in Engineering,* 30.

Fischer, K., Jungbecker, A. & Alfen, H. W. (2006), "The emergence of PPP Task Forces and their influence on project delivery in Germany", *International Journal of Project Management,* 24**,** 539-547.

Grimsey, D. & Lewis, M. K. (2002), "Evaluating the risks of public private partnerships for infrastructure projects", *International Journal of Project Management,* 20**,** 107-118.

Grimsey, D. & Lewis, M. K. (2005), "Are Public Private Partnerships value for money?: Evaluating alternative approaches and comparing academic and practitioner views", *Accounting Forum,* 29**,** 345-378.

Heravi, G. & Hajihosseini, Z. (2012), "Risk allocation in public-private partnership infrastructure projects in developing countries: Case study of the Tehran-Chalus toll road", *Journal of Infrastructure Systems,* 18**,** 210-217.

Ho, S. P. (2006), "Model for financial renegotiation in public-private partnership projects and its policy implications: Game theoretic view", *Journal of Construction Engineering and Management,* 132**,** 678-688.

Jin, X. H. & Doloi, H. (2008), "Interpreting risk allocation mechanism in public-private partnership projects: An empirical study in a transaction cost economics perspective", *Construction Management and Economics,* 26**,** 707-721.

Kovács, G. (2016), "Process description languages in construction logistics", *Periodica Polytechnica Transportation Engineering,* 44**,** 50-59.

Li, B., Akintoye, A., Edwards, P. J. & Hardcastle, C. (2005), "The allocation of risk in PPP/PFI construction projects in the UK", *International Journal of Project Management,* 23**,** 25-35.

Liu, J., Love, P. E. D., Smith, J., Matthews, J. & Sing, C. P. (2016), "Praxis of performance measurement in public-private partnerships: Moving beyond the iron triangle", *Journal of Management in Engineering,* 32.

MoF (2014), Circular on the Issuance of Public-Private Partnership Mode Operation Guide (Trial)*,* Beijing.

National Audit Office (2001), Managing the relationship to secure a successful partnership in PFI projects, London.

NIST (1993), Integration Definition for Function Modeling (IDEF0), Washington D.C.

Sanvido, V., Grobler, F., Parfitt, K., Guvenis, M. & Coyle, M. (1992), "Critical Success Factors for Construction Projects", *Journal of Construction Engineering and Management,* 118**,** 94-111.

Sanvido, V. E. (1990), "Towards a process based information architecture for construction", *Civ. Engrg. Systems,* 7**,** 157.

Sanvido, V. E. & Medeiros, D. J. (1990), "Applying Computer‐Integrated Manufacturing Concepts to Construction", *Journal of Construction Engineering and Management,* 116**,** 365-379.

Sanvido, V. E. & Norton, K. J. (1994), "Integrated Design-Process Model", *Journal of Management in Engineering,* 10**,** 55-62.

Shen, H., Wall, B., Zaremba, M., Chen, Y. & Browne, J. (2004), "Integration of business modelling methods for enterprise information system analysis and user requirements gathering", *Computers in Industry,* 54**,** 307-323.

Shen, L. Y., Bao, H. J., Wu, Y. Z. & Lu, W. S. (2007), "Using bargaining-game theory for negotiating concession period for BOT-type contract", *Journal of Construction Engineering and Management,* 133**,** 385-392.

Sugiyama, H., Hirao, M., Mendivil, R., Fischer, U. & Hungerbühler, K. (2006), "A hierarchical activity model of chemical process design based on life cycle assessment", *Process Safety and Environmental Protection,* 84**,** 63-74.

Van Buiten, M. & Hartmann, A. (2015), "Asset management perspective on the duration of public-private partnership contracts: Cost-control trade-off?", *Journal of Construction Engineering and Management,* 141.

Verweij, S. (2015), "Producing satisfactory outcomes in the implementation phase of PPP infrastructure projects: A fuzzy set qualitative comparative analysis of 27 road constructions in the Netherlands", *International Journal of Project Management,* 33**,** 1877-1887.

