DYNAMIC MODELS AT THE TRANSFER PHASE OF WATER PUBLIC-PRIVATE PARTNERSHIP PROJECTS IN CHINA

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PhD

The Hong Kong Polytechnic University

This programme is jointly offered by The Hong Kong Polytechnic University and Sichuan University

2019

The Hong Kong Polytechnic University

Department of Building and Real Estate

Sichuan University

Institute for Disaster Management and Reconstruction

Dynamic Models at the Transfer Phase of Water Public-Private Partnerships in China

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A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy

March 2019

CERTIFICATE OF ORIGINALITY

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___________________________________ (Signed)

Fengyu Bao (Name of student)

for my beloved family

ABSTRACT

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, PPPs have been much studied. However, due to their long concession period, which runs 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 situation is about to change as many PPPs, especially water PPPs, approach their TP. Unfortunately, knowledge about this phase remains limited, causing a problematic transfer process in practice. Hence, the purpose of this study is to define and investigate the main managerial issues in the TP of PPPs in China, with a specific focus on the water sector, from the local governments' perspective.

Firstly, this study uses transaction cost economics (TCE) theory to define the particular issues existing in the TP, including the adaptation, safeguarding and performance evaluation issues. Four research objectives plus 12 research questions are further established according to the nature of the three TCE issues in the TP. On the basis of the detailed research objectives and questions, appropriate research methods are adopted, such as literature review, Integration DEFinition 0, logical framework method, qualitative interview, questionnaire survey and case study, as well as several analytical techniques, including content analysis, mean score analysis, risk significance index, one-sample t-test, Kruskal–Wallis test, Mann–Whitney U-test, fuzzy synthetic evaluation and correlation analysis. This triangulation approach guarantees the reliability of the multiple research findings of this exploratory study.

The four research objectives are attained by developing three sub-models and one overall model. The first sub-model regards the generic transfer process model by which the entire transfer process is hierarchically exhibited to address the adaptation issue; the second sub-model, the transfer risk management system, is developed to effectively mitigate significant transfer risks that could lead to the safeguarding issue in the TP; and the third sub-model, the transfer performance evaluation system, serves as a tool to evaluate the authentic performance of the transfer management to avoid the performance evaluation issue. Finally, supported by statistical evidence, the integration of the three sub-models into the dynamic framework transfer management system is conducted and validated by the viewpoints of the experts in water PPPs of China.

To the best knowledge of the author, this study is the first attempt to systematically examine the TP of the water PPPs in China. Outcomes of the study could provide useful knowledge for practitioners, especially for the local governments in China, to come up with an overall transfer management plan that covers various aspects such as transfer process management, transfer risk management and transfer performance evaluation, and to compatibly deal with these aspects during the transfer process. The research outcomes also contribute to the body of knowledge by defining a number of new concepts and related theories, such as critical transfer success factors, critical transfer risk categories and key transfer performance indicators, as well as by identifying the significant correlations among the above three types of factors. Researchers with interests in other PPP sectors or phases can also benefit from the replicable research manner shown by this study.

PUBLICATIONS

Chapters of this report have been fully, or partially, published in the following publications:

A. Refereed Journal papers (Published)

Bao, F., Chan, A. P. C., Chen, C., and Darko, A. (2018). Review of Public-Private Partnership Literature from a Project Lifecycle Perspective. *Journal of Infrastructure Systems*. *24* (3): 04018008.

Bao, F., Martek, I., Chen, C., Chan, A. P. C., and Yu, Y. Lifecycle performance measurement of public-private partnerships: a case study in China's water sector. *International Journal of Strategic Property Management*. 22 (6): 516-531.

Yu, Y., Darko, A., Chan, A. P. C., Chen, C., and **Bao, F.** Evaluation and ranking of risk factors in Transnational Public-Private Partnerships projects: Case study based on the Intuitionistic Fuzzy Analytic Hierarchy Process. *Journal of Infrastructure Systems*. *24* (4): 04018028.

B. Refereed Journal papers (Accepted for publication)

Bao, F., Chen, C., Chan, A. P. C., Martek, I., and Shrestha, A. Dynamic framework transfer model for Public–Private Partnerships: Lessons from a China water sector case study. *Engineering, Construction and Architectural Management*. Manuscript ID: ECAM-01-2018-0028.R1.

C. Refereed Conference papers (Published)

Bao, F., Chen, C., and Chan, A. P. C (2017). Transfer Success Criteria for Public-Private Partnership Infrastructure Projects. *Proceedings of 22nd International*

Conference on Advancement of Construction Management and Real Estate [C]. Melbourne, Australia: CRIOCM 2017 Organising Committee. ISBN 978-0-6480742-4-3.

ACKNOWLEDGMENTS

I am indebted to many individuals who gave their time, energy and support in making this study possible. Grateful acknowledgment is first given to Professor Albert P.C. Chan, my chief supervisor, for his continuous support, encouragement, valuable guidance and advice in the process of conducting this study. I would also like to express my gratitude to Professor Chuan Chen at Sichuan University, my co-supervisor, for his continuous encouragement and support for my research work.

Special thanks are also given to Dr Igor Martek of Deakin University for his patient supervision; Dr Gang Tian, the former general manager of the Chengdu No. 6 Water Plant B Project, for his great support during the survey and interview period; and to Ms Yao Yu, Ms Jackie Yang, Mr Amos Darko and Mr Emmanuel Kingsford Owusu of The Hong Kong Polytechnic University, as well as Miss Weiling Jiang and Mr Yubo Guo of Sichuan University for their kind help during the research period. The experience of working with them not only witnessed my progress in conducting scientific research, but also, more importantly, became a precious source of fortune in my life.

Last but not least, I would like to extend my deepest gratitude to my wife, Ms Yuan Liu, who cheered me up when I was low in spirit, emboldened me when I faced challenges and comforted me when I received my first rejection letter and faced other frustrating moments; to my parents, Ms Zhuzhen Fan and Mr Chengwu Bao, who are the most unselfish parents in the world, for their unconditional support in taking care of the whole family; and to my son, Linan (Leon) Bao, who has been giving and will continue to give the most powerful impetus to me, his dad, to become a real father.

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ABBREVIATIONS

BOT	Build-Operate-Transfer
BTO	Build-Transfer-Operate
CBGPM	China's BOT Generic Process Model
CGMW	Chengdu Générale des Eaux-Marubeni Waterworks Co., Ltd.
CMG	Chengdu Municipal Government
CRFs	Critical Risk Factors
CSFs	Critical Success Factors
CTSFs	Critical Transfer Success Factors
CTRCs	Critical Transfer Risk Categories
CWGC	Chengdu Waterworks General Company
DBFO	Design-Build-Finance-Operate
DFTMS	Dynamic Framework Transfer Management System
GTPM	Generic Transfer Process Model
IDEF0	**I**ntegration **DEF**inition language **0**
KPIs	Key Performance Indicators
KTPIs	Key Transfer Performance Indicators
LFM	Logic Framework Method
O&M	Operation and Maintenance
PLC	Project Life Cycle
PPP	Public-Private Partnership
ROT	Rehabilitate-Operate-Transfer
SPV	Special purpose vehicle

TCE	Transaction Cost Economics
TCQ	Time, Cost and Quality
TMS	Transfer Management Success
TOT	Transfer-Operate-Transfer
TP	Transfer Phase
TPES	Transfer Performance Evaluation System
TPS	Transfer Product Success
TRMS	Transfer Risk Management System
VfM	Value for Money

CHAPTER 1 INTRODUCTION

In this chapter, the research background is firstly introduced in Section 1.1. Afterwards, the research aim and objectives are presented in Section 1.2. Research questions, the methodology and the structure of the thesis are presented in Sections 1.3, 1.4 and 1.5, respectively.

1.1 Research background

1.1.1 Brief introduction of public-private partnerships (PPPs)

The concept of public–private partnerships (PPPs) can be defined as a long-term agreement between the private sector (typically a consortium) and a government body to provide public assets or services, in which the private sector is responsible for dealing with significant risks and management duty and the payment is related to performance (World Bank 2014). Since the term was first coined as build–operate–transfer (BOT) by the Turkish Prime Minister Turgut Ozal in 1984, PPPs have been utilised widely and swiftly for the development of infrastructure projects around the world due to their effectiveness in project financing (Tiong 1990). Apart from its advantage in helping the government attract private capital investment, its continuous popularity also rests on many other benefits, such as increasing the effectiveness and efficiency of public service/product provision, reducing bureaucracy of the administrative system and protecting both existing and future taxpayers (Adams et al. 2006), or in simple terms, it is better than conventional public procurement in terms of delivering value-for-money (VfM) (Chan et al. 2010), which can be defined as 'the optimum combination of whole life costs and quality' (HM Treasury 2004).

In practice, various contract types exist to realise PPPs. To distinguish these types, World Bank (2014) suggests three main features to be taken into consideration: assets involved (i.e. greenfield projects versus brownfield projects), functions of the private sector (generally including design, build, finance, maintain and operate) and payment mechanism (i.e. user pays, government pays or a combination of them). Combining these three features in different ways can create a wide range of PPP types to suit the particular situation of projects and the unique context of the jurisdictions where the projects locate. To name a few, possible types may include BOT, build–transfer–operate (BTO), design–build–finance–operate (DBFO), transfer–operate–transfer, rehabilitate–operate–transfer, lease or affermage and O&M. BOT, BTO and DBFO have been widely used in developing new infrastructure projects, while the rest were mainly adopted to handle existing ones. However, no universal arguments exist for the best type to PPPs as how a PPP is structured depends on country-, sector- and project-based conditions (Delmon 2010).

Arguably, PPP has now become the most significant trend in the public sector around the globe (Garvin and Bosso 2008). In the United Kingdom, the number of projects facilitated by the Private Finance Initiative (PFI), which was launched in 1992, and its updated version Private Finance 2 (PF2) in 2012 was up to 716, with a capital value of nearly €60 billion as at 31 March 2016 (HM Treasury 2016). Similarly, in Australia, the state of Victoria alone has implemented 29 PPPs with more than $15.6 billion capital investment for major roads, hospitals, schools, prisons and water initiatives over the last two decades (Victoria State Government 2017). A larger market for PPPs lies outside the developed world. According to the World Bank (2017), PPP infrastructure projects in 139 low- and middle-income countries totalled 5,800, consuming a total investment of $1,429.869 billion (data from 1990 to July 2017). In those non-developed areas, billions of people still lack access to clean water, electricity and all-weather roads. To address this important issue, the Global Infrastructure Facility, a cooperation among major multilateral development banks, private investors and governments, was founded in 2014 to provide an open platform with integrated resources for developing complex international infrastructure PPP projects (World Bank 2017). That is to say, with the urgent, considerable demand for infrastructures worldwide plus the efforts of international facilitating entities, a continuous increase in PPPs can be expected over time.

1.1.2 Transaction cost economics (TCE) view of PPPs

A transaction exists in any activity where some kind of good or service is transferred between separate entities (Williamson 1981). In this context, the PPP model is undoubtedly a complex transaction with idiosyncrasies such as long duration, multiple stakeholders and uncertainty (Jin 2012). Completing a transaction as complex as a PPP model entails high cost. Dudkin and Valila (2005) investigated the relationship between PPP transaction cost in the procurement phase and six variables (i.e. countries, sectors, project size, length of the procurement process, number of bidders and the year of contract signing) in the UK and concluded that the average transaction cost amounted to an appalling 10% of the capital value of the project. This figure did not include the cost for procurement implementation monitoring and possible renegotiation during the lengthy project operational phase. One can hence easily expect that the total transaction cost for developing and managing PPPs would not be a negligible amount.

Due to the complexity of the PPP mode, the high PPP transaction cost could be incurred by various issues related to different aspects of PPPs (Carbonara et al. 2016). Some researchers have made efforts to investigate some of the issues by transaction cost economics (TCE) theory. For instance, Jin and Doloi (2008) used TCE theory to develop risk allocation mechanism for PPPs. Carbonara et al. (2016) adopted TCE theory to facilitate the choice of PPP procurement procedures. However, the more fundamental and generic mechanism that leads to problematic outcomes in developing PPPs is yet to be known. To fill this gap, and more importantly, to lay basis for the later discussion on the managerial issues at the TP, this sub-section defines the mechanism resulting in the excessive transaction cost of PPPs by using the TCE theory as well. The mechanism is shown in Figure 1.1, regarding two assumptions, two dimensions, and three issues led by the combinations of the assumptions and dimensions. In the rest of this sub-section, these assumptions and dimensions are introduced first, and the detailed discussion on the three issues follows.

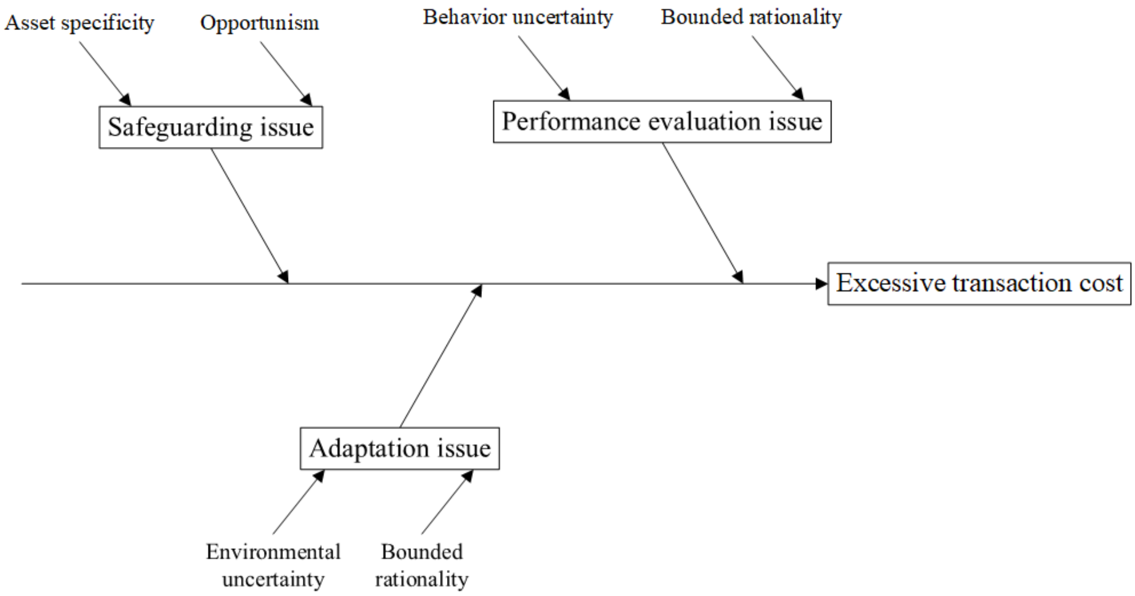

Figure 1.1 Mechanism for the formation of excessive transaction cost in PPPs (adapted from Rindfleisch and Heide 1997)

The two basic assumptions are bounded rationality and opportunism (Williamson

1981) [1].

- Bounded rationality means that humans' rationality is bounded by nature. Given this limitation, drawing a contract that fully includes all relevant situations is impossible. As a result, an incomplete contract is the best achievement in any transaction; and
- Opportunism means that the economic man who has simple self-interest seeking has the tendency to use the incompleteness of the contract to pursue profit deceptively. This tendency is difficult to discover ex ante.

The two dimensions to understand TCE are asset specificity and uncertainty (Rindfleisch and Heide 1997; Williamson 1981):

- Asset specificity refers to the extent to which the assets involved in a particular transaction can be freely allocated to other uses by the investor. It basically comprises three kinds of specificity, that is, site specificity, physical asset specificity and human asset specificity; and
- Uncertainty refers to unanticipated changes in terms of both external environment and behaviour of the exchange partners. In other words, uncertainty consists of behavioural uncertainty and environmental uncertainty.

From the TCE theory, three main issues, which are defined as TCE issues in this study,

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[1] In Williamson's work, three assumptions are given, i.e. bounded rationality, opportunism and risk neutrality. Only the former two are discussed here due to the unreality of risk neutrality in PPPs. Similarly, among the three dimensions defined by Williamson (i.e. asset specificity, uncertainty and transaction frequency), only the first two are referred to in this study, given that, unlike transaction with general merchandise, the PPP emphasises the 'duration' (i.e. concession period) of the transaction rather than the frequency.

would be incurred in the development process of PPPs, namely, the safeguarding, adaptation and performance evaluation issues. As can be seen in Figure 1.1, these possible issues arise in the combination of the aforementioned TCE dimensions and assumptions, leading to the excessively high transaction cost of PPPs.

Safeguarding issue originates from project asset specificity and opportunism. To ensure the success of a PPP project, all parties must entrust their best resources, such as time, money, tools, energy, intelligence and work places (National Audit Office 2001). During the long contractual term, apart from assets invested for successful procurement, ongoing investments from both the public and private parties for smooth contract enforcement (e.g. product/service provision and performance monitoring) are necessary as well, which results in high project asset specificity in PPPs. Evidently, both parties fear that their counterpart will opportunistically harness their investments. However, the existence of opportunism provides a chance for both parties to do so, giving rise to a significant increase in cost for safeguarding the appropriate utilisation of the specified assets against potential hazards (Williamson 1985). Moreover, the assets of a PPP could not only be misused but also harmed by many other factors, such as force majeure, policy changes and economic situation, as they are continuously exposed to a long-term process beset with various difficulties and pitfalls. Therefore, for PPPs, understanding the safeguarding issue in a broader way, where multiple factors or risks could lead to this issue, is practical and necessary.

Adaptation issue results from environmental uncertainty and bounded rationality. As stated previously, an incomplete PPP contract is doomed because of bounded rationality. On the other hand, over the life of PPPs, things that could not have been anticipated when the concession agreement was signed will unavoidably happen (World Bank 2014). Disputes or renegotiations between the partners then may emerge under changed environmental conditions as they may maintain a distinct understanding about the incomplete contract signed years ago (Chou et al. 2016). As a result, when changes happen, the adaptation of the PPP contract becomes a problem that might give rise to excessive transaction cost in dealing with subsequent disputes or renegotiations.

Performance evaluation issue stems from behaviour uncertainty and bounded rationality. Throughout most of the PPP life cycle, the project is under the full responsibility of the private investors, while the government mainly plays a monitoring role with much less information obtained, thereby causing information asymmetry between the government and investors (Liu et al. 2016). Taking advantage of this information asymmetry, the private investors' performance may not be always compliant with the contract, because when they sometimes fail to do so, either intentionally or unintentionally, the government may have no awareness of that due to bounded rationality (Williamson 1985). Thus, the government may find evaluating the real performance of the private parties difficult and costly.

1.1.3 Why transfer phase (TP), water sector, and China?

1.1.3.1 Why the transfer phase (TP)?

Every PPP project includes transfer of some sort at the end of the concession period (Delmon 2010). Compared with the lengthy operation period, the transfer phase (TP) is relatively shorter, covering the last few years prior to the expiry of the PPP contract (MoF 2014; World Bank 2014). In simpler cases, such as the public authority renewing the PPP contract with the same project company, the TP may merely refer to nominal ownership transition and some legal procedures for the continuation of the partnership, and except in cases in which the project runs as usual. However, in more complicated, perhaps more general as well, cases, the entire project needs to finally revert from the project company back to the public authority, which leads to much more challenges in the TP. This study focuses on the latter for practical reasons.

From the TCE perspective discussed previously, the first challenge lies in the safeguarding issue. In the TP, both public and private parties invest a considerable amount of assets (e.g. time, money, expertise and so on) into the project, which have been integrated into all kinds of project assets, tangible or intangible. Thus, the safeguarding issue may occur at any time when those assets are at risk of being misused or destroyed. For instance, facilities, equipment or structures of a water PPP could be poorly used in the TP as the private party tends to opportunistically seize the last chance to gain profit from the project (Yescombe 2007). As a result, residual value risk could emerge under unawareness of the government, which has limited control and monitoring over the project (Yuan et al. 2016; Yuan et al. 2015). Similarly, other risks could also harm the project assets and consequently cause the safeguarding issue, as observed from some transferred PPP projects (Abdul-Aziz 2001).