Wang, S. Q., Tiong, R. L. K., Ting, S. K. & Ashley, D. (1999), "Political risks: Analysis of key contract clauses in China's BOT project", *Journal of Construction Engineering and Management,* 125**,** 190-197.

Wen, H. W. (2012), "Gains and loss of Laibin B Power Plant", *Energy Observer*.

World Bank (2014), Public-Private Partnerships reference guide v2.0, Washington D. C.

World Bank (2016), The APMG PPP Certification Program Guide, Washington, DC 20433, USA.

Yuan, J., Chan, A. P. C., Xiong, W., Skibniewski, M. J. & Li, Q. (2015), "Perception of residual value risk in public private partnership projects: Critical review", *Journal of Management in Engineering,* 31.

Yung, P., Wang, J., Wang, X. & Jin, M. (2014), "A BIM-enabled MEP coordination process for use in China", *Journal of Information Technology in Construction,* 19**,** 383-398.

Zhang, X. (2004a), "Concessionaire selection: Methods and criteria", *Journal of Construction Engineering and Management,* 130**,** 235-244.

Zhang, X. (2004b), "Improving concessionaire selection protocols in public/ private partnered infrastructure projects", *Journal of Construction Engineering and Management,* 130**,** 670-679.

Figure 1. Research process

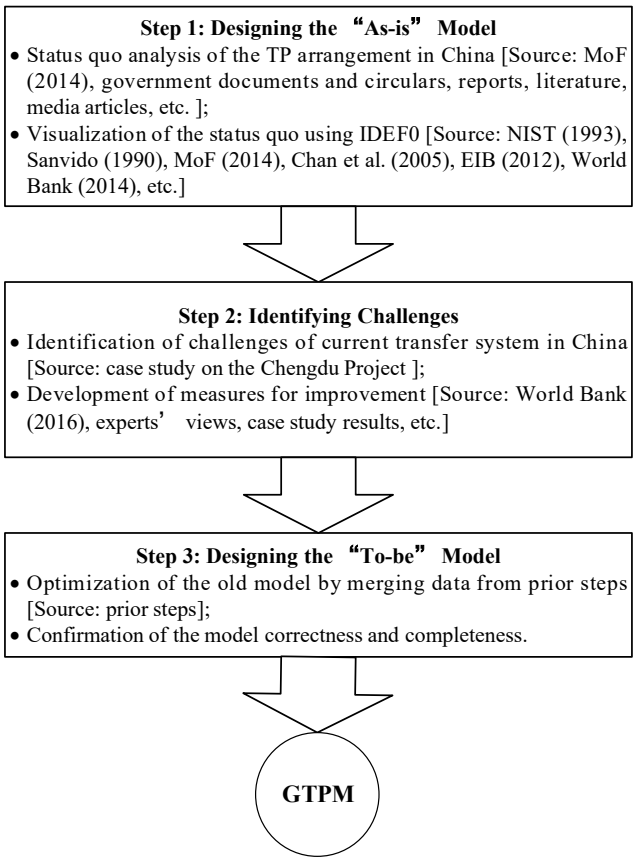

Figure 2. Example of IDEF0 Diagrams [Adapted from NIST (1993)]

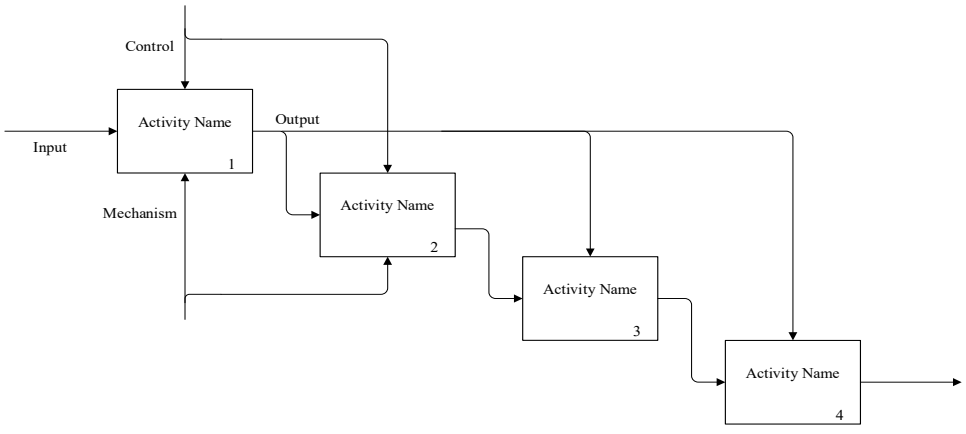

Figure 3. A-0 level of the as-is model

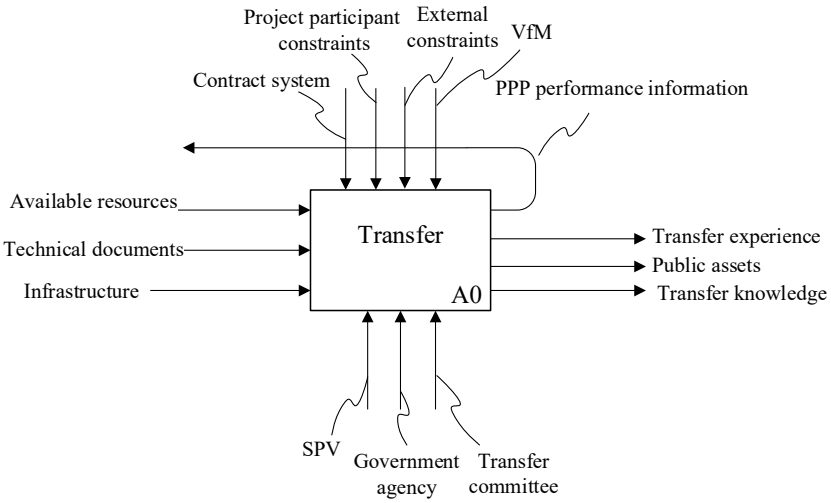

Figure 4. A0 level of the as-is model

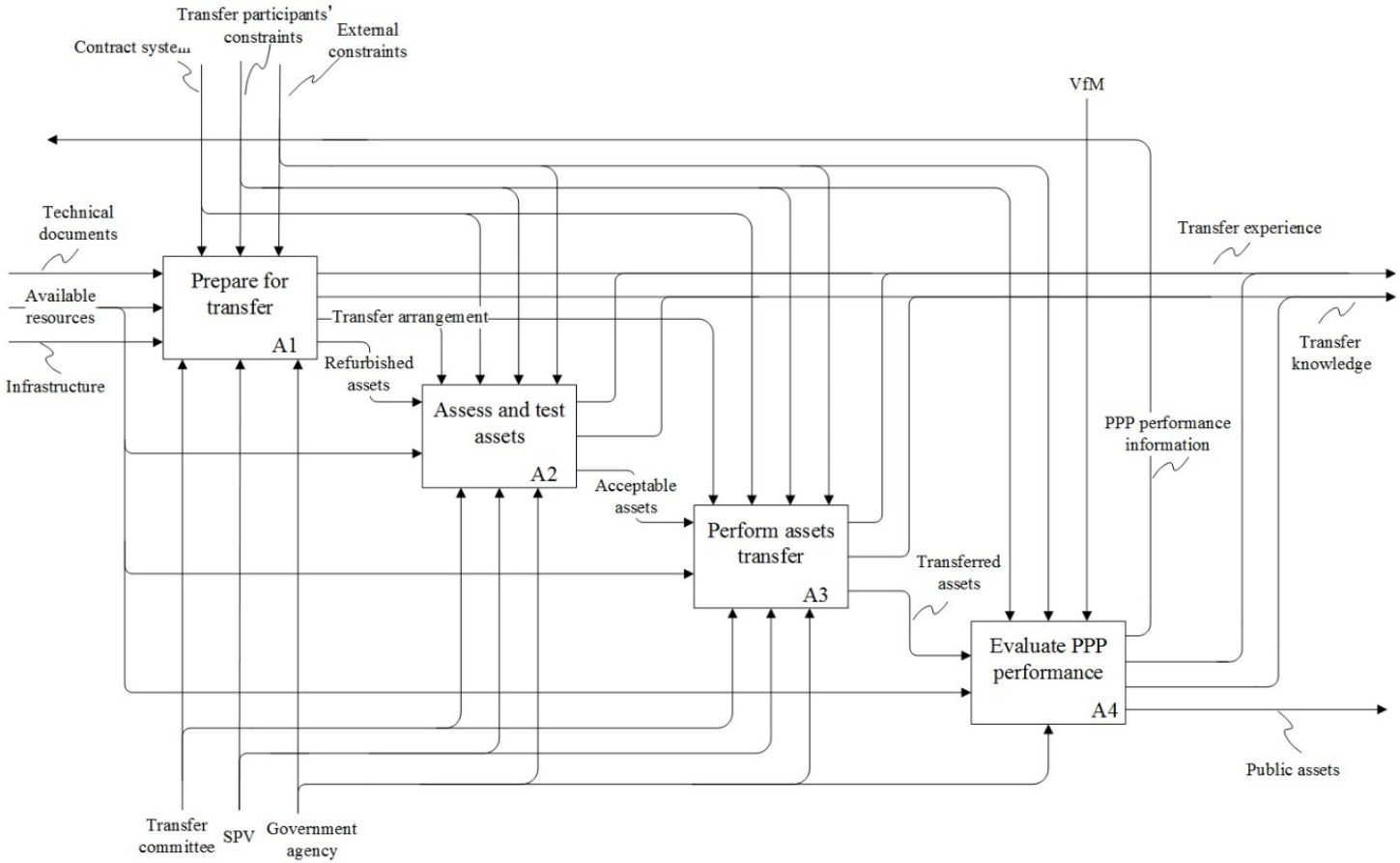

Figure 5. Transfer (A0): to-be model

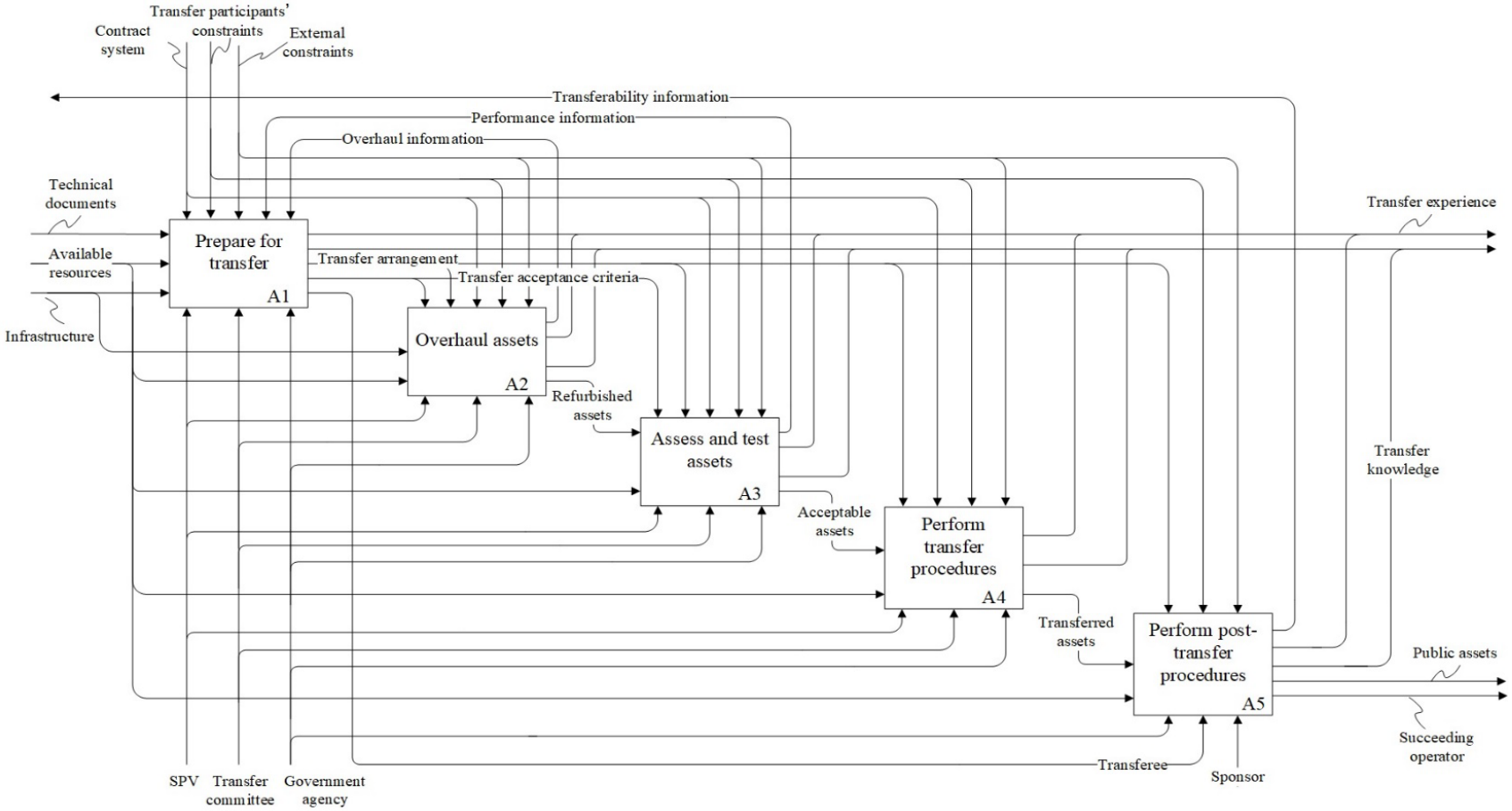

Figure 6. Prepare for transfer (A1): to-be model

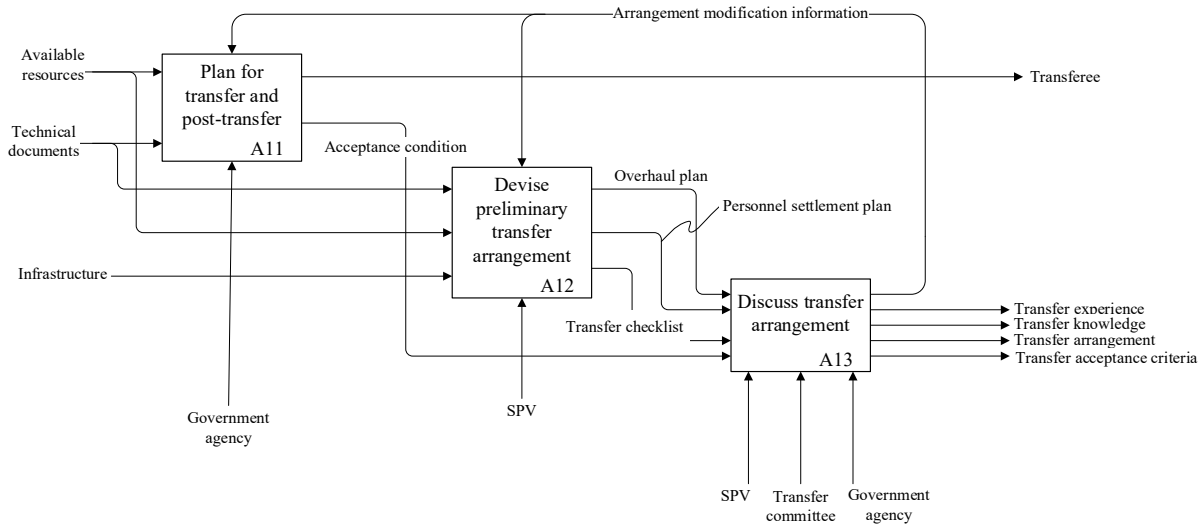

Figure 7. Dynamic management framework for transfer phase

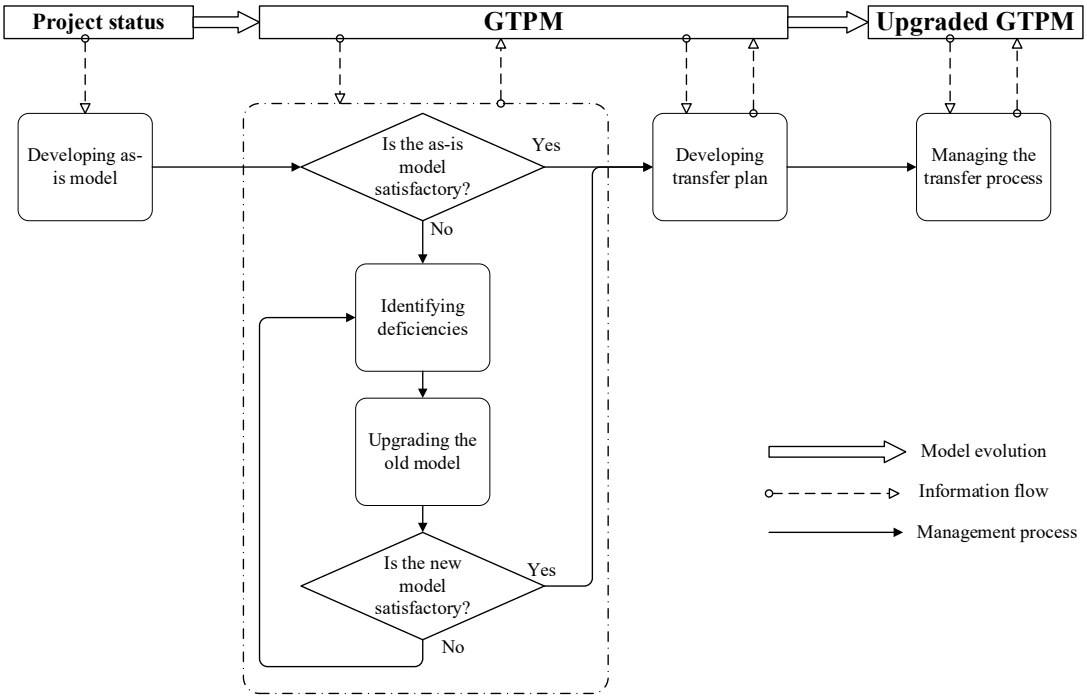

Table 1. Profile of the Chengdu No. 6 Water Plant B Project