The adaptation and performance evaluation issues could also rise from uncertainty and bounded rationality in the TP. As mentioned earlier, having a perfect PPP contract under bounded rationality is not possible, and over time, the contract may need to be adapted with changes that result from environmental uncertainty. Especially in the TP, the changes accumulate to the greatest level; thus, the original arrangement for the TP becomes inapplicable in practice, which is well understood. A costly, time-consuming transfer process can then be expected due to the absence of useful guidelines for transfer (World Bank 2016). Therefore, to effectively fulfil various tasks within a relatively short TP, the adaptation issue should be carefully addressed. Attention should also be paid to the performance evaluation issue, which, as has been noted, rises from behaviour uncertainty and bounded rationality. This issue may occur in the TP because the private sector is more likely to use its information advantage to act opportunistically at the end of the contractual life (Yescombe 2007). Similar to the situation in the operational phase, the government still lacks effective measures to evaluate whether or not the private party's behaviours are in line with the arrangement for the TP. At last, even after the finalisation of the TP, the government may not be very clear about the real extent to which the objectives of the TP have been accomplished.

In a nutshell, the abovementioned issues give rise to an urgent, practical need to comprehensively understand and scientifically arrange the TP in case unexpected risks appear and unresolved hazards are negligently transferred with the reversion of the project (Delmon 2010).

Unfortunately, by now, most practitioners have difficulties in handling the TP efficiently given the lack of necessary knowledge and experience (World Bank 2014). The academic literature barely helps, because although a large amount of PPP research has focused on distinct PPP phases, the TP still receives little attention from academia (refer to Chapter 2 of this report). Instead, many governments and institutions have been gradually realising the significance of the TP as a growing number of PPPs are getting closer and closer to this point. For example, in China, the MoF specifies 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), also provide helpful suggestions on TP management. Nevertheless, these suggestions are frequently impractical, speaking broadly and theoretically, without accounting for specific regional realities. As a result, a problematic and costly transfer process is likely to be incurred (World Bank 2016), and the adverse impact may further extend to the post-transfer operation of the project, ending up with more harmful consequences due to the knock-on effect. Therefore, this study focuses on the TP.

1.1.3.2 Why the water sector?

Of the various PPP infrastructure sectors, the water sector (i.e. water supply and sewage treatment) makes up a rather large proportion. According to the World Bank (2017), the number of water PPPs in developing and undeveloped countries is up to 958 as of July 2017, which is more than any other sector except electricity. Commonly, more projects carried out by PPP will result in more projects that need to be transferred back at the end of the contract term, and the challenges practitioners may encounter during the TP can be expected to increase as well. As a result, the total cost of dealing with these challenges could be high. As the second largest sector in PPP implementation, the water sector is definitely a field where above issues are more likely to emerge. Thus, considerable attention should be paid to the TP of this sector.

The water sector itself has some unique features that result in increased difficulties in the TP. The first feature is that its efficient operation relies on a large number of facilities and equipment, which means a long checklist of items to be overhauled and transferred back. As a result, the process of reaching an agreement between the government agency and the project company on the detailed arrangement of the overhaul plan and transfer checklist could be full of disputes and conflicts. Even if the transfer arrangement is settled early in the beginning of the TP, it does not necessarily mean that a successful end is predetermined, as the overhaul and performance test result may also be influenced by other factors, such as the bureaucracy of the government agency (Adams et al. 2006) and the temptation for the project company to be opportunistic in the last years of the concession period (Yescombe 2007). The situation could be worsened by the uncertainty of the asset condition of the project because the overwhelming majority of the assets of water projects (e.g. pipes, underground tanks, valves) are underground (Infrastructure Canada 2004). In addition, the water sector provides a vital service for the public in relation to their general welfare, health, security and environment (Alegre et al. 2006). Given their fundamental role in protecting basic human rights, the government and the public tend to be sensitive in dealing with issues related to the water sector in case of dreadful consequences (Saurí et al. 2007; Wibowo and Mohamed 2010). In this regard, the possible problems in the TP of water PPPs should by no means be neglected.

1.1.3.3 Why China?

The PPP concept has been utilised in China for more than 30 years. While the development of PPPs has been inconsistent, as national policies have been revised over and over, the total number of initiated PPP projects has grown large. According to the Private Participation in Infrastructure (PPI) Database, a total of 1,372 PPI projects in China have achieved financial closure as of July 2017. This number does not include projects initiated by state-owned enterprises (SOEs) who are in fact major investors in Chinese PPP projects. Consequently, the true number of PPP projects is far higher than that indicated by the PPI Database. In fact, the total number is estimated to be as high as between 7,000 and 8,000 (Dayue Consulting 2014).

Of the various PPP infrastructure sectors, the water sector makes up the largest proportion. Cheng et al. (2016) analysed all the current PPP projects in China, which are identifiable through the Internet, and claims that water projects account for 54.6% of all projects. Though large, the proportion is explicable because water projects are in high demand, tend to have stable returns and require only a relatively small investment with a correspondingly low investment risk. Indeed, the water sector was where one of the three pilot PPP attempts was initiated by the central government, back in the mid-1990s, consequently providing a precedent by which foreign and private investors found access to the market (Cheng et al. 2016).

As previously indicated, the TP will inevitably arrive at the end of the concession period of most of the PPPs, giving rise to loads of challenges due to TCE issues which have neither been adequately experienced in practice nor studied in the literature, and the water sector may suffer more due to its unique features. As a result, in China, where a great number of water PPPs exist and PPP system remains immature, PPP practitioners are likely to encounter these challenges when dealing with the coming boom in PPP transfer tasks. A systematic investigation of the TP of the water PPPs can thus be expected to provide a timely contribution to improved management strategies for the smooth transfer of the PPP infrastructure projects in China.

1.2 Research aim and objectives

The aim of this study is to provide insights into the TP of PPP to facilitate the resolution of the TCE issues to the greatest extent, thereby achieving the smooth transfer of PPP infrastructure projects, especially the water PPPs in China. As has been discussed earlier, the performance of TP could be influenced by three main TCE issues, i.e., adaptation issue (P1), safeguarding issue (P2) and performance evaluation issue (P3) (Table 1.1). Specifically, with P1, a costly, time-consuming transfer process may emerge due to serious disputes on details of transfer arrangement; with P2, all kinds of risks may destroy the due value of various project assets; and with P3, systematically checking how the TP has been managed is difficult for the government (World Bank 2016; Yescombe 2007; Yuan et al. 2016; Yuan et al. 2015).

Table 1.1 TCE issues and outcomes caused at the TP

TCE issue	**Outcome caused at the TP**
Adaptation issue (**P1**)	Costly, time-consuming transfer process
Safeguarding issue (**P2**)	Risks destroying the due value of the project
Performance evaluation issue (**P3**)	Unclear transfer performance

On the basis of the above analysis, the specific objectives for achieving the aim of this study are as follows:

1. To develop a generic transfer process model (GTPM) that can simulate the proposed transfer process of China's water PPPs (refers to **P1**);
2. To develop a transfer risk management system (TRMS) that can effectively manage the risks in the TP of China's water sector (refers to **P2**);
3. To develop a transfer performance evaluation system (TPES) that can

objectively evaluate the performance of transfer management of China's water PPPs (refers to **P3**); and

4. To establish a dynamic framework transfer management system (DFTMS) that would dynamically inform practitioners to manage the entire transfer process of PPP infrastructure projects in developing countries based on the experience from the Chinese water sector and to verify the research findings (refers to **P1**, **P2** and **P3**).

The final model, DFTMS, would show the PPP practitioners the hierarchical structure of the transfer process, the key risk categories that influence the smooth transfer and the means to evaluate the transfer management performance. This model is also expected to allow PPP practitioners to systematically understand the TP of the water PPPs and make comprehensive plan for its management. Eventually, this study is expected to benefit the sustainable provision of public service/products of the infrastructure projects in their post-transfer life.

1.3 Research questions

To achieve the above research objectives, this study aims to answer the following questions:

For **objective 1**, four questions need to be answered.

1. What is the status quo of the transfer process of China's water PPPs?
2. What are the deficiencies of the current transfer process in China?
3. How can these deficiencies be addressed?
4. How critical are the model elements?

For **objective 2**, three questions need to be answered.

5. What are the key risk categories in the TP?
6. How significant are the key risk categories?
7. How can they be efficiently managed?

For o**bjective** 3, three questions need to be answered.

8. What are the criteria to evaluate the management performance of the TP?
9. How effective are the criteria?
10. How can these criteria be used to evaluate the transfer management performance?

For **objective 4**, two questions need to be answered.

11. What are the correlations among the GTPM, TRMS and TPES?
12. How effective are the findings of this study in addressing the TCE issues and facilitating the smooth transfer of PPPs in practice?

For more details about the research objectives and questions, please refer to Section 3.3 Research design.

1.4 Research methodology in brief

The overall research procedure consists of five stages, as shown in Figure 1.2. In stage 1, preliminary research was conducted to identify specific managerial problems, research aim, objectives, questions and possible research methods. This stage mainly relied on a broad literature review of general PPP studies and pertinent industry reports, and also on regular discussion with supervisors and colleagues and several practitioners in industry. At the end of this stage, the overall research framework was built.

In stage 2, the research focused on the definition and identification of the initial elements for the three models designed to achieve the research objectives. For GTPM, model elements referred to transfer steps and process factors connected to each step. The methods for identifying model elements include literature review, case study and **I**ntegration **DEF**inition language **0** (**IDEF0**), which is a special modelling language for complex systems or processes. For TRMS, model elements regarded risks in the TP, and the means to identify them include literature reviews and qualitative interviews. With regard to TPES, transfer success was firstly defined by the logic framework method (LFM), which was frequently used to define project success, and the specific success criteria were then identified by means of a literature review and qualitative interviews. On the basis of the identified model elements, the survey questionnaire that aims to elicit the viewpoints of experts from multiple stakeholders of water PPPs in China was developed.

In stage 3, formal questionnaire survey was conducted. Considering that the transfer of PPPs was rare in practice, only senior members that have considerable work or research experience in China's water PPP sector were selected as respondents. Those members normally had considerable experience and knowledge in dealing with distinct PPP phases and hence were believed to be able to view the TP in a more objective way based on their understanding of the whole life cycle of the PPP projects. Snowball sampling was adopted for the questionnaire survey, that is, all the respondents were requested to deliver the questionnaire to people with similar qualifications for this study.

In stage 4, the data acquired from the prior stage were statistically analysed, and the other two models, TRMS and TPES, as well as the final DFTMS, were developed based on qualitative and quantitative results that were gained previously. Adopted statistical analysis techniques included mean scoring, parametric tests, non-parametric tests, fuzzy synthetic evaluation, and correlation analysis. These techniques allowed the author to well understand the items surveyed by the questionnaire, uncovering the internal relationships between each item and, in turn, clarifying the mechanism by which all the models work.

In the last stage, stage 5, research outcomes were validated by experts' insights. The verified models and other research findings were then reported to individuals who possibly have interest in the subject by means of research articles, conference presentations and industry reports.

1.5 Structure of the report

This thesis contains eight chapters.

Chapter 1 presents a general introduction of this study, covering the main research background, followed by the research aim and objectives, research questions and a brief description of the research methodology and the structure of the report.

Chapter 2 offers an extensive literature review of PPP studies from a life cycle perspective. It shows how the studies being reviewed were identified from seven top-tier international journals in construction management domain and how those various studies were categorised and analysed. It concludes with recommendations of possible future research agenda.

Chapter 3 introduces the research design and research methods adopted in a more detailed way. It provides a more comprehensive discussion about the modelling language for describing the TP, i.e., IDEF0; the ways to collect and analyse the data; and the strategies adopted to verify the research outcomes.

Chapter 4 models the transfer process using the IDEF0 method to hierarchically display the main activities occurring in the TP and the process factors that connect the activities. It begins with the description of the status quo of the transfer management regime in China, after which the deficiencies are discussed by analysing a real case, it and ends with the proposed model, GTPM.

Chapter 5 deals with the risks that may impede the smooth transfer of PPP water projects in China. It demonstrates the procedure of developing the TRMS, including the identification of the specific risk categories from the literature and the experts' views, the quantitative evaluation of those factors, the in-depth discussion of the evaluation results and the presentation of the transfer risk management system.

Chapter 6 sheds light on a method of evaluating the management performance of the TP. The identification of the transfer success criteria is primarily reported, the assessment results and in-depth discussion are given, and the fuzzy evaluation approach is built. At the end of this chapter, the TRMS built based on the prior findings is presented.

Chapter 7 reposts the development of the integrated model for the systematic management of the TP. Three hypotheses describing the significant relationships between three sub-models are presented, followed by data analysis for the verification of the hypotheses. With the verified hypotheses, the chapter concludes with the description of the overall model that merges the three sub-models.

Chapter 8, the last chapter of this thesis, offers the conclusions and recommendations of the entire research study. A series of key conclusions and their significance to the practice and academic research are highlighted; the main research limitations are reported; and several potential research directions are proposed for future researchers.

1.6 Summary of the chapter

This chapter provides an introduction of this study. Given their advantage in delivering VfM, PPPs have been widely and swiftly utilised for the development of infrastructure projects around the world. Developing a PPP is a complicated process with many possible pitfalls that could lead to excessive transaction cost. With the use of TCE theory, these possible pitfalls were defined as three managerial issues, namely, safeguarding issue, adaptation issue and performance evaluation issue. These three TCE issues were also found to be critical in the TP of PPPs given that a great number of PPPs need to be transferred back to the government at the end of the contract term; China's water sector is facing this urgent issue. Therefore, the specific research aim of this study was determined as the mitigation of the TCE issues in the TP of China's water PPPs. To achieve the research aim, four research objectives were established, referring to the development of three sub-models (i.e. GTPM, TRMS and TPES) and one overall model (i.e. DFTMS), and were decomposed into 12 detailed research questions to be answered by this study. The entire research was performed through five stages, and qualitative and quantitative research methods were employed during the research procedure, resulting in valid research outcomes by which all research questions were answered. This thesis reports the complete research study in eight chapters. The next chapter will present an extensive literature review on the PPP domain to show the state of the art of PPP research at different PPP phases.

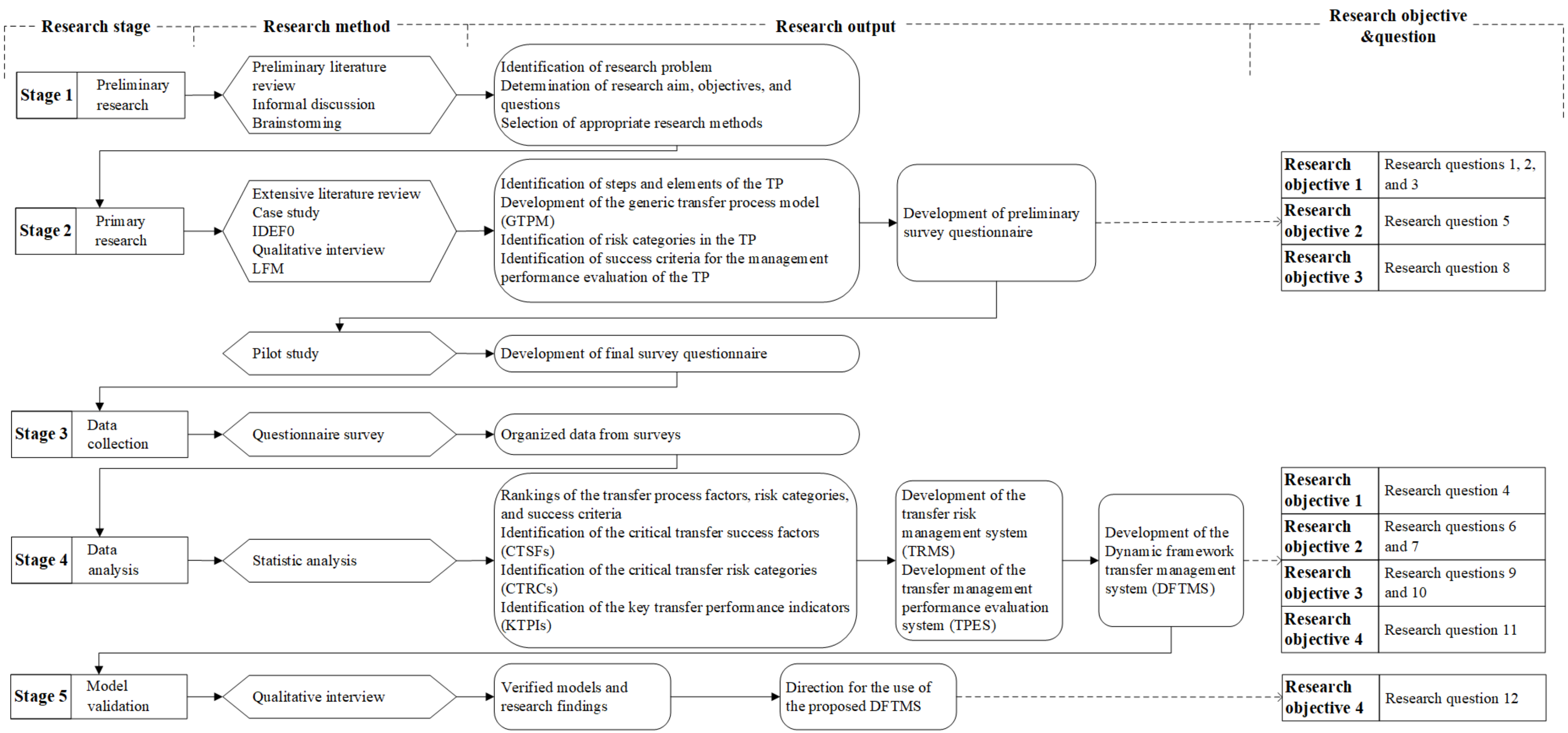


Figure 1.2 Overall research procedure of this study

CHAPTER 2 LITERATURE REVIEW: A LIFE CYCLE PERSPECTIVE[2]

2.1 Introduction

The PPP life cycle is complex and beset with pitfalls (Chan et al. 2005). To facilitate the success of the growing PPP infrastructure development, researchers should continue to observe PPP life cycle (PLC), identify potential issues, and provide solutions. To learn the state of the art in addressing issues in PLC, this chapter reviews literature of PPPs from a life cycle perspective. The efficiency of life cycle perspective in reducing holistic cost of construction projects has been testified for decades of years (Guo et al. 2010). Life cycle philosophy is particularly crucial for PPP projects due to the integrated duties on design, finance, construction and maintenance (EIB 2012). Essentially, VfM is recognized as the paramount objective of PPP, which cannot be defined, let alone to be achieved, without a life cycle perspective (HM Treasury 2004). Therefore, a systematic literature review from the life cycle perspective is necessary to provide a better understanding of the state-of-the-art PPP research and in turn, to facilitate improving life cycle management. With the stipulated justifications, this chapter extensively reviews the papers published by seven top-tier construction management journals from 1996 to 2016. The purpose of this chapter is to analyse the research status and possible future studies from the viewpoint of project life cycle. The findings show that different PPP phases encounter different problems, attracting

[2] Published in **Bao, F**., Chan, A., Chen, C., & Darko, A. (2018). Review of Public–Private Partnership Literature from a Project Lifecycle Perspective. *Journal of Infrastructure Systems,24*(3): 04018008.

uneven attention from researchers. Specifically, the TP, which is the end of PPP contract life cycle and the starting point of post-transfer operation, requires systematic research in the future.

In the rest of this Chapter, Section 2.2 presents the main divisions of the PPP life cycle phases. Section 2.3 introduces the method to fulfil the literature review. Sections 2.4 and 2.5 present a detailed literature analysis and future studies, respectively.

2.2 Life cycle phases of PPP infrastructure projects

Project Management Institute (PMI) (2013) defines project life cycle as the series of sequential phases through which a project is developed from its origination to its closure. In spite of the impossibility of distinguishing every type of project life cycle, extracting generic characteristics can benefit the establishment of a basic framework for project management. The names and numbers of the project lifecycle phases depend on many aspects, including how the project is managed, what the project is for, what sectors are involved, and what traits the project has. The life cycle of a construction project is normally divided into four phases, namely, conceptual (feasibility), design, construction, and operation phases (Zou et al. 2007).

PPP infrastructure projects, such as water sectors, power plants, highways, bridges, and rail lines, are generally large-scale projects with ongoing maintenance requirements (PricewaterhouseCoopers 2010). Owing to the complexity of PPP arrangement, plenty of governments and organizations [e.g., World Bank, Asian Development Bank (ADB), Department of Infrastructure and Regional Development

(DIRD) of Australia, and European Investment Bank (EIB)] have developed procedure guidelines for evolving and maintaining PPP projects. Summarizing those generic guidelines, a detailed phase division includes project identification, project preparation, competition, preferred bidder phase, contract signing, design, construction, operation, and transfer phase (ADB 2008; Department of Infrastructure and Regoinal Development 2015; World Bank 2014). EIB (2012) suggests a clear and concise four-phase division for PPP lifecycle, in which competition, preferred bidder phase, and contract signing are merged as procurement. Then, design, construction, operation, and transfer phases are defined as project implementation. Ministry of Finance (MoF) (2014) of China promotes these four-phase division by highlighting transfer as a separate phase requiring the public clients to be more responsible. By contrast, other phases (i.e. design, construction, and operation) are mainly the responsibility of the concessionaire contractor (World Bank 2014). Furthermore, the transferred back infrastructure is expected to continue to serve the public, which can be viewed as the post-transfer phase. Therefore, for the sake of discussion, this study considers PPP lifecycle into six phases (see Figure 2.1), namely, project identification, project preparation, procurement, implementation, transfer and post-transfer phase. In particular, the six-phase division of PPP lifecycle serves as the basis for the literature review section where the specific knowledge gap in literature is identified.

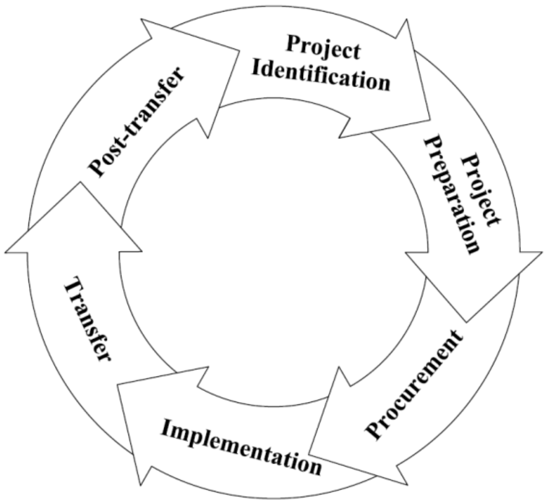


Figure 2.1 PPP lifecycle phases (Adapted from EIB (2012); MoF (2014))

2.3 Review method

PPP-related literature published from 1996 to 2016 was obtained via an approach used by previous researchers (Darko and Chan 2016; Ke et al. 2009; Yi and Chan 2014). The reason for the specified year period is that PPP started expanding considerably worldwide since 1996 (World Bank 2010). This study began with the selection of a suitable search engine (Scopus) and keywords, followed by the selection of journals and papers, the classification of papers into PLC phases, then a critical analysis of the papers from the life cycle perspective. The various stages of the research methodology are explained in detail in the following sub-sections.

2.3.1 Selection of search engine and keywords

Scopus search engine was used to search for the relevant papers for this study. Scopus was widely used to conduct similar reviews on a variety of topics in literature. This powerful search engine, for example, has been adopted by Ke et al. (2009); Hong and Chan (2014); Yi and Chan (2014); Darko and Chan (2016) and many others to conduct thorough reviews in varying construction management fields.

PPP is a terminology that describes a wide range of contract types (World Bank 2014). In a particular country or jurisdiction, different nomenclature is used to define specific PPP contract types. Therefore, a comprehensive search code is necessary to ensure that relevant types of PPP contracts are not missed. Considering new development in PPP practice [e.g., the UK has promoted PFI (Private Finance Initiative) to PF2 (Private Finance 2)], this study added *"private participation infrastructure"* and *"private finance 2"* and their acronyms to keywords widely used by previous researchers.

2.3.2 Selection of journals and papers

The initial search identified more than 8000 papers published in over 160 different academic journals. In spite of search restrictions, many journals focusing on unrelated domain appeared (e.g., Nursing, Medicine and Applied Economics). Therefore, it is necessary to emphasize that the current research was limited to PPP studies in construction management journals. That is, journals that do not concentrate in construction management were excluded. Due to the numerous number of papers that were retrieved form the search, a set of criteria was stipulated to trim the number of papers needed for further analysis. As a result, the journals selected in this study project had to meet either of the criteria below:

1. The journal contains a significant number of papers in the initial search. Hong et al. (2012) set the benchmark in their review on partnering research as exceeding 1% of the total papers. To minimize the possibility of excluding relative papers, the present study adopted 0.25% of the total papers as the benchmark.

2. The journal was ranked within the top six in the quality rating conducted by Chau (1997). Chau's ranking was used because it is widely accepted by researchers in the construction management domain.

Either one or two of these criteria are normally used in most construction management review research (Darko and Chan 2016; Hong et al. 2012). Finally, ASCE's Journal of Construction Engineering and Management (JCEM), Construction Management and Economics (CME), International Journal of Project Management (IJPM), and ASCE's Journal of Management in Engineering (JME) were selected based on the above criteria. Engineering, Construction and Architectural, Proceedings of Institution of Civil Engineers—Civil Engineering (PICE-CE), Engineering Construction and Architectural Management (ECAM) were selected based on criterion 2, and Journal of Infrastructure Systems (JIS) was selected based on criterion 1.

Of the initial numerous papers identified, the seven selected journals captured 325; however, a few unrelated papers still appeared; as they met some of the search keywords. Also, since this study paid attention to "PPP infrastructure project", most of the retrieved papers that did not satisfy this criterion had to be discarded. Therefore, the authors scanned all the papers by reading the titles and abstracts, and, if necessary, the main parts, to filter out irrelevant papers. After filtering, 282 papers were valid for further analysis. Table 2.1 shows the number of papers in selected journals from 1996 to 2016. During the last two decades, JCEM has published the most papers in PPP (78), followed by IJPM (67), then CME (52), JME (41), JIS (21), ECAM (18), and PICE-CE (5). These numerous papers exhibited the long-term popularity of the PPP subject in the past two decades.

Table 2.1 Number of Papers in Selected Journals from 1996 to 2016

Journal Title	Number of Papers
Journal of Construction Engineering and Management	78
International Journal of Project Management	67
Construction Management and Economics	52
Journal of Management in Engineering	41
Journal of Infrastructure Systems	21
Engineering Construction and Architectural Management	18
Proceedings of Institution of Civil Engineers: Civil Engineering	5
Total	282

2.3.3 Classification of papers

As stated previously, the life cycle perspective is of great importance for achieving VfM through PPP. This study, therefore, analysed literature identified from the life cycle perspective. To conduct the analysis, the foremost step is to classify the papers into fit PLC phases. The classification was performed by the research team, following a five-step systematic procedure designed for minimizing subjectivity:

1. Refined the detailed PLC phase information based on widely used PPP guidelines such as EIB (2012) and World Bank (2014). These guidelines provide reliable definitions of PLC phases and explicit description of the detailed tasks in each phase;
2. Identified the topic of a paper as precisely as possible to ease designating a paper into proper PLC phase;
3. Matched the detailed phase information with the precise topic information. A paper was classified into one phase if clear and direct relation between them had been identified;
4. Merged similar precisely defined topics into main topics at each phase to

facilitate a systematic and accessible discussion on literature; and

5. Repeated the above steps until no more changes to the result could be found. For instance,

EIB (2012) suggests that, at the project identification phase, risks that originate from the project should be identified, analysed and allocated. Meanwhile, the present study has recognized a few papers focusing on risk identification, risk analysis and risk allocation. Based on the particular phase requirement, the papers focusing on the three abovementioned topics were classified into the project identification phase. In addition, risk allocation mainly consists three steps, that is, identifying risk, analysing risk and allocating risk (EIB 2012). Consequently, the three topics (i.e., risk identification, risk analysis and risk allocation) were merged into one main topic – risk allocation.

Following these steps, a total of 16 main topics including a series of subtopics were identified and distributed into suitable phases. The subjectivity and uncertainty of the classification were further minimized as the research was conducted by the same group of researchers (Hong et al. 2012). In this manner, most of the papers can be classified into corresponding phases. However, the research team found that some papers cannot be classified into certain phases as their topics refer to the entire PLC, or the relation between the topic and certain phase is not sufficiently evident for proper classification. For example, topic *application introduction* referring to the research that introduces how PPP is applied and what lessons and experiences can be drawn in particular countries, always covered the entire PLC. Therefore, it is inappropriate to categorize application introduction into any single phase. Hence, topics like *application introduction* were defined as indivisible topics that cannot be divided by phases due to their coverage of the whole PPP life cycle. In the following sections, a complete topic list and the number of papers for each phase are presented, followed by a detailed literature analysis and future study recommendation.

2.4 Literature analysis from life cycle perspective

2.4.1 Overview of literature

Figure 2.2 summarizes the complete distribution of the existing PPP research and future studies. Six research categories (i.e., research into five PLC phases and the indivisible topics) are presented from the left to the right, with the number of papers under the name of each category. The existing research, located in the upper half of the figure, covers the entire PLC. However, a distinct distribution in each phase can be observed. Likewise, the distribution of future studies, which are shown in the lower half, is also uneven. Among the five phases, the project preparation phase has the most papers, mainly focusing on management structure and detailed PPP design, followed by the implementation phase with papers concerning diversity of issues such as risk management, stakeholder management, implementation performance and dealing with changes. Papers at the procurement phase studied bidding process and bidders' concerns, while risk allocation and project selection were discussed by papers at the project identification phase. A significant number of papers shed light on indivisible topics such as application introduction, success, investment environment, failure and other topics. Only three papers were identified at the transfer phase referring to residual risk and review of transferred project. In contrast, the future studies for each phase seem less uneven except for the transfer stage, where a considerable number of future research agendas have been suggested.

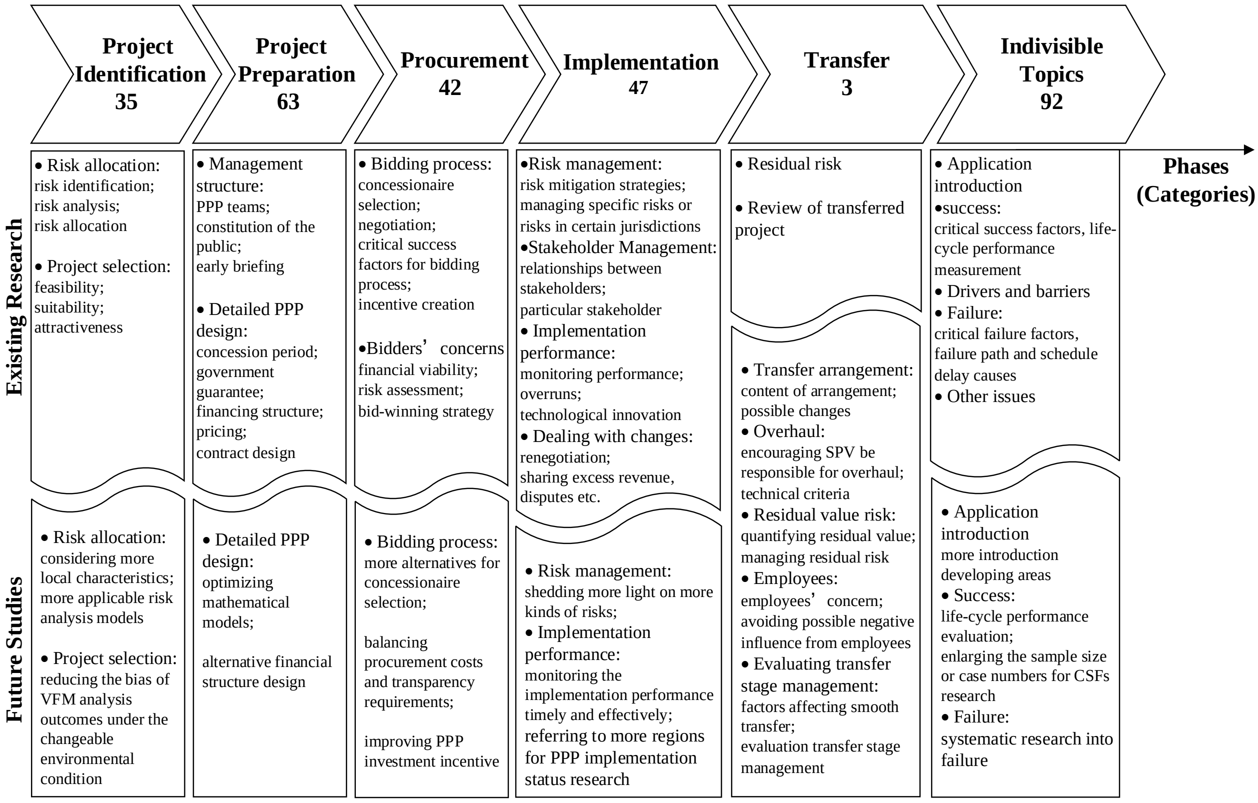
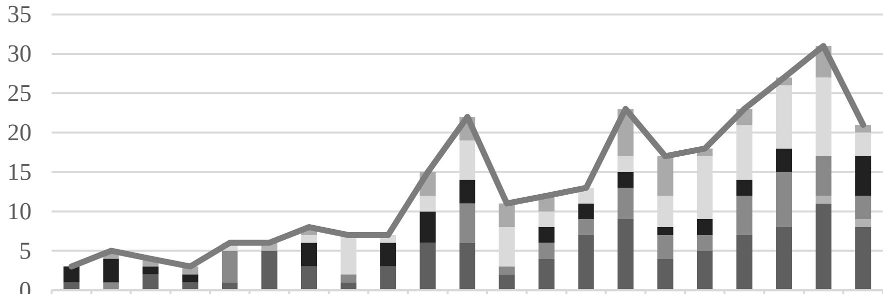


Figure 2.2 Complete distribution of existing research and future studies

Within the studied period, a growing trend of PPP papers can be observed with the highest number of publications in recent years (i.e., 2014 and 15) (see Figure 2.3). The total number of publications shows that PPP research soared to double digit since 2005 before which relatively less attention was paid to this domain. However, throughout the past two decades, the publication of PPP papers has never been interrupted, which, again, reflects the continuous appeal of PPP research area. More specifically, considering the five phases, researchers seemed more caring about the procurement phase in the initial years. It is understandable given that PPP was still in its exploratory phase then and thus procuring PPP agreements successfully was the primary task. Afterwards, papers in other phases rose gradually, which may reflect that researchers began to realize that other phases also matter in terms of PPP success. Recently, the project preparation and the implementation phase have attracted relatively more attention from researchers, which may show the difficulty in conducting detailed preparation and long-term implementation of PPP projects. It is also noticeable that studies referring to the transfer phase are rather rare, with only three publications throughout the period in question.



	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
Project identification stage	0	1	1	1	0	0	1	0	0	3	3	3	2	0	6	5	1	2	1	4	1
Project preparation stage	0	0	0	0	1	0	1	5	1	2	5	5	2	2	2	4	8	7	8	10	3
Procurement stage	2	3	1	1	0	0	3	0	3	4	3	0	2	2	2	1	2	2	3	0	5
Implementation stage	0	1	0	0	4	0	0	1	0	0	5	1	2	2	4	3	2	5	7	5	3
Transfer stage	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Indivisible topics	1	0	2	1	1	5	3	1	3	6	6	2	4	7	9	4	5	7	8	11	8
Total	3	5	4	3	6	6	8	7	7	15	22	11	12	13	23	17	18	23	27	31	21

Figure 2.3 Annual number of papers for each phase (category)

2.4.2 The project identification phase

The analysis of literature shows that, at the project identification phase, risk allocation has been studied the most over the past two decades. Up to 24 papers focused on this topic, taking up 69 per cent of the total 35 papers. The rest papers at this phase studied issues referring to project selection process.

As risk comes from the complex nature of PPP (Grimsey and Lewis 2002), project risks should be identified, analysed, and allocated adequately to justify the PPP option.

Empirical research methods such as questionnaire survey, case study and expert interview have been used by researchers to develop risk allocation preference. For instance, Li et al. (2005) claimed that risks, such as nationalization and land acquisition, should be retained in the public sector, although majority of risks should be borne by the private. Ng and Loosemore (2007) emphasized the consideration of participant capability, resources, and knowledge to manage risks effectively. The analysis of other relevant papers shows that different industries or jurisdictions prefer different risk allocation schemes [e.g., (Ameyaw and Chan 2016; Jin 2010)]. Therefore, appropriate risk allocation is a cumbersome task in PPP development (Medda 2007). To improve the objectivity of decision making, prior researchers have also offered various decision means relying on mathematic methods such as game theory, fuzzy set theories and artificial neural networks (Jin 2010; Medda 2007).

Project selection is another key process at this phase, through which the projects with the most possibility to achieve VfM are highlighted. The feasibility, which refers to various factors concerning social, political, environmental, legal and financial aspects (Salman et al. 2007), should be justified before employing PPP form to a project. Research into feasibility mainly focused on designing evaluation models/frameworks that can consider the multiple factors as well as stakeholders holistically (Abdel Aziz and Russell 2006; Ashley et al. 1998). VfM analysis is widely used for measuring feasibility. The result of VfM analysis can be gained by a complicated calculating process; however, biased result tends to appear if important parameters (e.g., discount rate) and assumptions are not set properly (Cruz and Marques 2014). Researchers also stressed the attractiveness as well as suitability of PPP, reminding participants that PPP should not be seen as a panacea for the development of all infrastructures (Soomro and Zhang 2016).

2.4.3 The project preparation phase

The project preparation phase is a necessary, resource-intensive undertaking, which deals with all prerequisites before formally starting a PPP (EIB 2012). Among the five contractual phases, the project preparation phase possessed the most papers (66), partly showing the complexity of managing this phase. Within this phase, the majority (up to 90 per cent) of previous research focused on issues about the detailed PPP design, in which concession period, government guarantee and financing structure were discussed extensively. Relatively less attention has been paid to management structure issues.

The concession period is an important component of the detailed PPP design, which is a measure for determining when the project should be transferred back to the public sector, and differentiates the responsibilities and benefits between public and private sectors (Shen et al. 2002). As a result, the private sector expects the concession period to be as long as possible, which is contrary to the expectation of the public client. Prior researchers explored numerous mathematical and empirical models to support the concession period decision, such as game theory model, Monte Carlo model and stochastic revenue and cost model etc. (Hanaoka and Palapus 2012; Ng et al. 2007). However, Zhang (2009) pointed out that determining the concession period should be based on the win-win principle instead of the traditional means in which a fixed duration is solely provided by the government. Recent research has improved those models, taking into account more factors such as the perception of the publics and the social welfare (Song et al. 2015). Government guarantee, too, has been discussed in plenty of previous research. Although potential cost increase to the public sector may occur, analysis of the existing research shows that most of researchers suggest the provision of appropriate guarantee in PPP arrangement due to its effectiveness in encouraging private investments. All kinds of guarantees have been studied, such as minimum revenue guarantee, minimum traffic guarantee, maximum interest rate guarantee, debt guarantee, tariff guarantee, restrictive competition guarantee and so on. To set the level of guarantee, some researchers suggested real option-based models and testified them via Monte Carlo simulation, and obviously, the guarantees should be controlled to a proper level, and the best is the minimum level (Ashuri et al. 2012). Cheah and Liu (2006) suggested that the provision of government guarantees needs more consideration concerning their real worth.