PPP model	Build Operate Transfer (BOT)
Financial closure year	1999
Project contents	A water plant, water intake facilities, a 1030 m discharge pipeline, and a 27-km water transmission pipeline (DN2400 mm) linking the water plant to the urban water distribution network.
Capacity of the water plant (1000 m^3/day)	400
Total investment (US$ M)	106.5 (32 as equity stake + 74.5 as debt)
Contract term (years)	18
Sponsors	Veolia (providing 60% of the equity)
	Marubeni (providing 40% of the equity)
Lenders	ADB (providing $48 million of the debt)
	EIB (providing $26.5 million of the debt)

Note: ADB - Asia Development Bank

Table 2. Key factors of the as-is model and their sources

Key factor		Sources								
		MoF (2014)	**EIB (2012)**	**ADB (2008)**	**World Bank (2014)**	**World Bank (2016)**	**Chan et al. (2005)**	**Sanvido (1990)**	**Wang et al. (1999)**	**Others (media articles, industry reports, etc.)**
Process control factors	Contract system	×	×		×	×	×	×		
	Transfer committee	×					×			
	SPV	×				×	×			
	Government agency	×	×		×	×	×			
	Available resources	×				×	×	×		
	Infrastructure	×				×	×			
	Technical documents			×			×			
	Transfer experience	×					×	×		
	Value for Money	×								
Product factors	Transfer arrangement					×				
	Refurbished assets					×				
	Acceptable assets					×				
	Transferred assets									×
	Public assets					×				×
	Transfer knowledge							×		
Feedback factors	PPP performance information	×						×		×
Constraint factors	External constraints						×	×	×	
	Transfer participants' constraints						×	×		