For financing structure, most previous research shed light on how to determine an appropriate mix of equity and debt. A high proportion of debt tends to be more welcome in PPP due to its increased cash flows, but low equity financing may increase project profit risks (Schaufelberger and Wipadapisut 2003). Distinct models have been proposed to facilitate the decision making of financing structure [e.g., (Bakatjan et al. 2003)]. The pricing-related literature presents various methods to build reasonable pricing models/mechanisms for PPP services or products to balance the different interests of the public and private sectors [e.g. (Cheng and Tiong 2005; Xu et al. 2012)]. Researchers reached the consensus that PPP allows private investors to seek reasonable profits when producing social welfare via the PPP project (Subprasom and Chen 2007). Research into contract design focused on dealing with uncertainties during detailed PPP design by designing proper contract structure. For instance, Cruz and Marques (2013) claimed that a flexible contract design can increase the value of project in changing conditions. A few previous research has also investigated issues about management structure that relates to tasks to make PPP preparation organized (EIB 2012). For example, research into PPP teams discussed the roles of multiple teams with respect to PPP, including project teams, advisory teams, PPP Task Forces, and PPP units [e.g., (Tserng et al. 2012)].

2.4.4 The procurement phase

At the procurement phase of PLC, an interesting finding is that the prior researchers paid almost the same attention to both participants of the procuring activity. 22 papers focused on the issues in bidding process (e.g., concessionaire selection, negotiation and incentive creation) concerned by the public client, while the remaining 20 papers concerned the bidders' interests such as financial viability, project risk assessment and bid-winning strategy.

The bidding process consists of a series of steps through which the concession can be awarded to the concessionaire selected. The concessionaire is significant for PPP success because it assumes far more responsibilities and risks than a mere contractor (Zhang 2004). Therefore, it is understood that most of the research into bidding process focused on concessionaire selection. Zhang (2004) claimed that the key to appropriately select concessionaire is to guarantee the high quality of evaluation criteria and methods for evaluating candidates. Zhang (2005) reviewed the literature on evaluation criteria of concessionaire and identified evaluation packages, which consisted of financial, technical, health, safety, and environmental and managerial dimensions. Succeeding researchers continued to improve the criteria definition and the ways to measure proposals, aiming to find robust methods for concessionaire selection (El-Mashaleh and Minchin 2014). The second focus of bidding process is negotiation, which commonly occurs after the selection of the preferred bidder and is about PPP contract details. This negotiation process is always time- and cost-consuming due to conflicting benefits pursued by public and private sector. To better understand what is important in negotiation, researchers identified attributes that impact the contract process from both sectors, such as organizational capabilities for the public sector and high quality of technical proposals for the private sector (Ahadzi and Bowles 2004). Furthermore, contractual negotiation models based on different methods (e.g., real option and Monte Carlo method) were developed to improve negotiation efficiency (Liou and Huang 2008; Liou et al. 2011). Several researchers have identified the critical success factors of bidding process, such as robust business case, quality of project brief and the capability of public sector etc. (Liu et al. 2016). Some researchers focused on improving incentive creation to attract more potential bidders, as a good procurement of PPP is expected to be competitive. From their investigations, several strategies, such as bid compensation, may work under certain conditions (Ho and Hsu 2014).

On the other hand, bidders' concerns have also been considered by researchers. Based on the analysis of literature, the first concern of bidders is the financial viability of PPP projects. It is understandable because, as mentioned previously, the private sector should be allowed to gain reasonable profit by PPP. Unfortunately, the financial viability is always uncertain due to the nature of PPP infrastructure projects, that is, large size, long contractual period, nonrecourse financing, and distinct motivations (Zhang 2005). Previous researchers therefore have made numerous attempts to evaluate financial viability accurately. For example, Ho and Liu (2002) presented an option pricing-based model that can overcome the shortages of traditional net present value method; Jeong et al. (2016) integrated discounted cash flow analysis, real option valuation and expanded net present value, coming up with a more comprehensive model for financial viability evaluation. Moreover, researchers suggested that the private sector should conduct thorough risk assessment before bidding. To conduct such an assessment, a prototype evaluation model has been introduced, by which bidders can calculate the risk index and rank projects to spot the least risky one (Zayed and Chang 2002). Previous research also suggested some bid-winning strategies for the bidders, such as expressing financial commitments, employing systematic decision models and adopting suitable financing strategy (Tiong and Alum 1997).

2.4.5 The implementation phase

The implementation phase covers a long period from financial close to the end of the contractual time, normally more than 10 years, filled with complexities and uncertainties (Grimsey and Lewis 2002). Four aspects have drawn much attention from researchers: risk management, stakeholder management, implementation performance and dealing with changes. As shown in Fig. 3, this phase contains a number of subtopics, showing the difficulty in managing PPP contract for such a long time.

Unlike the risk research at other phases that focused on evaluation and allocation of all possible risks, how to manage particular risk or risks in particular jurisdiction became the core at the implementation phase. In other words, mitigations for risks have been emphasized by many researchers. To name a few, Wang et al. (2000) conducted international questionnaire survey and summarized effective mitigating measures for a bunch of political risks in different infrastructure sectors; Boeing Singh and Kalidindi (2006) proposed Annuity-based PPP model to mitigate the traffic revenue risk existing in Indian road projects; Loosemore and Cheung (2015) emphasized the system thinking can be potential solution to risk problems. Previous research has shown much care on mitigating risks in emerging economies (e.g., India and China), which can be seen as a reminder for both authorities and foreign investors to be aware of risk management in places with growing PPP implementation environment.

Stakeholders can be defined as any individual or organization involved in a PPP project with lawful benefit. Much previous research has emphasized that stakeholder involvement is of great significance in achieving PPP success (De Schepper et al. 2014; El-Gohary et al. 2006). Researchers observed many issues such as credibility gap and unreasonable responsibility allocation between stakeholders, and proposed possible solutions to tackle those issues. For example, to facilitate the communication of stakeholders with multidisciplinary background, El-Gohary et al. (2006) presented a sematic model and taxonomy that contain multidiscipline knowledge. Some research also focused on better understanding of particular stakeholders. For instance, Wu et al. (2016) emphasized that the role of the government should be clearly defined, otherwise the partnership will not work.

In order to guarantee the VfM, implementation performance should be monitored by the public client over the implementation phase. Raisbeck et al. (2010) claimed that, in Australia, PPP projects have better implementation performance than traditional delivery projects. However, low level of performance in the implementation phase has also been observed by previous research, showing the diversity of PPP performance and space for performance increase (Robinson and Scott 2009). Particularly, overruns have been investigated by researchers who found that PPP does not necessarily mean saving time and cost simultaneously (Rajan et al. 2014). Raisbeck and Tang (2013) claimed that PPP does not automatically result in technological innovation, either. Dealing with changes is inevitable in view of the long term of project operation. Some changes are so disadvantageous that should be avoided to the greatest extent. For instance, renegotiation is undoubtedly unwelcome at the implementation phase given that critical changes are not allowed by the concession agreement (EIB 2012). To minimize the negative influence when renegotiation occurs, researchers have proposed decision models like game theory model (Ho 2006; Javed et al. 2014), while others have attempted to uncover key determinants and explain why renegotiation happens easily in particular areas (Cruz and Marques 2013). Previous research also studied positive changes. Excess revenue from successful implementation, for example, has been discussed and the sharing strategy has been proposed (Wang and Liu 2015).

2.4.6 The transfer phase

Ideally, the transfer process should be clearly defined in the concession agreement. However, either practical experience or existing guideline in managing the transfer phase is relatively limited (World Bank 2014). In current study, only two topics with three papers have been identified at the transfer phase. Based on review of residual risk (or residual value risk) research, Yuan et al. (2015) identified six critical factors leading to residual risk and proposed a conceptual model to facilitate residual risk management. Yuan et al. (2016) continued to validate this model through two practical projects, and further identified the cumulative effects of residual value. Abdul-Aziz

(2001) reviewed a water PPP project in Malaysia which has been transferred back to the government, drawing salutary lessons for future PPP arrangement.

Given that most PPP projects are at phases before transfer (Yuan et al. 2015), a little attention has been paid to this phase. However, long-term vision on the PPP projects is essential for pursuing public benefits because the transfer phase eventually transpires (Yuan et al. 2015). Hence, this phase needs to be further investigated to guarantee successful transfer of PPP projects, and finally, to render infrastructures sustainable in providing public services post-transfer.

2.4.7 The indivisible topics

Despite the considerable paper number, the research on the indivisible topics is rather concentrated: 47 papers, more than half of the total 92, focused on topic *application introduction*. The remaining half analysed success, failure, drivers and barriers and other issues related to the entire PLC. Numerous research relating to indivisible topics may imply that system thinking is significant for PPP development (Loosemore and Cheung 2015).

Research on application introduction mainly introduced PPP application in various jurisdictions. This topic has been studied by the most papers identified in current study. This finding confirms the claim of Zhang et al. (2016) who also found that the PPP application had received the most attention from both Chinese and international journals. In this study, of those jurisdictions studied, the top five most-mentioned are China, the United Kingdom, Australia, Hong Kong, and the United States (Table 2.2). These places have been highlighted by previous literature reviews on PPP research

(Ke et al. 2009; Osei-Kyei and Chan 2015). China, which was identified by this paper as the most frequently studied country, has witnessed a long period of PPP application practice since the first attempt of Shenzhen Shajiao B power plant (Cheng et al. 2016). Nevertheless, an unstable trend can be observed during the past three decades, and the performances of the existing projects are controversial (Chen 2009; Cheng et al. 2016; Smith et al. 2004). Researchers believe that the future of PPP in China is promising, whereas some unique risks should be noticed due to the special administrative system of China (Zhang and Kumaraswamy 2001). Compared with China, the other four most-mentioned regions are all developed economies. These developed places are relatively experienced in applying PPP. Hence previous research made efforts to summarize their valuable experience to facilitate the PPP development in places where relevant expertise and experience are still inadequate [e.g., (Carrillo et al. 2008; Jefferies and McGeorge 2009)].

Table 2.2 Top 5 most-mentioned countries/jurisdictions in research on topic *application introduction*

Countries/Jurisdictions	Mentioned times
China	12
United Kingdom	5
Australia	4
Hong Kong	4
United States	3

Previous research also discussed the success of PPP. In particular, critical success factors (CSFs) have been investigated by a number of researchers who identified those factors mainly by questionnaire survey or case study [e.g. (Chan et al. 2010; Li et al. 2005; Zhang 2005; Zou et al. 2014)]. The specific CSFs differ from jurisdictions or sectors. In the UK, for example, the top three critical factors identified through questionnaire survey are strong and good private consortium, appropriate risk allocation and available financial market (Li et al. 2005); while in Australia, a case study showed that approval and negotiation process, clear project brief and client outcomes, and increased competition during the tendering process were the most critical (Jefferies 2006). Another important aspect for the research on success is the life-cycle performance. The life-cycle performance of a PPP should be arranged in advance and conducted as soon as possible after transfer phase (MoF 2014). To date, research showed that the measurement criteria of PPP performance has already moved beyond the so-called iron triangle criteria (i.e., time, cost, and quality), and the integrated measurement methods that can combine iron triangle, life-cycle and stakeholder perspectives are critical [e.g. (Liu et al. 2016; Yuan et al. 2009)].

Drivers and barriers of applying PPP, which are often analysed simultaneously, are essential for fostering a mature PPP market [e.g. (Chen and Doloi 2008; Chou and Pramudawardhani 2015; Yuan et al. 2012)]. Similar to CSFs, the drivers/barriers were commonly identified by empirical studies and the specific factors vary from regions. In the US, for instance, the first reason for most companies reject PPP is the availability of adequate funds; in Nigeria, the first barrier goes to capacity deficiencies of the public and private sectors (Algarni et al. 2007; Babatunde et al. 2015). Several recent research has investigated failure since numerous PPP projects have failed to meet the VfM goal as expected. Motivated by these cases, Soomro and Zhang (2015) investigated the responsibilities of the private and public sectors for PPP failure, and mapped the failure path. Critical failure factors in low-cost housing program in Thailand, such as policy pressure, poor bidding documents and inappropriate contractors etc., have also been discussed by researchers (Trangkanont and

Charoenngam 2014).

2.5 Future studies from life cycle perspective

2.5.1 The project identification phase

Allocating risks of a PPP project appropriately remains an issue needs more research. Previous researchers have identified a variety of risks for their own research areas based on a series of risk factors originating from countries with mature PPP system, such as the U.K. and Australia (Li et al. 2005; Ng and Loosemore 2007). Note PPP practice varies significantly from different jurisdictions (Chan et al. 2011); therefore, for developing countries, different risk factors and risk allocation strategies in PPP may have not been revealed sufficiently. Hence, future researchers are recommended to consider more about the local characteristics when conducting risk allocation. Besides, more applicable risk analysis models are still needed. Previous research has attempted to improve the objectivity and accuracy of risk analysis models via complex means (e.g., fuzzy theory and game theory) (Li and Zou 2011; Medda 2007). However, their real popularization may be limited by the necessary knowledge requirement for the practitioners to use them. In addition, feasibility research can be improved by figuring out how to reduce the bias of VfM analysis outcomes under the changeable environmental condition. Demonstrating VfM is always difficult for the government agency that is relatively inexperienced in contrast with the large consortia (Holmes et al. 2006). In this case, it is crucial for researchers to help the government agency choose or estimate key parameters (e.g., discount rate and traffic volume) wisely when conducting VfM analysis.

2.5.2 The project preparation phase

For research on the project preparation phase, the first possible improvement relates to the further optimization of mathematical models, which are frequently regarded by different items of detailed PPP design, e.g., concession period and government guarantee. Take concession period as an example. Carbonara et al. (2014) summarized three aspects from which concession period models are constructed, namely, concession period calculation, uncertainties and risk factors, and satisfied parties. Their study attempted to integrate three aspects into their model; however, the effectiveness of the model should be testified and compared to other models with resembling function. Usually, the problem for models is not the shortage in number but to demonstrate the effectiveness alleged (Yi and Chan 2014). The second possible improvement goes to the financial structure research. Previous research has discussed various ways to set optimal debt and equity arrangement; however, only a little research has analyzed how to design optional financial structure if both debt and equity are not adequate (Regan et al. 2013). Considering the growing number of PPP projects, this situation should be concerned more before any real problem occurs. Therefore, future researchers are recommended to find more optional finance mechanisms apart from the traditional finance mechanism.

2.5.3 The procurement phase

Existing research has shown a variety of methods and criteria to select concessionaire. Typically, the final awarded one tends to be business companies with solid financial or technical ground. However, it is possible for other kinds of organizations to play the role of concessionaire efficiently. For instance, Chen et al. (2006) analyzed the possibility and benefit for a non-profit organization (NPO) engaging in a PPP. The present research therefore recommends the future researchers to seek more choices for selecting concessionaire, which may be particularly beneficial to places with immature capital markets. What is more, few researchers considered a pair of natural contradiction existing in the procurement process. On the one hand, EIB (2012) highlights transparency and fairness as two key good procurement principles through bidding procedure. These two principles require a competitive bidding process (World Bank 2014), which means more time and cost consumed. On the other hand, public sectors like to minimize transaction costs that are borne by themselves (Carbonara et al. 2016). Therefore, balancing procurement costs and transparency requirements is necessary and needs to be examined. Besides, as mentioned in the introduction section, an increasing demand for infrastructure is expected globally; however, global economic recession has been observed for years and is believed to continue. Consequently, research into incentive creation could be strengthened to appeal to more PPP investment under the frustrating economic situation.

2.5.4 The implementation phase

As previously mentioned, research into risk management has attempted to investigate particular risks in detail. The analysis of literature shows that a few risks, such as revenue risk and foreign exchange risk, received relatively more attention. Note that dozens of risks could be identified in a typical PPP infrastructure project due to the complexity nature. As a result, the current study recommends the future researchers to shed more light on more kinds of risks. This will be meaningful and beneficial given that the different risk preferences differ from jurisdictions (Ke et al. 2010). Moreover, implementation performance remains a future research agenda. The first promotion could be gained in monitoring implementation performance for which the government should be responsible (EIB 2012). Previous research has examined the performance for many projects mainly by ex-post evaluation; nevertheless, little has been known on how to monitor the implementation performance timely during the implementation phase. In addition, more research is expected worldwide to map a full scenario of PPP implementation status. The geographic scope of the current research is still not sufficiently wide regarding the vast areas PPP covers, e.g., to the authors' knowledge, less has been known about the PPP implementation in Latin America or Africa.

2.5.5 The transfer phase

Although very few previous studies were identified, the current research claims that the transfer phase of PPP is worth more future studies. Based on observation on real cases as well as in-depth analysis on literature, the authors found that transfer phase is also filled with uncertainties and risks. Without proper management, transfer process may be disturbed, and more severely, the sustainability of the public service provision may be not ensured. In combination with the main tasks of the transfer phase (EIB 2012; MoF 2014), some possible research agendas are discussed as follows:

- After the transfer preparation, a detailed transfer arrangement is expected to be determined. As mentioned previously, both guidelines and practical experiences on developing transfer arrangements are lacking (World Bank 2014). Even if a detailed transfer arrangement is accomplished initially, ensuring that all details are still appropriate or acceptable after 10 to 30 years is difficult (Cruz and Marques 2013). Therefore, the following questions should be answered:

1. What should be defined in advance about transfer arrangement?
2. What changes may occur when a PPP project is under the transfer phase?

3. How should those changes be dealt with for a smooth transfer?

- Overhaul of the main facilities and equipment is usually conducted by the private sector. However, the private sector often lacks incentive to do so due to its high cost (Xu et al. 2012). Besides, overhaul cannot be managed without acceptable technical criteria for transfer. Yet, current technical criteria of PPP seem mainly for maintenance other than transfer. Hence, at least two questions about overhaul require answers:

1. How should the private sector be monitored and encouraged to fulfil its overhaul responsibility?

2. What special technical criteria for transfer should be followed?

- Despite the fact that some research into residual risk has been done, little has been known on how to manage this risk. Furthermore, it is acknowledged that the residual assets can be divided into tangible and intangible assets (Yuan et al. 2015); however, how to quantify them is still unknown. Hence, for residual risk, the following questions should be solved:

1. How should the value of residual assets, especially the intangible assets, be calculated?

2. How should residual risk be managed?

- At the transfer phase, the posts of some employees may be threatened by the project transaction. This may impact the interests of the employees and lead to unstable working atmosphere. However, little research has concerned this issue during the transfer phase. Therefore, questions relating to employees may include:

1. How should the employees' interests during the transfer phase be protected?

2. How can possible negative results related to worried employees during the

transfer phase be avoided?

- The legal finalization of the transfer procedure does not necessarily spell the success of the transfer phase management as success has various definitions from different perspectives (Sanvido et al. 1992). Hence, the performance evaluation of the transfer phase management is also essential once a PPP project has been transferred back to the government. The following questions can be examined:

1. What are the criteria and performance indicators for a successful transfer phase management?

2. How can the performance of transfer phase management be evaluated?

2.5.6 The indivisible topics

In spite of the considerable existing research, a couple of studies are recommended by the present research. First, more application introductions from all over the world, especially from developing areas, are beneficial to present the full picture of PPP application status. Table 2.2 shows that lessons and experiences from developing places are still fewer, which does not match the tremendous market capacity of those places. Second, as an increasing number of projects have been/will go into the latter half of the PLC, research into success, particularly into life-cycle performance evaluation, remains a focus. The accurate evaluation of the life-cycle performance will be a difficult task considering the long period and complexity of PPP. For research into success, the CSFs research could also be extended. Previous research has acquired CSFs by limited samples or cases. To make the CSFs more representative, enlarging the sample size or case numbers may help. What is more, a detailed examination of failure is of great benefit as failure can result in huge waste of social resources.