Table 3. Challenges and solutions of China's transfer status quo

Challenges	Solutions
● The original A1 step, prepare for transfer, encompasses activities widely different in characteristics, leading to huge difficulty in managing the step orderly.	● To further divide this step into two steps: A1 prepare for transfer, and A2 overhaul assets.
● It is rather time-consuming to reach an agreement on the final thorough overhaul plan.	● To appropriately increase the time period of the TP; and ● To figure out subdivided activities and factors in A1 step.
● The determination of the transferee is not timely enough, decreasing the efficiency in making decisions.	● The government should advance some work related to post-transfer arrangement; and ● A step "perform post-transfer procedures" needs to be added to the end of the TP in order to make the transfer arrangement fulfilled completely and promptly.
● While much attention has been paid to the project assets, the criticality of the personnel settlement was overlooked by the original transfer management process.	● To emphasize the criticality of better dealing with the possible issues related to staff leaving, such as personnel settlement and new staff training.
● It is not practical to carry out the original A4 step, evaluate PPP performance, in a relatively short TP due to the complexity of the evaluation process.	● The government should make efforts to systematically evaluate the PPP performance after the TP.
● The low quality of some factors (e.g., contract system, transfer committee, transfer experience, transfer acceptance criteria, etc. in the Chengdu Project) in the model retards the progress of the TP.	● To take good care of all the factors of the entire model before they are used.

Table 4. Steps and key factors related to model upgrade

Steps/Key factors	Action taken	Definition
● Original A1, prepare for transfer	Divided into two steps:	
	● A1, prepare for transfer	● The same as the original A1 step excluding the content of the final thorough overhaul
	● A2, overhaul assets	● Includes all activities required to repair or replace project assets to be transferred. Inputs refer to untreated infrastructure and available resources, while outputs contain relevant experience and knowledge, overhaul information (such as overhaul report), and refurbished assets. The entire process is in the charge of the SPV, and under monitoring of the government agency. This step also needs to be in line with the transfer arrangement, transfer acceptance criteria, and controlled by the project participants' and external constraints.
● Original A3, perform assets transfer	Renumbered and renamed as:	
	● A4, perform transfer procedures	● Apart from the activities and factors from the original definition, this step also includes activities for appropriate personnel settlement and new staff training before the expiry.
● Original A4, evaluate PPP performance	Removed	
● Original A2	Renumbered as A3	Remain unchanged
● A5, perform post-transfer procedures	Developed	● Comprises all functions required to finish all the uncompleted matters related to transfer as well as the post-transfer operation. Inputs include transferred assets and available resources, while outputs are transfer experience and knowledge, public assets, and succeeding operator. This step is mainly supported by the government agency, sponsor, and transferee, and controlled by transfer participants' and external constraints.
● VfM	Removed	
● PPP performance information	Removed	
● Sponsor	Added to the category of process control factors	● The entity who invested or sponsored a PPP. This factor plays its role in the A5 step when the SPV has finalized its major transfer mission.
● Transferee	Added to the category of product factors	● The entity who represents the government to be responsible for the project after transfer. It appears to be the output of the A1 step by certain means (e.g. bidding or designation) and works as the mechanism of the A5 step.
● Transfer acceptance criteria	Added to the category of product factors	● Executable standard for the government to assess and test project assets. This factor should be prepared in A1 step and be used as the control of the A3 step.
● Succeeding operator	Added to the category of product factor	● The entity who is to operate the project after transfer. This factor is the output of the A5 step and flows into the post-transfer life of the project.

● Overhaul information	Added to the category of feedback factors	● Information about the completeness of the overhaul step. This factor is produce by A2 step, showing whether the task of the overhaul work is completed or not. If necessary, decisions in step 1 could be adjusted according to the information.
● Performance information	Added to the category of feedback factors	● Information about the performance of the project assets. This factor is generated by A3, showing whether the project is ready for transfer or not. If necessary decisions in step 1 could be adjusted according the information.
● Transferability information	Added to the category of feedback factors	● Information about the general scenario of a transferable PPP. This factor appears to be the output of A5 step, facilitating the TP by influencing decisions in the initial phase of PPP development.