Although a few studies have been recently carried out, future researchers can continue to focus on failure in a more systematic way.

2.6 Summary of the chapter

This chapter systematically reviewed PPP literature from a life cycle perspective. Inspired by previous literature review studies, this study explored a structured means for the identification and classification of relevant research articles. Following the designed means, seven top-tier construction management journals were selected as the source for paper identification due to their productivity in publishing PPP studies and their desirable reputations in construction management field. A total of 282 PPP studies published in the selected journals were identified, analysed and classified into distinct PPP phases following a structured five-step procedure that was designed for objectivity. Following the designed means, all identified papers were classified into six groups; five of them referred to PLC phases, and one was defined as indivisible topics. The literature analysis indicated that academic attention to the distinct PLC phases varied. In particular, continuous research interest was observed on the project preparation, implementation, procurement and identification phases, whereas the TP of the PPP is a significant research gap that requires systematic investigation. On the basis of the literature analysis, future research directions were suggested at each PLC phase, and potential RQs in the TP were listed.

Limited by research time and capability, this study does not attempt to cover all the possible identified research agendas, but merely focuses on some issues in the most neglected phase of PPPs, that is, the TP. Three issues that are closely correlated through the TCE logic, namely, the adaptation issue, the safeguarding issue and the performance evaluation issue, are addressed in particular. The next chapter will discuss the research methodology employed to investigate these three TCE issues in the TP of China's water PPPs.

CHAPTER 3 RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the research methodology adopted in this study. Section 3.2 introduces several groups of dialectics in scientific research to show various research types in literature and to summarise the type of this project. Section 3.3 presents the detailed design of this study based on the research objectives and questions. The research techniques used in this study are explained in detail in Section 3.4.

3.2 Research dialectics

Generally, the purposes of research include exploration, description and explanation (Babbie 2016). Exploration aims to obtain an initial understanding of certain old or new study subjects; description aims to observe the study subjects and to precisely report what was observed; and explanation aims to discover and report the relationships among different subjects (Babbie 2016). Typically, a research study can comprise multiple purposes.

Two logical processes can be followed to generate research theories, that is, deductive reasoning and inductive reasoning (Adams et al. 2014). Deductive reasoning starts from a hypothesis built from known theories, and then, through observations of the practice, the hypothesis is tested to be accepted or rejected. By contrast, inductive reasoning begins with observation by which a pattern is found and gradually forms a tentative conclusion about the pattern (Babbie 2016).

Observation can be realised through two approaches, namely, quantitative and qualitative (Fellows and Liu 2015). Quantitative approaches need numerical data to obtain measurements from which quantified results and conclusions can be derived, whereas qualitative approaches seek non-numerical data such as opinions and understanding of people to gain insights into the study subjects. Quantification leads to explicit results of the observation, while qualification improves the richness of meaning (Babbie 2016).

More dialectics of research can be found in general or construction management literature. Those dialectics lead to various research types that perform particular functions. Notably, the selection of research types should be oriented by multiple factors such as the nature of research issues, extent of existing knowledge, available sources and time, and expertise of researchers (Chen 2005). Taking into consideration all influential factors, an appropriate research design for achieving research objectives may be determined (Fellows and Liu 2015).

3.3 Research design

As stated earlier, the TP of the PPP life cycle is a new area that requires attention from both the industry and the academia (Bao et al. 2018). From a TCE perspective, three issues in the TP can be summarised, that is, adaptation, safeguarding and performance evaluation issues (see Table 1.1). Therefore, the purpose of this study is to find solutions for the three issues in question. To achieve the research purpose, four research objectives with 12 specific research questions were proposed (see Figure 3.1).

Considering the abovementioned characteristics, this study generally has an exploratory nature, relying heavily on the inductive reasoning process to draw its theories with the support of qualitative and quantitative data. However, in the analysis of specific questions, the other research approaches, such as description, explanation and deduction, were used where appropriate and necessary.

A triangulation approach was adopted, consisting of multiple research methods, namely, literature review, IDEF0, LFM, qualitative interview, questionnaire survey and case study (see Figure 3.1). This triangulation approach is appropriate for construction management research because construction projects are characterised as complex and dynamic, thereby requiring researchers to use mixed methodologies to better understand related problems (Love et al. 2002). Triangulation is also deemed effective in controlling research bias and testing research outcomes in itself (Denzin 1978; Nesan 1997). The forms of triangulation vary, such as data, methodological, investigator and interdisciplinary triangulations (Denzin 1978). This study mainly considered the former two, that is, the triangulation of data collection methods (e.g. questionnaire survey, interview and case study) and data analysis methods (e.g. quantitative or statistical analysis and qualitative analysis).

Multiple research methods were selected according to the nature of the research objectives and research questions. Therefore, the rest of this subsection further clarifies how each research objective and related research questions and research methods are formulated.

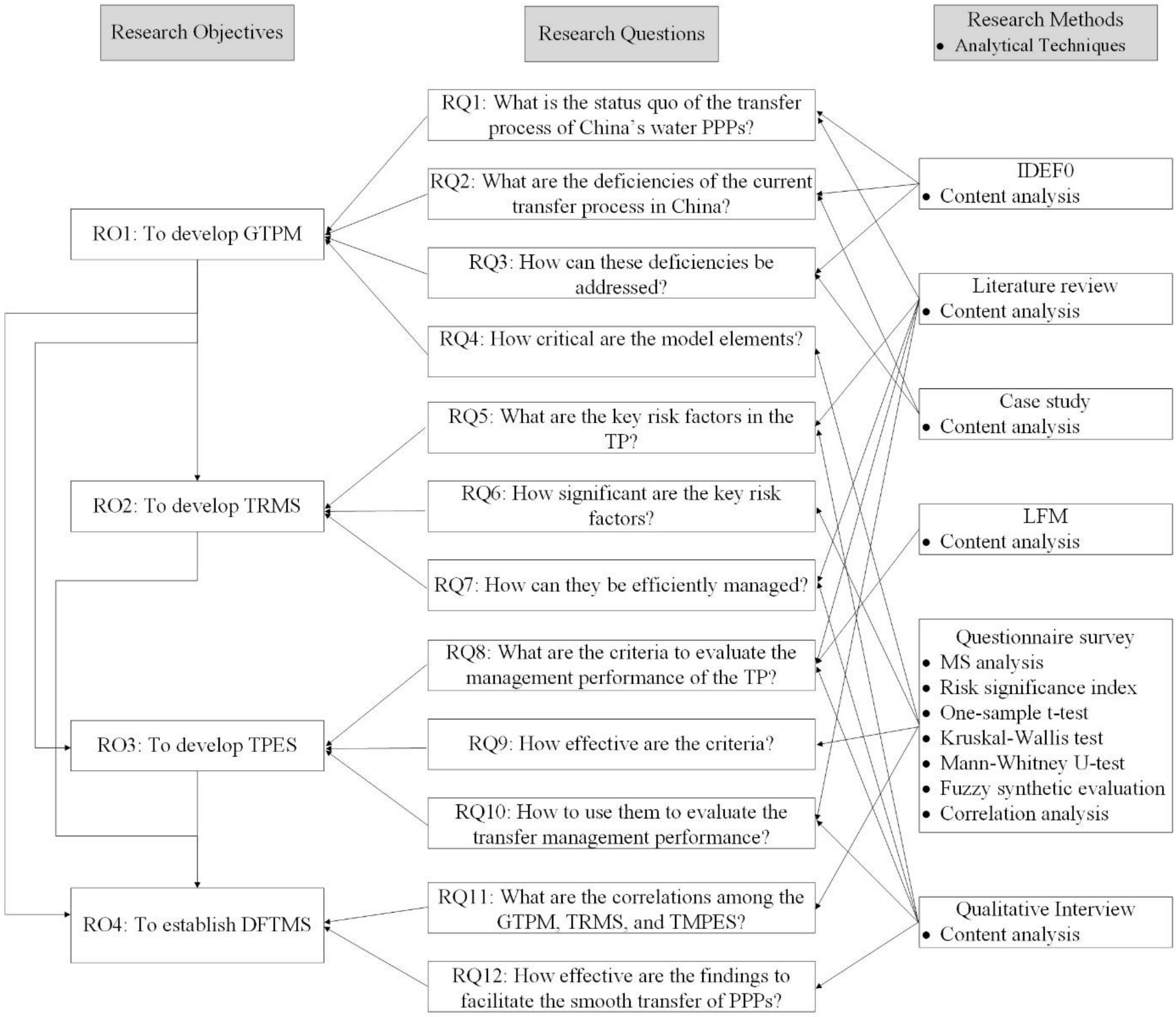


Figure 3.1 Overview of the research design

3.3.1 RO1: To develop GTPM

RO1 is to cope with the adaptation issue. This issue could be significant in the TP because anticipating what will happen to the project and the environment at the end of the long PPP life cycle is arguably impossible for the contract designers of a PPP. Now that the PPP contract cannot provide a clear route for the project transfer, this issue should primarily be considered when the project enters the TP. In other words, to manage the TP of China's water PPPs, basic knowledge should be obtained in the first place, such as how the transfer process is required under current transfer management regime, whether deficiencies exist in the current transfer process and, if deficiencies exist, how they can be addressed. Therefore, the process model, GTPM, which can explicitly depict the TP in a hierarchical structure, was developed to answer those research questions, namely, RQ1, RQ2, RQ3 and RQ4 (see Figure 3.1).

Multiple research methods were used for modelling the GTPM. A literature review was firstly adopted to learn the status quo of the transfer process of China's water PPPs. To identify the deficiencies in the current transfer management regime and possible solutions for those deficiencies, a case study was conducted on a typical PPP project in China's water sector, which is also the only water PPP in China that experienced the TP. The entire model development process was facilitated by the modelling language IDEF0. To validate the model components, a questionnaire survey was conducted among water PPP experts. For the details of developing the GTPM, please refer to Chapter 4 of this thesis.

3.3.2 RO2: To develop TRMS

The RO2 aims to tackle the safeguarding issue. As stated previously, this issue is difficult to avoid due to the asset specificity of the PPP project and the opportunism of practitioners. From a risk management perspective, this issue could also be deemed that, in the TP, the value of the project assets could be degraded by opportunism risk. Moreover, considering the volume of the assets invested throughout the long life cycle of a PPP, the safeguarding issue in the TP could be incurred by not only the opportunistic behaviour of practitioners but also by other risk events under which the project assets are poorly consumed or devaluated. This critical situation triggers the demand of a systematic investigation to all possible risks that may occur in the TP.

Accordingly, three research questions are to be answered, referring to the identification of risk categories (RQ5), evaluation of the factors (RQ6) and development of the risk management system (RQ7).

Methods used to answer relevant research questions include literature review, case study and questionnaire survey. Given that no prior research has specifically investigated the risks in TP, the initial risk categories in the TP were identified through two ways, that is, literature review and interview with water PPP experts. Through the former, the general risk categories of the PPPs were identified before being rephrased to suit the characteristics of the TP. Through the latter, possible new risk categories that merely exist in the TP were identified. All identified risk categories were evaluated by a questionnaire survey through which data were collected and statistically analysed, and the final TRMS was constructed and validated with the support of experts' insights. Notably, the development of TRMS was based on a process-based perspective which has been defined by the GTPM. The development of TRMS is reported in Chapter 5 of this thesis.

3.3.3 RO3: To develop TPES

The RO3 refers to the performance evaluation issue. This issue indicates that the public sector may experience difficulty in evaluating the performance of the private party during the TP due to the private party's uncertain behaviour and the public sector's bounded rationality. In other words, given the lack of access to monitoring the transfer process, especially the behaviours of the private party, the government may be unable to determine the extent to which the tasks required by the transfer arrangement have been strictly performed by the private party and may consequently be unable to evaluate how successful the TP is. Therefore, the RO3 emerged from the need to address this issue by developing a comprehensive performance evaluation system, that is, the TPES. Specifically, three research questions will be answered to satisfy RO3, regarding the performance evaluation criteria, the effectiveness of the criteria and the way to employ the model built, which are shown in Figure 3.1 as RQ8, RQ9 and RQ10, respectively.

Similar to TRMS, the model elements of TPES (i.e. transfer success criteria) cannot be directly identified from the literature either, as this question has not yet been studied by prior researchers. Therefore, the primary task for transfer performance evaluation was to clearly define what transfer success is, which was completed via LFM, and then literature review and expert interview were used to identify specific transfer success criteria. The effectiveness of all the identified model elements was evaluated through questionnaire survey. In addition, the discussion of the TPES was based on a process-based perspective facilitated by the GTPM. Please refer to Chapter 6 of this thesis for more details.

3.3.4 RO4: To establish DFTMS

The RO4 regards the attempt to integrate the three sub-models as a comprehensive model, that is, the DFTMS, to dynamically and systematically deal with all three TCE issues in the TP. This attempt is necessary because, without appropriate integration, practitioners could be confused about how to utilise those distinct models to facilitate the transfer of water PPPs. An integrated model can help decision makers pre-evaluate the status and identify possible risks before transfer to manage those possible risks and adjust management strategies duly under transfer and to evaluate the management performance after transfer. Therefore, two research questions related to the basis for the integration of sub-models will be answered, that is, RQ11, which refers to the correlations among three models, and RQ12, which regards the applicability of the final outcomes.

The formation of the DFTMS should be based on solid evidence. Thus, statistical analysis was conducted on the data acquired through questionnaire survey to realise RQ11, that is, to investigate the correlations among the key elements of GTPM, TRMS and TPES. Consequently, the findings revealed the mechanism through which the three sub-models are connected. To validate the applicability of a IDEF0 model, prior researchers mainly adopted the case study method (e.g. (Bevilacqua et al. 2012)) or expert interview (e.g. (Mokhtar et al. 2016)). Considering that few water PPPs in China have entered the TP, the proposed DFTMS was validated through an interview with relevant experts with professional insights. The details of this section are reported in Chapter 7 of the thesis.

3.4 Research methods

As discussed above, multiple research methods were adopted to pursue the research objectives, including literature review, IDEF0, LFM, questionnaire survey, interview and case study. The details of the multiple research methods are presented as follows.

3.4.1 Literature review

Literature review is an efficient and effective means to identify knowledge gaps and provide insights into future research directions. Many researchers have utilised this method to investigate the length of progress in the PPP area. For example, Ke et al. (2009) analysed the annual number of published papers, the contribution of main researchers and several research interests over 1998 to 2008. Tang et al. (2010) reviewed 85 PPP-related papers from empirical and non-empirical research perspectives. Zhang et al. (2016) conducted a comparative study between the PPP research in international and Chinese journals.

In this study, a literature review plays three important roles. Firstly, it contributes to the identification of knowledge gaps, research objectives and questions. The research began with a literature review to introduce the research background in which basic knowledge about PPP, TCE, and relevant issues was reported, and in turn, the specific research niche was gradually determined. An extensive literature review of the PPP research in leading construction management journals was conducted from a life cycle perspective to comprehensively show the state of the art and knowledge gaps. These processes are reported in detail in Chapters 1 and 2. Secondly, a literature review serves as the source of data and information. This role refers to the development of the three sub-models that were expected to meet the main research objectives. To build these models, the primary step was to identify the initial model elements which were either simply adopted from or inspired by the literature. To include as much data and information as possible, a large number of literature categories were searched and analysed, covering academic journals, industry reports, governmental documents and project materials, among others. These efforts are mainly linked with Chapters 4, 5 and 6. Thirdly, a literature review was used to support or justify certain viewpoints, insights or research findings. From time to time, the authors referred to prior research to seek support and, more importantly, to make a connection between this study and the existing body of knowledge. This process was concurrently performed throughout the entire research course (Chen 2005). Thus, it appears in almost all chapters of this study.

3.4.2 IDEF0

As discussed previously, given the adaptation issue, the concession agreement can give practitioners little effective instruction on how the transfer process of a water PPP project in China should be executed. Therefore, this study aims to develop a transfer process model that can provide a wealth of detailed information about the TP. The development of the process model mainly relied on the IDEF0 method, which was selected due to its unique advantages in hierarchically modelling complex processes or systems. Justifications for selecting IDEF0 to model the transfer process are presented below.

3.4.2.1 Process model and relevant modelling tools

A process model can be defined as a simplification of a complex process (Carnaghan 2006). It helps illustrate the important aspects of the process, in which critical individuals and entities and links between them are distinguished, thereby providing a comprehensive understanding of the process to decision makers (Aguilar Sommar 2004). A process model can also benefit decision makers by identifying possible deficiencies in the process to implement necessary improvements (Climent et al. 2009). Given the significance of a process model in achieving the objectives of processes, practitioners in various industrial sectors have made efforts to model the business process in their particular contexts, such as the business process model within companies (Climent et al. 2009), the communication process model (Björk 2007) and the construction process model (Karhu 2003). Inspired by past studies, the TP model was developed in this study to facilitate the management of the TP of the water PPPs in China.

Among the various process modelling methods, Shen et al. (2004) concludes that IDEF0, IDEF3 and data flow diagram are the preferred tools under conditions of system development where data are open-ended and the capability to capture all data is limited. A comparison of the three methods shows that IDEF0 is suitable for preliminary design to describe the entire process in a top–down structure, while the other two methods are suitable for a detailed discussion from a bottom–up perspective (Shen et al. 2004). Developing GTPM aims to uncover the TP holistically, serving as the basis of the systematic research on the TP; in other words, it has an exploratory and preliminary nature. Considering the above analysis, IDEF0 was chosen as the appropriate modelling tool.

3.4.2.2 Using IDEF0 to model processes

IDEF0 is a modelling technique to design, maintain and promote systems or processes [National Institute of Standards and Technology (NIST), 1993]. Several unique merits make IDEF0 popular in process modelling. To name a few, it is adept at describing complex processes by providing multiple levels of details and also providing a complete overview with the entire process (Sugiyama et al. 2006). Learning the method and interpreting the built model are also easy for users (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.

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 (Sanvido and Norton 1994; Yung et al. 2014) 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 was therefore adopted as the tool to develop the transfer process model of this study.

An IDEF0 model is composed mainly of hierarchical diagrams formed by boxes and arrows (Figure 3.2). 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).

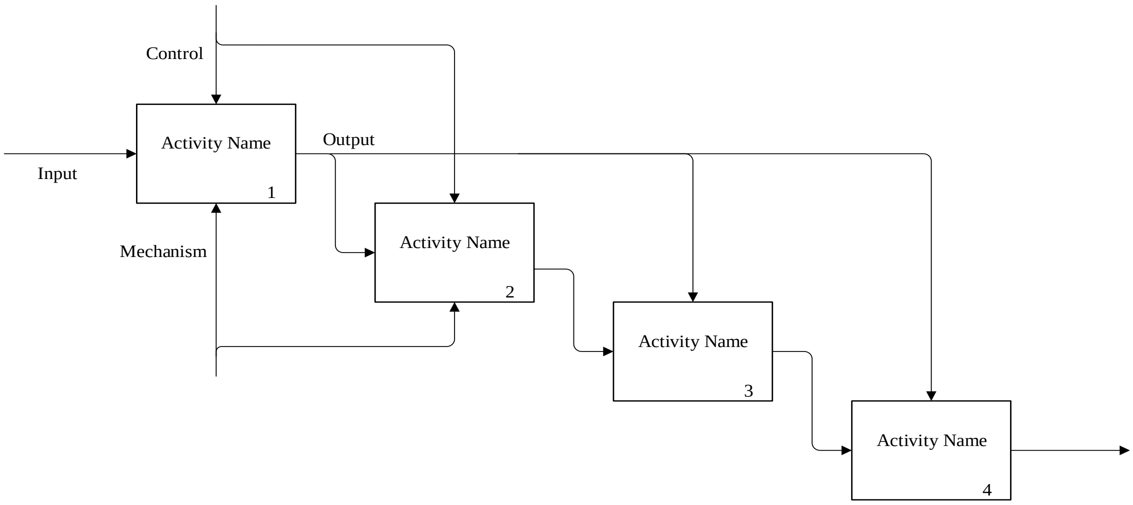


Figure 3.2 Example of IDEF0 Diagrams (Adapted from NIST (1993))

Commonly, the procedure for using IDEF0 to model processes includes three steps (Bevilacqua et al. 2012; Climent et al. 2009; Mokhtar et al. 2016).

1. To design an 'as-is' model. This step aims to comprehensively analyse the status quo of the process, e.g. the status quo of the transfer process of the water PPPs in China;
2. To identify challenges. This step focuses on the identification of critical challenges for improvement and possible solutions to those challenges based on the as-is model, e.g. the challenges in the transfer process of the water PPPs in China; and
3. To design a 'to-be' model. In this step, solutions to the identified challenges are proposed and the original process is re-engineered according to the solutions, e.g. the challenges and corresponding solutions of the transfer process of water PPPs in China.

3.4.3 LFM

The RO3 of this study refers to the development of a performance evaluation system to evaluate the success degree of the transfer management process. To achieve this objective, the primary task is to figure out the definition of transfer success so that the evaluation can be performed; however, this definition is still missing in existing studies. This study therefore defined transfer success, which consisted of a series of hierarchical criteria. LFM was adopted to construct the structure of the transfer success mainly due to its effectiveness in dealing with performance definition issues.

3.4.3.1 Wide usage of LFM

LFM, a.k.a. logical framework analysis, was firstly employed by the USAID as a planning tool to facilitate its decisions on overseas development in the early 1970s. Given LFM's effectiveness in strategic planning and project management, it was then adopted and adapted by other agencies to solve management problems of different sector projects. such as health sector and technical cooperation projects (Akroyd 1995; Cordingley 1995). LFM can be helpful to project management from many aspects, including problem analysis, establishment of hierarchical project objectives, project implementation monitoring and review, and project evaluation after completion (Kumar et al. 2006). LFM can better measure the performance of a project as it takes the focus away from day-to-day activities and focuses instead on results, benefits and ultimate impact (Frey 2013). Considering this advantage, many researchers have utilised LFM to define the success of various projects, such as Baccarini (1999) on general projects, Al-Tmeemy et al. (2011) on building projects and Liu et al. (2015) on PPP projects. The present study aims to build a performance measurement system that, on the one hand, is capable of measuring the extent to which various transfer objectives have been attained after the TP and, on the other hand, could be used as a tool to monitor the transfer process during this phase. With this purpose in mind, LFM emerged as a suitable means to define the transfer success of water PPPs in China.

3.4.3.2 Using LFM to define project success

LFM emphasises that a project's various objectives can be formulated using a hierarchical structure where cause–effect relationships exist between different levels of objectives (Baccarini 1999). That is, project success contains two components: product success and project management success (see Figure 6.1). Product success is related to project goal and project purpose. The project goal pertains more to long-term objectives, while the project purpose emphasises near-term objectives. Project management success focuses on the project process, i.e. on what are needed in the process and how the process is conducted. Normally, product success is more critical than project management in the construction industry (Baccarini 1999). According to LFM concept, a 'how–why' logic exists in the project success definition. As shown in Figure 3.3, 'how' denotes means and 'why' denotes ends. Through the how–why logic chain, the relationship between the four objectives is defined clearly as follows: To the question, 'How can the project goal be achieved?', the answer is project purpose. If the question is 'How can project purpose be achieved?', then the answer is project outputs, and so on. Similarly, starting with inputs, the objective on the left side interprets why the objective on the right is necessary.

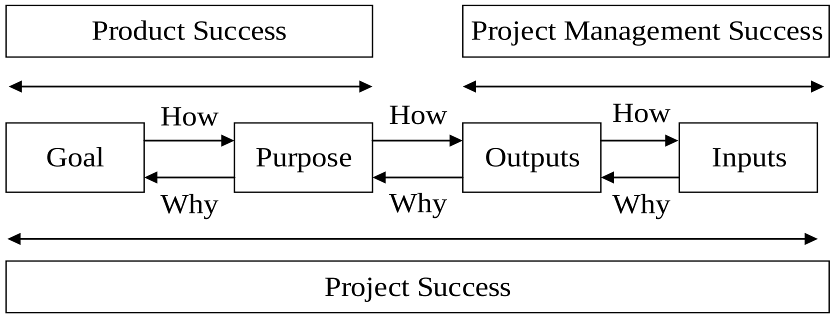


Figure 3.3 Link between LFM and project success (adapted from Baccarini (1999))

3.4.4 Qualitative interview

Qualitative interview is an interaction between interviewers and interviewees, which is based on a general research plan rather than a series of structured questions with specific words and sequence (Babbie 2016). This method offers a way to conduct in-depth investigation on certain issues and also allows flexibility for the participants to express their insights fully (Merriam and Tisdell 2015). The main forms adopted for interviews in the PPP domain include structured, semi-structured and unstructured interviews (Choi et al. 2010; Hong and Chan 2014; Yuan et al. 2015). Semi-structured interviews were often used to provide additional information to results from other research methods such as questionnaire survey and literature review (Bao et al. 2018; Liu et al. 2016).

To achieve RO2 and RO3, this study needs to identify transfer risk categories and transfer success criteria. The identification process began with an extensive literature review; however, due to the lack of relevant knowledge in existing studies, the identification cannot be fully completed merely by a literature review. Under this circumstance, previous researchers often used qualitative interview method to seek contributions from experts relating to their topics, by which the initial list of particular factors was refined (Liu et al. 2016). Therefore, this study also utilised the semi-structured interview format to refine the preliminary list of transfer risk categories and transfer success criteria adapted from the literature.

The rest of this subsection presents more detail about the interview method, including sampling frame, interview design, sample size and data analysis. A detail that should be noted is that, besides being used to facilitate factor identification, an interview is also mentioned on other occasions of this thesis, serving as, for example, a technique to perform a case study in Chapter 4 and validate the final research outcomes in Chapter 7. Interviews on the latter two occasions focused on totally different questions with those discussed here and are thus reported in detail in relevant chapters.

3.4.4.1 Sampling frame

One of the key factors for a successful interview is that both the interviewers and interviewees should be familiar with the topics and questions under investigation (Kvale 1996). With this point in mind, purposive sampling means was used for data collection (Ameyaw and Chan 2015). Target interviewees were senior-level professionals from four types of organisations, that is, the public sector, the private sector, PPP consultancy and PPP academia.

The public and private sectors are obviously the most important stakeholders throughout the life cycle of PPPs. In the TP, the partnership becomes even closer than in the prior operational phase because the transfer of the project from the private to the public sector requires the simultaneous involvement of both parties. Therefore, their standpoints about the TP should be considered. In China, PPP consultancies were also deeply involved in the development of PPP projects in providing services for both the public and private sectors. Their experience in collaborating with both parties can lead to a complementary understanding about China's water PPPs. In addition, PPP consultants are deemed professionals with strong technical ability and expertise, tending to speak more candidly than those who have sensitive identities (e.g. the officials) (Shrestha et al. 2017). Their opinions can thus be valuable complements to what the public and private sectors offer unilaterally. Respondents from the PPP academia were also selected for the survey simply because PPP academics are generally believed to be knowledgeable and to take a neutral role in considering PPP issues (Chan et al. 2011). With their critical insights, objectivity of the survey results was expected to be improved.

To identify appropriate interviewees, previous PPP studies often pre-defined selection criteria, such as sound knowledge of PPP practice and hands-on experience in PPP delivery (Chan et al. 2010; Ke et al. 2010; Olusola Babatunde et al. 2012). Interviewees that satisfied one or more of the pre-defined criteria were deemed qualified to provide valid responses. This study set out more rigid criteria for interviewee selection to further guarantee the validity of responses. In particular, three criteria were pre-defined for interviewee selection:

1. Interviewees should have direct involvement in or research attention on China's water PPP projects;
2. Interviewees have participated in or researched China's PPP development for more than 10 years; and
3. Interviewees should be middle-level or above professionals in their organisations.

These extremely rigorous criteria largely narrowed the scope for selecting candidates in China. To facilitate the identification of appropriate interviewees, a list that includes senior-level management members of top water companies, active researchers in the PPP domain and PPP consultants in top consultancy companies in China were developed firstly. The names and contact methods of these entities and individuals were collected from the Internet and personal connection. Then, an invitation letter was sent to all listed candidates to briefly introduce the purpose of this study and invite them to participate.

3.4.4.2 Interview design

A formal structure that contained the same main topics and questions was used for all interviews to reduce possible bias during the interview process (Flick 2015). In addition, to avoid impacting the interviewees' independent judgment, the interviewer tried not to speak actively unless necessary introduction or interpretation was needed (Babbie 2016). A complete interview mainly followed four stages:

1. The interviewer briefly introduced the interview purpose and the interviewee was shown the preliminary list of transfer risk categories and transfer success criteria;
2. The interviewee went through the list and comprehensively understood all items on it;
3. The interviewee gave his/her opinions on the listed items and made adjustments to the list based on their understanding and expertise; and
4. The interviewee confirmed all adjustments and to make necessary re-adjustments, if any; otherwise, the interview ended.

The identification of the transfer risk categories is taken as an example. During an interview, the interviewee was firstly given the prepared list of transfer risk categories which were extracted from the literature. In the meantime, the interviewer briefly introduced the arrangement of the interview and generally explained the transfer risk list. Through the opening introduction, the interviewee was clearly informed that the transfer risk categories to be considered were adapted from past studies on general PPP risks so he or she had to evaluate whether the list was rational under the circumstance of the TP. After careful consideration, he or she was allowed to make any adjustment to the list, such as alteration, addition or deletion of transfer risk categories, according to his or her expertise and experience in dealing with water PPPs in China. Then, the interviewer and the interviewee went through the risk list to confirm all adjustments have been properly made. Finally, the list for transfer risk categories was set when the interviewee thought that no further adjustment was needed.

Following the same procedure, the list for transfer success criteria was thoroughly checked by all expert interviewees. With the triangulation of the qualitative interview method, the reliability of the complete list consisting of transfer process factors, transfer risk categories and transfer success criteria was improved and ready for the subsequent questionnaire survey and various statistical analyses.

3.4.4.3 Sample size

The interviews were conducted between January to March 2017 in China. Eight interviews were finished with three area managers from top water companies of China, two senior management staff from local state-owned water utilities, two PPP researchers who have published many research papers focusing on water PPPs of China and one general manager of a medium-scale PPP consultancy company. All interviewees had more than 10 years' practical or academic experience in China's PPP market and paid continuous attention to the water PPP area for more than five years. Each interview lasted between 60 to 90 minutes. These results showed the multiple backgrounds and extensive experience of the interviewees who were capable of providing valid and reliable insights into the refinement of the two types of factors.

The sample size depends on the saturation of the data. In qualitative research, saturation serves as '*the point in data collection when no new or relevant information emerges with respect to the newly constructed theory*' (Saumure and Given 2008). In other words, if the researchers find that no additional information related to the topic of interest can be attained from the interviewee, then data saturation can be deemed as achieved and, hence, the data collection can be considered complete (Morse 1995). In this study, by the end of the eighth interview, some words were obviously observed to have repeatedly occurred in several interviews and no novel points could be drawn, indicating data saturation. Consequently, the interviews were concluded.

3.4.4.4 Data analysis

All interviews were recorded with the permission of the interviewees. After each interview, the audio records were immediately transformed into an interview transcript that would be further processed via content analysis technique[3]. The audio records

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[3] Please refer to subsection 3.4.7.1 for more information about "content analysis".

were constantly referred to when transcription was taken. Data from each interviewee were coded for convenience of revisit during the analysis process (Bao et al. 2018). Through this process, all the collected data were organised, and the major themes generated by interviewees became apparent, which that the meant findings of the qualitative interview were ready to move towards the subsequent important usage—developing the questionnaire.

3.4.5 Questionnaire survey

A survey is a suitable technique for researchers who hope to study certain groups that are too big to observe directly (Babbie 2016). A questionnaire is one of the most frequently used tools for the survey, which is deemed as the best way to collect data from respondents that are scattered in different places by asking them a series of the same questions (Kumar 2011). In this study, professional contributions were needed to evaluate the initial TP factors, transfer risk categories and transfer success criteria of water PPPs in China. To guarantee the validity of the evaluation results, experts who had a deep understanding of and a close relation to China's water PPPs are mostly suitable. Although China's water PPP sector is deemed as a narrow research scope in the construction management area (Bao et al. 2018), directly observing all relevant experts with such complex backgrounds and working locations is impossible for researchers. Hence, the questionnaire survey was used in this study to collect data from nationwide experts with extensive experience and expertise in China's water PPP sector.

3.4.5.1 Sampling frame

Similar to the sampling for the qualitative interview, purposive sampling was adopted to identify experts with sufficient expertise. Four types of stakeholders (i.e. the public sector, the private sector, PPP consultancy and PPP academia) were mainly considered to seek survey subjects owing to their close relation to the development of water PPPs in China and, more importantly, their important roles in managing the TP (Bao et al. 2018). Moreover, given that many statistical analysis techniques can work effectively when the amount of data exceeded a minimum number, other important stakeholders of PPP development such as PPP lawyers and bankers were also taken into account to gain as large a number of responses as possible.

Along with the purposive sampling method, snowballing means was an ideal choice for respondent selection (Cheung et al. 2010; Cheung et al. 2012). Firstly, a number of senior management members of top water companies in China were targeted and contacted via different methods, such as mutual acquaintance’s referral, emails, phone calls and personal visits. The experts who showed willingness to participate in this study were asked to fill out the questionnaire and to nominate other experts with a suitable background and rich experience as subsequent respondents. Then, efforts were continuously made to establish new contacts with these nominated respondents who were invited to fill out the questionnaire and offer new nominations. To guarantee the adequate expertise and experience of the selected respondents, two pre-defined criteria that have been frequently used by PPP researchers in questionnaire surveys were employed as well (Chan et al. 2009; Ke et al. 2010; Osei-Kyei et al. 2017). The pre-defined criteria considered the following:

1. Respondents should have in-depth knowledge about PPP and should have close relation to PPP development in China; and
2. Respondents should have hands-on practice and/or research experience in at

least one water PPP project in China.

Respondents who met the above two criteria were considered appropriate to provide valid contributions to the evaluation of the TP factors, transfer risk categories and transfer success criteria in China's water PPP sector.

3.4.5.2 Sampling process

Before the formal survey, a pilot study was conducted to seek experts' viewpoints about the understandability of the questionnaire. Six PPP experts participated in the pilot study—three from the academia and three from the industry. On the basis of their suggestions, necessary changes to the questionnaire were made, such as rephrasing some questions for clarity and simplicity consideration. Through the pilot study, ambiguities and mistakes (mostly regarding the wording of the text) were removed and the overall construct of the questionnaire was greatly improved.

The formal questionnaire surveys were conducted from August 2017 to February 2018. The respondents were invited to fill out the questionnaires online due to the prevailing use of the Internet, especially mobile Internet, in mainland China. Two login means of the online questionnaire, namely, website linkage and QR code, were propagated by multiple tools, such as email, QQ and WeChat. The latter two are popular social media software in China, greatly assisting the respondents in accessing the survey interface through their smartphones. In particular, WeChat was demonstrated to be of great help to spreading the questionnaire owing to its great number of users in China. According to a financial report of Tencent, the provider of WeChat, this software alone had more than one billion monthly active users after the Spring Festival of China in 2017

(Tencent 2018).

3.4.5.3 Questionnaire design

Two types of questions can be raised in a questionnaire, namely, open-ended and close-ended questions. As shown in Figure 3.1, this study mainly used questionnaire survey to evaluate the model elements with respect to the transfer process, risk categories and success criteria. The evaluation results led to outcomes such as CTSFs, CTRCs and KTPIs (see Figure 1.2). This study manner is similar to that of many prior PPP studies focusing on, for instance, critical success factors (CSFs) (Li et al. 2005), key performance indicators (KPIs) (Yuan et al. 2009) and risks (Jin and Doloi 2008), which all designed close-ended questions in their questionnaires. Therefore, close-ended questions were adopted in the questionnaire of this study. In the final questionnaire, four sections were presented to elicit distinct information from respondents (refer to Appendix A). These four sections are

Section A: Information of participants

Section B: Evaluation of the transfer process factors for water PPPs in China

Section C: Evaluation of transfer risk categories for water PPPs in China

Section D: Evaluation of the transfer success criteria for water PPPs in China

The four sections are discussed in detail below.

(1) Section A: Information of participants

This section was designed to investigate the expertise and experience of the respondents. Considering that the TP is a relatively fresh domain for PPP research, the authors wished to receive feedback from those who possessed profound understanding and professional insights into the water PPPs in China, especially those who had experienced the whole life cycle of a PPP water project. The questions in this section referred to their professional affiliations, current positions, duration in the PPP field and number of projects involved. The abovementioned information is believed to be helpful to determine the validity and accuracy of their responses.

(2) Section B: Evaluation of the TP factors for water PPPs in China

This section was designed to evaluate the *criticality* of the process factors constituting the GTPM, which was the main outcome in attaining the RO1. The development of GTPM relied on IDEF0, which translated the entire transfer process into a visible hierarchical structure, in which a number of key steps and factors representing the key model elements were identified (refer to Chapter 4). As suggested by Sanvido et al. (1992), for a construction project, if all the process factors identified by IDEF0 are met, then the success of this project can be ensured. They therefore defined those process factors as potential CSFs of the construction project. Following this precedent, this study defined the process factors of the GTPM as the potential CTSFs. The final CTSFs were expected to emerge after the evaluation of the expert respondents.

Section B began with an explanatory passage showing the respondents the purpose of this section, background of the items to be evaluated, and basic rules for rating. A total of 23 factors identified by the GTPM were included in this section. All factors were rephrased and numbered in sequence to facilitate the respondents' easy understanding. The respondents were requested to indicate their answer to the *criticality* of each factor on a five-point categorical scale. This scale setting was adapted from the widely used rating scale proposed by Likert (1932). Among the five ratings, 1 denotes extremely low, 2 denotes low, 3 denotes moderate, 4 denotes high and 5 denotes extremely high. In addition to the five-point scale, respondents could also select *not applicable* (shown as N/A in questionnaire) for factors that they deemed should be excluded. Extra blanks were provided below the 23 factors for the respondents to add and evaluate any other factor that they believed needed to be included. More details about the 23 factors and GTPM are shown in Chapter 4.

(3) Section C: Evaluation of transfer risk categories for water PPPs in China

This section was designed to evaluate the significance of major risks in the TP. To attain RO2, possible risk categories in the TP were primarily identified from risk management literature and insights of expert interviewees (refer to Chapter 5). After the identification of a list of risks, an assessment determining the significance of the risks is necessary prior to seeking risk mitigation and monitoring the risks (EIB 2012). Typically, risk significance depends on two parameters, that is, likelihood of the risk occurrence and severity of the risk consequence; risks with high significance, which generally means a high probability to happen and high severity for the consequence, can be defined as critical risk factors (CRFs) (Jin 2012; Shrestha et al. 2017; Xu et al. 2010). Similarly, this study analyses risk significance by considering the combination of the risk probability and severity and defines risk categories with high significance in the TP as CTRCs. Thus, the question about each risk in the questionnaire contained two dimensions, that is, risk *probability* and *severity*.

The layout design of this section resembles that in Section B. In the very beginning is a simple introduction of the evaluation rules, followed by the main body of the risk categories to be assessed. Both probability and severity were rated by using a five-point Likert scale, in which the bigger number denotes higher significance. The respondents could also give N/A to certain items they want eliminate from the risk list or add new risk categories in the extra blanks at the end of the section. More details about the development of TRMS are shown in Chapter 5.

(4) Section D: Evaluation of the transfer success criteria for water PPPs in China

This section was designed to evaluate the *effectiveness* of the success criteria for measuring the transfer management performance, and the data collected will facilitate the realisation of RO3 (refer to Chapter 6). Similar to the transfer risk categories, the success criteria in the TP also need verification before further discussion because one of their sources was expert respondents' intuitive perceptions. As discussed in Chapter 6, the success of PPPs is a complex concept because a PPP is related to multiple stakeholders and long-term development process. PPP success therefore cannot be measured by merely several isolated indicators such as time, cost and quality; instead, it should be a compound that comprises different objectives and performance indicators which are integrated by a certain internal logic (Baccarini 1999; Liu et al. 2015). Identically, this study tries to develop a TPES in which a series of KTPIs is expected to be effective to measure the success of the TP. Therefore, this section aims to facilitate the identification of KTPIs by surveying how effectively the initial transfer success criteria could measure the success of the TP.

In terms of the setting of questions, Section D was the same as Sections B and C, including instruction of the evaluation rules, rephrased and numbered items to be assessed, and extra blanks for adding new items. For each item, respondents were required to offer their ratings from one to five or select N/A. Please refer to Chapter 6 for more details about the development of TPES.

3.4.5.4 Response rate

A total of 430 visits to the questionnaire page were recorded by the online survey system. Fifty-two visitors from more than eight provinces of China completed questionnaires. The overall response rate was 12%. Although this response rate does not seem very high, it is close to that of other studies in the PPP area. Li et al. (2005) used the questionnaire survey method to investigate the CSFs of PPP projects in the UK and had a response rate of 12%. However, they argued that this rate was acceptable and typical in construction and project management studies. Jin and Zhang (2011) conducted a questionnaire survey to model optimal risk allocation in PPP projects in Australia and received a response rate of 11.4%. They claimed that their low response rate was not atypical due to the nature of social science research and the sensitivity of the PPP topic.

In a previous study conducted by Shrestha et al. (2017), where risks in PPP water projects in China were examined using the questionnaire survey method, the response rate was 30%, higher than that of this study. However, the total useful respondents were only 32, which was much less than the 52 respondents of this study, not to mention the fact their respondents had only one background (PPP consultants). In another study, Osei-Kyei et al. (2017) used a questionnaire survey to extract the international experts' opinion on the success criteria of PPP projects. Their response rate was 14%; however, the number of their respondents was only 42, less than that of this study. In addition, they found that small samples were not uncommon for e-mail/web-survey based research in the PPP domain.

Unlike the abovementioned studies on the general PPP projects of countries with a mature institutional system (e.g. the UK and Australia), this study focused on a specific area, that is, the TP of the water PPPs in China. Under this circumstance, a relatively smaller population for this study to perform sampling could be easily expected. Consequently, the acquired sample size can be considered a more desirable result compared with the past studies. The multiple backgrounds (see Figure 3.4) and senior-level positions (see Figure 3.5) of the responsive experts of this study also contributed to the reliability of the survey responses.

3.4.5.5 Reliability analysis

For the questionnaire survey method, reliability represents the internal consistency of the scales (Yuan et al. 2009). Acceptable reliability is the prerequisite to valid quantitative analysis. To test the reliability of the questionnaire, this study used Cronbach's alpha coefficient as an index, which is one of the most popular statistics for reliability analysis in the PPP area (Henjewele et al. 2011; Thomas et al. 2003; Yang et al. 2010). Generally, a Cronbach's alpha coefficient locates somewhere between 0 and 1 and can be seen as acceptable if it is between 0.7 and 1.0 (Santos 1999). In this study, the Cronbach's alpha coefficient for each section of the questionnaire and the overall coefficient were computed. As shown in Table 3.1, all the values of the Cronbach's alpha were more than 0.9, thereby indicating extremely high reliability of the scale used in this study. As a result, collected data can be processed by subsequent statistical techniques to probe more underlying constructs.

Table 3.1 Results of reliability analysis of the questionnaire

Items	No.	Cronbach's Alphas (by section)	Cronbach's Alpha (overall)
Transfer process factors	23	0.966	
Transfer risk categories (probability)	19	0.961	0.986
Transfer risk categories (severity)	19	0.969	
Transfer success criteria	14	0.963	

3.4.5.6 Demographic profiles of respondents

In this study, 52 respondents comprised all four desired stakeholders with a well-proportioned distribution (see Figure 3.4). Respondents from the private companies took up a total of 35%, slightly more than those from the public sector (20%), academic/research institutes (20%) and consultancies (17%). A further 8% belonged to other sectors, such as lawyers and bankers.

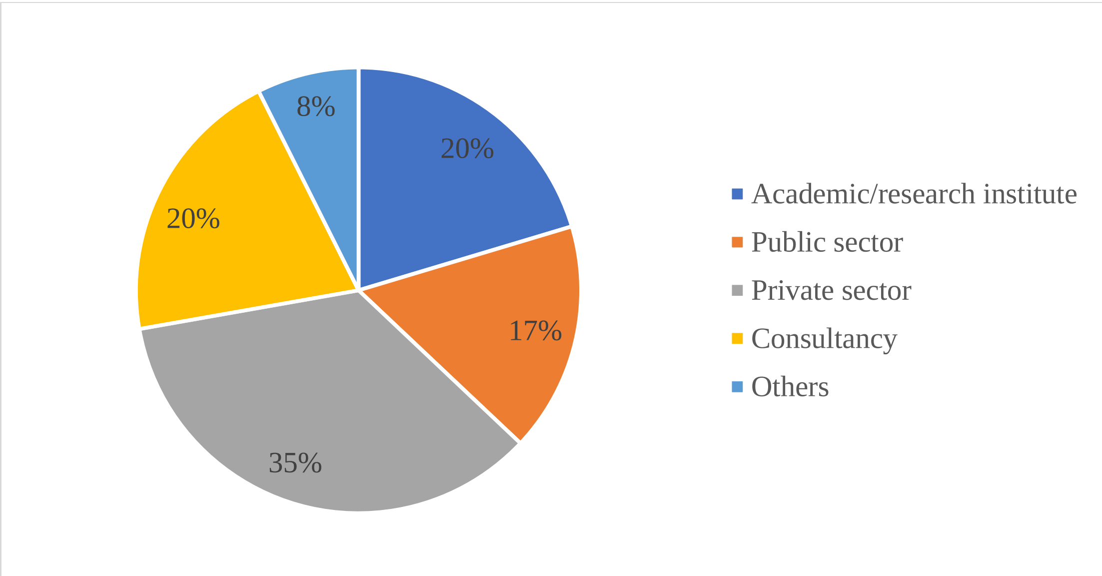

Figure 3.4 Professional affiliations of respondents

More than half of the respondents (58%) held senior positions in their organisations, while the other one-third (29%) had middle titles (see Figure 3.5). Only 9% of the respondents were frontline staff. Commonly, people with high professional titles are deemed to have a relatively deep understanding to their business and were therefore always a priority for researchers in the PPP domain to select target respondents (e.g. (Koops et al. 2016; Liu et al. 2016; Wu et al. 2016)). In this study, the overwhelming majority of respondents were middle or senior professionals, implying that the samples could be good representatives of the expert population in China's water PPP sector.

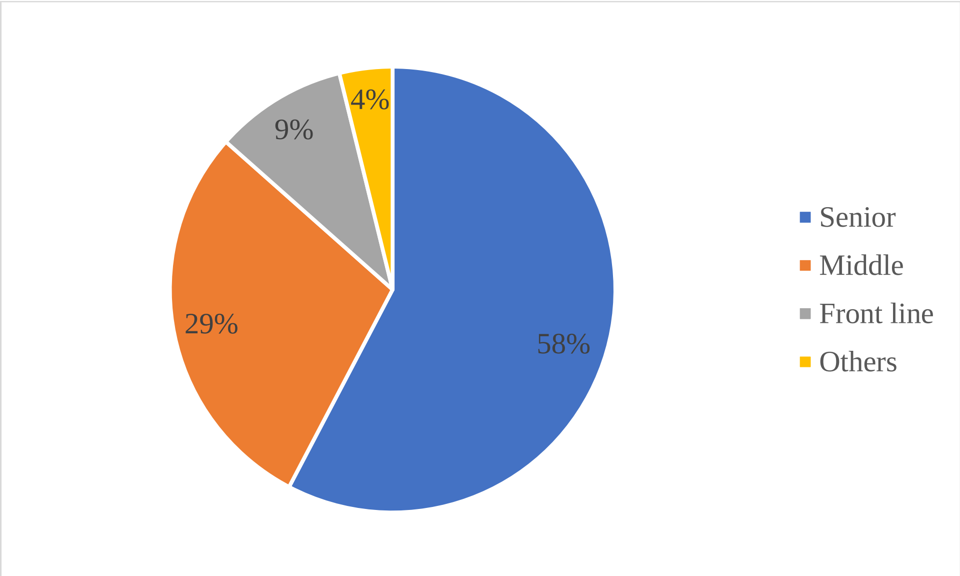

Figure 3.5 Professional titles of respondents

Figure 3.6 shows the respondents' experience in China's PPP market. More than two-thirds of the respondents have participated in this market for over four years. This experience was helpful for respondents to understand China's new stage of PPP development, which started in 2014 when the central government began to promulgate a series of administrative documents to improve the entire institutional environment for developing PPPs in China (The International Institute for Sustainable Development 2015). Still, 31% or 16 respondents had less than three years' experience in China's

PPP market. They seemed to have too little experience to give valid answers. However, revisiting the data sets revealed that 14 out of the 16 respondents were middle or senior professionals, and all of them had been involved in more than five PPP projects in China. This finding indicated that, in spite of their limited time participating in the PPP market, they accumulated enough PPP knowledge in a relatively short period through considerable hands-on experience because they possess solid industrial knowledge basis, which could definitely equip them with much stronger learning ability than laymen.

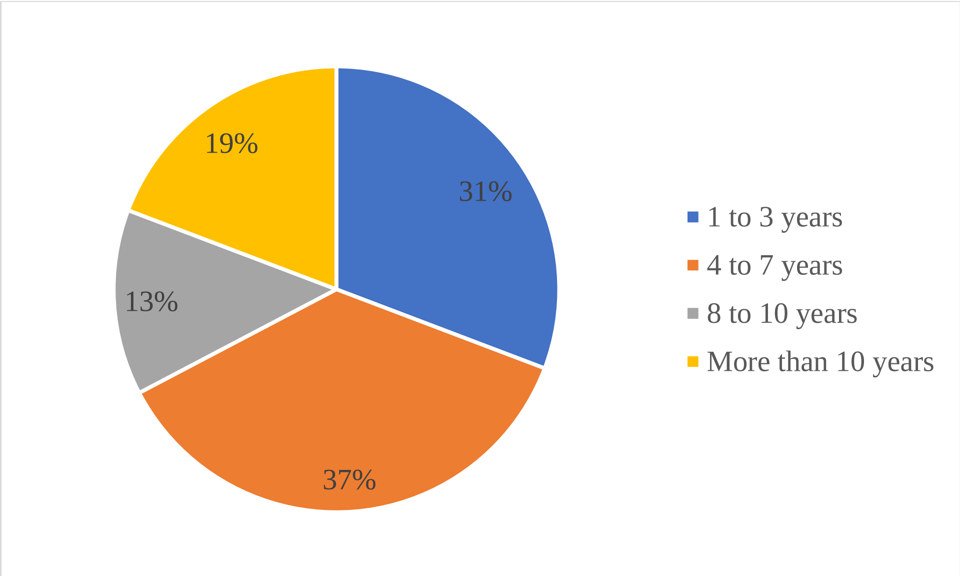

Figure 3.6 Working experience of respondents

Figure 3.7 shows that most of the respondents have handled PPP projects in multiple sectors. Among the 52 respondents, 42 were directly involved in the water sector; other relevant sectors included municipal engineering (30), transport (25) and energy (12). Although the focus of this study is China’s water sector, experience in multiple sectors could be helpful as it enabled the respondents to understand China’s PPPs in a more comprehensive way.

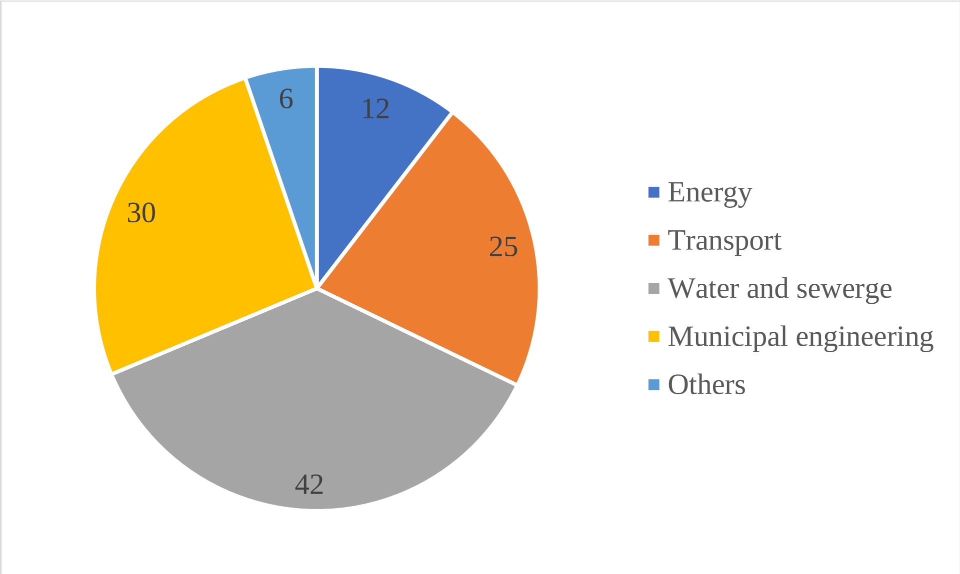

Figure 3.7 Involved sectors of respondents

3.4.6 Case study

Case study is a research method that is appropriate to solve research questions such as *what*, *why* and *how* (Yin 2014). It was adopted in this study to facilitate the pursuit of three research objectives. As shown in Figure 3.1, the process of attaining RO1 rested heavily on case study, while for the other objectives, this method was mainly used to show how the established models can be applied.

PPP projects in distinct circumstances frequently have varied characteristics, thereby considerably challenging the adoption of existing knowledge focusing on places with different contexts (Cruz et al. 2015). This feature makes the development of PPPs a highly complicated project-specific process. To facilitate PPP management under a particular circumstance, an in-depth analysis of cases under the same circumstance could be helpful (Zhang et al. 2016). Moreover, the case study is an effective way to evaluate and identify the practices and lessons drawn from frontline application and provide beneficial implications to decision makers (Chen 2009). This study focuses on the TP of China's water PPPs, which is an area with much uniqueness and limited existing research outcomes for reference (refer to Chapter 1). Consequently, the case study is an appropriate option for this study.

3.4.6.1 Case selection

Normally, comparative or multiple-case study method would be seen as robust (Zhang et al. 2016), but this study selected a single case, that is, the Chengdu No. 6 Water Plant B Project (hereinafter referred to as the Chengdu Project), as the research object for the following reasons: (1) this study aims to establish an systematic management framework for the TP of China's water PPPs; thus, cases that underwent the TP could be suitable. The Chengdu Project remains the only water PPP with that accomplishment in China; (2) the Chengdu Project is also the first official BOT project in the Chinese water sector; as mentioned earlier, many significant aspects, such as governance structure, risk allocation and payment mechanism, have been duplicated by most, if not all, subsequent water PPPs in China (Chen 2009). Therefore, this case is representative of numerous water PPPs, and insights from this could benefit the transfer management of all those projects; and (3) a trend exists in the PPP area to use a single typical project as a case to gain empirical knowledge (Cheung and Chan 2009; Shen et al. 2006; Wang et al. 1998).

3.4.6.2 Data collection and analysis

For RO1, the Chengdu Project was analysed extensively to solve two types of significant questions: *what* and *how*. For the rest of the research objectives, the Chengdu Project was mainly utilised to answer *how* questions (see Figure 3.1). To achieve the multiple research objectives, a wide range of archival data on the Chengdu Project were collected from inception to completion. These data cover the economic, financial, technical, legal and environmental aspects of the project, including the project proposal, government directives, feasibility study report, bidding documents, contract documents, financial records, safety records, QA and QC files, project completion reports, environmental appraisal reports, interim performance check reports, audit reports and media news and reports. The archival data revealed key performance data, such as TCQ of construction, volume of water produced, water quality and the project's financial condition. To cross-check the archival data and to augment any missing information that may be pertinent to the project, qualitative interviews were conducted with key stakeholders of the project. Audio records of interviews were then transformed into an interview transcript that was further processed through content analysis to extract useful information regarding the TP of the project. For more details about the use of case study, please refer to Chapters 4, 5, 6, and 7 of this thesis.

3.4.7 Analytical techniques

Analytical techniques used in this study included qualitative and quantitative analysis ones depending on the nature of the data to be processed. Qualitative analysis technique referred to content analysis, which was used to deal with, as the name suggests, qualitative data generated during the research process. Quantitative analysis techniques regarded a series of statistical analysis techniques, mainly including mean score (MS) analysis, risk significance index, one-sample t-test, Kruskal–Wallis test, Mann–Whitney test, fuzzy synthetic evaluation (FSE) and correlation analysis. These statistical techniques were employed to handle the data from the questionnaire survey responses. The Statistical Package for Social Science (SPSS) software was used for the quantitative data analysis. These techniques are introduced in detail as follows.

3.4.7.1 Content analysis

Content analysis is an intellectual process of analysing qualitative textual data recorded by a wide range of human communication media, such as interview transcripts, drawings, photographs and video, to search specific patterns or themes from the data under analysis (Babbie 2016; Mayring 2000). According to Fellows (2015), in the construction management area, content analysis can be conducted qualitatively and/or quantitatively. Qualitative content analysis focuses on deriving the meaning of the data (i.e. grouping data into categories), while the quantitative one goes further to measure, for example, the frequencies of these different categories to perform more statistical analyses and comparisons (Fellows 2015; Vaismoradi et al. 2013).

Both qualitative and quantitative content analyses were adopted in this study. As to qualitative content analysis, this study focused on the identification of themes from data generated by the literature review, case study and semi-structured interviews. On the basis of the results of qualitative content analysis, the significance of particular themes was highlighted by conducting quantitative content analysis. All textual data were thoroughly analysed and categorised, from which main themes were derived and used to facilitate the answer of particular research questions of this study (Julien 2008).

3.4.7.2 Mean score analysis

The mean scores of resulting data from respondents are widely used in PPP research to rank the items surveyed through questionnaires, such as studies on foreign exchange and revenue risks (Wang et al. 2000), interface management of PPPs (Chan et al. 2005) and CSFs (Li et al. 2005). Similarly, this analytical technique was used in this study to determine the relative criticality of the transfer process factors, significance of the transfer process factors and effectiveness of the transfer success criteria, leading to the identification of CTSFs, CTRCs and KTPIs. In addition, the mean scores of the surveyed factors also provided a basis for other statistics used for the solution of various research questions. Given the five-point scale of this study, the mean score of a certain item will be calculated by

$$MS = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{N} \tag{3-1}$$

where MS = mean score of an item; n = score given by respondents based on a five-point scale from one to five; and N = number of respondents that rated the variable.

3.4.7.3 Risk significance index

As discussed in the literature review, the significance of a PPP risk is normally measured by two dimensions, that is, risk probability and severity (Ameyaw and Chan 2015; Ke et al. 2010; Roumboutsos and Anagnostopoulos 2008). By comparing the significance of different PPP risks, practitioners can know better about the strategies in allocating, controlling and mitigating PPP risks (Heravi and Hajihosseini 2012). Obviously, numeric values that represent the significance of PPP risks should be obtained firstly before the comparison can be precisely conducted. One of the widely used techniques to quantify the significance of PPP risks was to compute the risk significance index, which combined the risk probability and risk severity in product form (Chan et al. 2015; Shrestha et al. 2017; Xu et al. 2012). Following the established precedent, this study employed the risk significance index to quantify the significance of the transfer risks. The formula for calculating the index is

$$Risk\ significance = \sqrt{risk\ probability \times risk\ severity} \tag{3-2}$$

3.4.7.4 One-sample t-test

Through a questionnaire survey, the mean scores of the three categories of factors (i.e. transfer process factors, transfer risk categories and transfer success criteria) were obtained. An easily observed fact was that the mean scores varied from factors, which raised the need to distinguish which factors were more critical. In academic terms, this need refers to the identification of factors with statistical significance. This study used one-sample t-test technique to analyse the significance of those factors, by which CTSFs, CTRGs and KTPIs can be defined.

One-sample t-test is a parametric inferential statistical technique for testing the hypothesis that a sample is drawn from a population with a known mean (Duignan 2016). In PPP studies, it was widely used to determine whether or not particular factors were significant enough to be defined as so-called CSFs. For example, Hwang et al. (2013) utilised one-sample t-test to investigate 42 risk factors of PPPs in Singapore and identified 23 critical risk factors. Liu et al. (2016) employed this technique to analyse the factors that influence the tendering process of PPPs in China and Australia and identified 14 critical factors that significantly affect the efficiency and effectiveness of the tendering process of PPPs. This method could be effective even if the sample size is as low as 30 cases (Abu-Bader 2011). Considering the objectives and sample size of this study, one-sample t-test was therefore selected as the suitable technique to identify the three abovementioned critical factors.

Following the precedent established by prior studies (Chan et al. 2017; Liu et al. 2016), the test value for determining the critical factors was set at 3, which was the mean of the five-point Likert scale, and the significance level for the test was at 0.05. The hypotheses for the one-sample t-test were

H_0: $\mu = \mu_0$

H_1: $\mu \neq \mu_0$

where μ denotes the mean score of the sample, and μ_0 denotes the test value 3. In other words, the null hypothesis means that the mean score of the factor is not statistically significant, while the alternative hypothesis means that the mean score of the factor is statistically significant.

The test statistic was t, given by

$$t = \frac{\mu - \mu_0}{\frac{\sigma_x}{\sqrt{n}}} \quad (3\text{-}3)$$

where σ_x denotes the standard deviation of the sample and *n* denotes the sample size.

3.4.7.5 Kruskal–Wallis test

A detail that can be observed from the practice is that a PPP risk's impact on multiple stakeholders may vary considerably from one to the other in a PPP project, leading to them having different attitudes to the particular risk. For example, under the 'take or pay' clause, the government needs to focus on the revenue risk, while the special purpose vehicle (SPV) does not (Bao et al. 2018; Chen 2009). As a result, comparing the attitudes of different stakeholders towards PPP risks is necessary so that practitioners could be more aware of which risks they should pay more attention to. In this study, given that transfer risk categories were newly identified, knowing whether or not the experts perceived each risk in the same way would be helpful to the better understanding of such risks.

The Kruskal–Willis test is one of the most popular statistical techniques for such a comparison. It is a non-parametric test technique that can determine whether or not three or more independent samples are significantly different. Researchers in the PPP area often use it to compare PPP risks from multiple perspectives (e.g. stakeholder or life cycle) to seek useful information for better risk management strategies. For instance, Shrestha et al. (2017) employed Kruskal–Wallis tests to analyse the difference in risk significance across the phases of the PPP life cycle in China. Similarly, this study conducted the Kruskal–Wallis test to compare the main four stakeholders (i.e. the public sector, private sector, PPP academia and PPP consultancy) of China's PPP development to understand the significance of different transfer risk categories.

According to Upton and Cook (2014), the hypotheses for the Kruskal–Wallis test are

H0: $\mu_1 = \mu_2 = \ldots = \mu_k$

H1: $\mu_i \neq \mu_j$

where μ denotes the mean score given by a sample. Hence, the null hypothesis indicates that the mean scores given by all samples are equal, while the alternative hypothesis indicates that at least one mean score given by a sample is statistically different from others. The significance level for the test was set at 0.05.

The test statistic was H, calculated by

$$H = \frac{12}{N(N+1)} \sum_{j=1}^{k} \frac{R_j^2}{n_j} - 3(N+1) \qquad (3\text{-}4)$$

where N denotes the total number of observations; n_j denotes the number of observations in the jth sample; k denotes the number of samples; and R_j denotes the sum of mean scores in the jth sample.

3.4.7.6 Mann–Whitney U-test

The Kruskal–Wallis test can unveil the transfer risk category on which multiple stakeholders of a PPP project take different views. However, it fails to specifically show which two stakeholders possess conflicting views. Learning this detail requires pairwise comparison between all the stakeholders. This study adopted Mann-Whitney

U-test to perform the pairwise comparison to complete the investigation on transfer risk categories. The Mann–Whitney U-test was selected because of its effectiveness in testing differences between two groups on a single, ordinal variable (Mann and Whitney 1947; Wilcoxon 1945). This technique was widely used in the PPP domain. For instance, Chan et al. (2011) conducted Mann–Whitney U-tests to compare risk rankings for PPPs in China among the public, private and academic sectors. Javed et al. (2014) used this technique to investigate whether any differences existed among the groups of samples to perceive the given change in negotiation strategy. Raisbeck et al. (2010) used this technique to examine the cost overruns of construction projects developed in traditional ways versus those by PPP mode. Similarly, in this study, the Mann–Whitney U-test was conducted to identify which two stakeholders have different perceptions on the significance of a transfer risk category.

In statistical terms, the hypotheses of the Mann-Whitney U-test were (McKnight and Najab 2010)

H_0: $\mu_i = \mu_j$

H_1: $\mu_i \neq \mu_j$

where μ denotes the mean score given by a sample. Hence, the null hypothesis indicates that the mean scores given by the *i*th and the *j*th samples are equal, while the alternative hypothesis indicates that the mean scores given by the two samples are statistically different. The significance level for the test was set at 0.05.

The test statistic was U, given by

$$\text{If } n_i > n_j: U = T_i - \frac{n_i(n_i+1)}{2}$$
$$\text{If } n_i < n_j: U = T_j - \frac{n_j(n_j+1)}{2} \quad (3\text{-}5)$$

where n_i denotes the size of the *i*th sample and T_i denotes the sum of mean scores in the *i*th sample.

3.4.7.7 Fuzzy synthetic evaluation

In this study, transfer success was defined with a series of multi-level transfer success criteria. To evaluate the transfer performance effectively, all the transfer success criteria have to be scrutinised. Therefore, a helpful step is to develop a synthetic evaluation method that can solve the multi-attribute and multi-level problem in the evaluation of the transfer success (Xu et al. 2010). In this study, the FSE method was used to calculate the success index of each transfer success criteria and the overall success index of the TP.

The FSE is an application of the fuzzy set theory and aims to offer a synthetic evaluation of an object relative to an objective in a fuzzy decision environment with multiple criteria (Xu et al. 2010). The fuzzy set theory is able to handle problems such as ambiguous and subjective evaluations and to quantify linguistic facets of data (Zhao et al. 2013). To develop an FSE model, three basic elements should be included (Xu et al. 2010; Zhao et al. 2016).

1. A set of criteria/factors $C = \{c_1, c_2, \ldots, c_m\}$; e.g. KTPIs identified from transfer success criteria;
2. A set of grade alternatives $E = \{e_1, e_2, \ldots, e_n\}$; e.g. 1 = extremely low; 2 = low; 3 = moderate; 4 = high; and 5 = extremely high;
3. An evaluation matrix $R = (r_{ij})_{m \times n}$ where r_{ij} denotes the degree to which the alternative e_j satisfies the criterion c_i. It is presented by the fuzzy membership function of grade alternative e_j in regard to the criterion c_i. With the above three elements, the evaluation result could be attained.

Given its advantage in dealing with fuzzy data, FSE can be used to represent the experiential knowledge of practitioners, allowing them to give judgments by natural language and then to quantify the imprecise expressions for better decision making (Ameyaw and Chan 2015). Hence, FSE has been frequently adopted by researchers to perform synthetic evaluation of objects with multi-level criteria in the construction management domain. For instance, Zhao et al. (2016) used FSE to present a model to assess the risks in green building projects in Singapore. Xu et al. (2010) developed a risk assessment model for PPP projects in China using FSE. Ameyaw and Chan (2015) investigated risks in PPP water supply projects in developing countries using FSE. Osei-Kyei and Chan (2017) employed FSE to study PPP success and proposed a pragmatic model to quantify the success of PPP projects in developing countries. The above studies demonstrated the effectiveness of the FSE as an appropriate tool to utilise the knowledge of domain experts to assess complex objects such as construction project risks and PPP success. Therefore, the FSE was adopted in this study to facilitate the performance evaluation of the transfer success.

3.4.7.8 Correlation analysis

To develop a transfer management system (i.e. DFTMS) that can concordantly combine three sub-models (i.e. GTPM, TRMS and TPES), the basis is the existence of close relationships among the three sub-models. In other words, the integrated model can make sense only if some kind of internal connections exists among the elements of the three sub-models. A notable detail is that the correlation between two factors does not imply causality; however, the strong positive correlation can be used to control the significance of one factor by reducing the other (Shrestha et al. 2017). For example, given the close correlations between the transfer process factors and transfer risk categories, the transfer risks can be controlled by managing the transfer process factors, or vice versa. In this context, correlation analysis was conducted in this study.

The strength of a relationship between two variables can be quantitatively measured by correlation coefficient (Chapman 2001). The correlation coefficient could be either negative or positive, ranging from −1 to +1. A value of 1 indicates a complete positive correlation between the two variables, and a value of −1 indicates a negative correlation. A value of 0 indicates that no correlation exists between the variables; hence, they are independent. The correlation coefficient can be calculated by (Black et al. 2017)

$$\rho_{xy} = \frac{Cov\ (x,y)}{\sqrt{Var(x)}\sqrt{Var(y)}} \tag{3-6}$$

where x and y denote two variables; ρ_{xy} denotes the correlation coefficient; *Cov* denotes covariance; and *Var* denotes variance. Normally, the significance level is 0.05.

A number of researchers have employed correlation analysis to discover the relationships between variables in the construction project management field. Wang (2014) investigated the relationships between the capital costs of PFI projects and their life cycle replacement costs using Pearson correlation coefficient. Martin (2013) used correlation analysis to investigate the relationships between the frequency of conflicts in construction projects and other variables under traditional and integrated procurement. Shrestha et al. (2017) analysed the relationships between PPP risks in China’s water sector by using Spearman’s rank correlation coefficient. Previous studies confirmed that the correlation coefficient is a useful tool to describe the relationships between variables. Hence, in this study, correlation analysis was adopted to measure the relationships between the three sub-models and in turn to provide theoretical support to their integration. In addition, the difference between the Pearson and Spearman’s correlation coefficients lies in the fact that the former deals with interval and ratio data, while the latter deal with ordinal data (Elliott and Woodward 2006). Given that the data of this study were in ordinal scale, Spearman’s rank correlation was adopted in this study.

3.5 Summary of the chapter

This chapter discussed the research methodology used in this study. The common research dialectics were introduced firstly, referring to the research purpose (exploration, description versus explanation), logical process (deductive versus inductive reasoning) and observing approach (quantitative versus qualitative approaches). The nature of a study can be known by analysing its research dialectics. Consequently, this study has an exploratory nature, simultaneously includes deductive and inductive reasoning processes, and is supported by qualitative and quantitative data. Taking into account the research nature and the characteristics of the research objectives and research questions, the main research methods and the analytical techniques were determined. In particular, six research methods (i.e. literature review, IDEF0, LFM, qualitative interview, questionnaire survey and case study) were used to construct the overall model and the three sub-models; in so doing, all the research questions were achieved. These research methods relied on a number of analytical techniques, such as content analysis, mean score analysis, risk significance index, one-sample t-test, Kruska–Wallis test, Mann–Whitney U-test, FSE and correlation analysis. The triangulation research approach of this study guaranteed the reliability and validity of the research outcomes. The next chapter will introduce how the first research outcome, the transfer process model GTPM, was achieved, and the findings will attain the first research objective RO1.

CHAPTER 4 MODELLING THE TRANSFER PROCESS USING IDEF0 METHOD[4]

4.1 Introduction

This chapter focuses on the construction of the transfer process model, GTPM, by which the RO1 is attended. Section 4.2 presents the design of the entire modelling process and the triangulation method used during the process. Section 4.3 reports the as-is model that represents the status quo of the transfer management regime in China. On the basis of the as-is model, existing challenges and according solutions are discussed in Section 4.4, which leads to the to-be model for the TP of the water PPPs in China. In Section 4.5, the evaluation results of the questionnaire survey on the process factors of the GTPM are reported, from which the critical transfer success factors (CTSFs) emerge.

4.2 Modelling process

A typical way to use IDEF0 to model a complex process or system includes three steps (Bevilacqua et al. 2012; Climent et al. 2009): (1) designing the "as-is" model; (2) identifying challenges; and (3) designing the "to-be" model (see Figure 4.1). This pattern was followed by this study. The methodology is a three-part, utilizing literature review, IDEF0, and case study.

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[4] This chapter has been accepted for publication in **Bao, F.**, Chen, C., Chan, A. P. C., Martek, I., and Shrestha, A. (2018). Dynamic framework transfer model for Public–Private Partnerships: Lessons from a China water sector case study. *Engineering, Construction and Architectural Management*.

As a foundation for modelling, 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 modelling. Those elements were then processed using IDEF0 which was selected as the modelling tool, and which is explained more fully in following sub-sections.

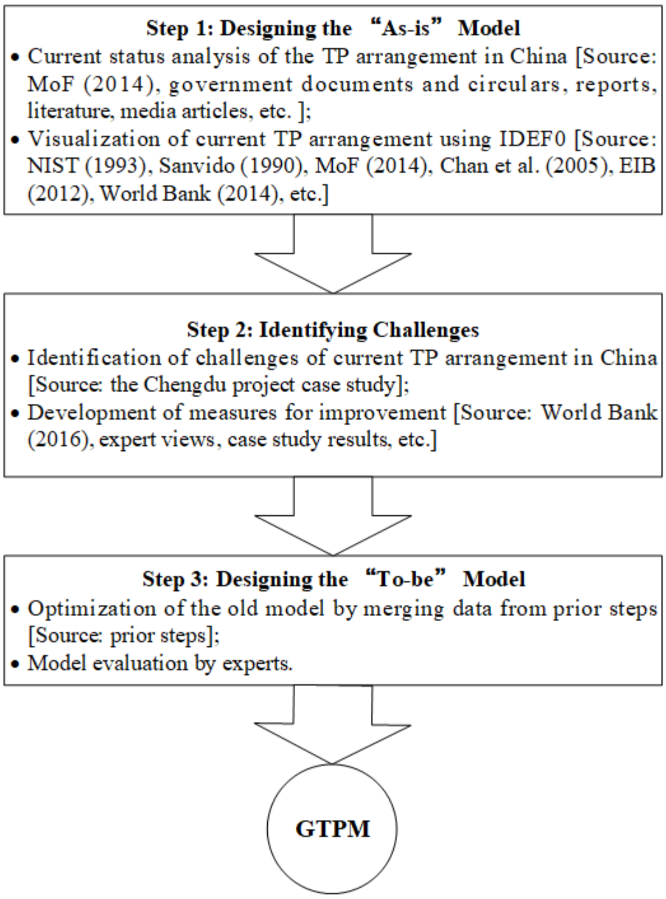


Figure 4.1 Process of modelling the TP

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) remodelled 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 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 (Chan et al. 2015; Chan et al. 2005; Chen 2009; Chen and Doloi 2008). 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 local waterworks company (state-owned), one from Veolia (one of the investors), and four from the project company. 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.

In the third step, 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. Findings from the prior steps were then 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.

4.3 Background of the Chengdu Project

The Chengdu Project lies in Chengdu city, Sichuan province, China. By the end of the 1990s, the daily demand for water in Chengdu had risen to 1.3 million m^3, yet water actual supply could only provide 1.053 million m^3. This left a significant shortfall of some 250,000 m^3 (People's Daily Online 2000). The situation was made worse when contamination further reduced water production of existing Chengdu plants (Chen and Doloi 2008). To assuage the water crisis, the Chengdu municipal government (CMG) initiated a new water plant development program that proposed several projects. Of these, the Chengdu Project was the only one that adopted a PPP model. It was initiated in 1993 as a traditional water project but was hastily suspended due to financing difficulties. The project was then revitalized in 1996 under the "National Experimental BOT Program," initiated by the central government. An international open bid was held that year and ultimately, Compagnie Générale des Eaux Group (currently Veolia Group), France, and the Marubeni Corporation, Japan were granted the concession. Subsequently, the Chengdu Générale des Eaux-Marubeni Waterworks Co., Ltd. (CGMW) was established as the project company, and it began immediate work on the project. The concession period was to be 18 years, including 2.5 years for construction, with 17.5 years for operation. Actual commercial operation began in 2001, with treated water was delivered to the Chengdu Waterworks General Company (CWGC), a local state-owned utility. Upon expiry of the 18-year concession period, the plant transferred to the CMG, with transfer having taken place on 10 August 2017.

Table 4.1 Summary 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 1,030-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 + 74.5 as debt)
Contract term (years)	18
Sponsors	Veolia (contributing 60% of equity) Marubeni (contributing 40% of equity)
Lenders	ADB (contributing $48 million of debt) EIB (contributing $26.5 million of debt)

The Chengdu Project has nine key identifiable stakeholders; one more than the eight identified by Liu et al. (2015). They are: public client, shareholders, creditors, general concession contractor, subcontractors, suppliers, employees, and end-users. The additional stakeholder here is the Xingrong Group, which is a state-owned enterprise that was designated by CMG as the transferee taking over the project after transfer. The complete list of the stakeholders of the Chengdu Project is presented in Table 4.2.

Table 4.2 Stakeholders of the Chengdu No. 6 Water Plant B Project

Public client	CMG
	CWGC
Shareholders	Veolia Group
	Marubeni Corporation
Creditors	ADB
	EIB
General concession contractor	CGMW
Subcontractors	Campenon Bernard-SGE
	Omnium de Traitements et de Valorisation
	SADE Compagnie Generale de Travaux d'Hydraulique
Suppliers	50 percent local companies
Employees	All Chinese
End-users	Residents in Chengdu
Transferee	Xingrong Group

As the first official PPP project undertaken in China's water sector, the Chengdu Project was expected to provide an exemplary precedent for the future development of the Chinese water market, and in so doing, attract further international and private investment (Chen and Doloi 2008). As the first project of its kind, it also attracted the attention of industry and academia, alike. Notably, Chen (2009) comprehensively reviewed the development process of the Chengdu Project, including contract structure, and the risk allocation and roles of the main stakeholders. Six factors were identified as impacting the re-applicability of the project. These were: (1) the flagship status of the project; (2) that local government bore relatively more of the risks and responsibilities; (3) that lenders participated in the project development process; (4) the localization of material procurement for construction and maintenance; (5) the adoption of reliable and economical technology; and (6) the complicated approval procedure and time-consuming development process. Chen concluded that the Chengdu Project could provide an important benchmark but could not be adopted as a template for future water projects.

4.4 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 4.2). The second level presents the TP in a more detailed way by breaking it down into several steps linked by 18 process factors, as shown in the A0 diagram (Figure 4.3). The sources of process factors are shown in Table 4.3.

Table 4.3 Process 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	×					×			
	Special purpose vehicle	×				×	×			
	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						×	×		

4.4.1 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 process factors connecting it to the outside (Figure 4.2). 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 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.

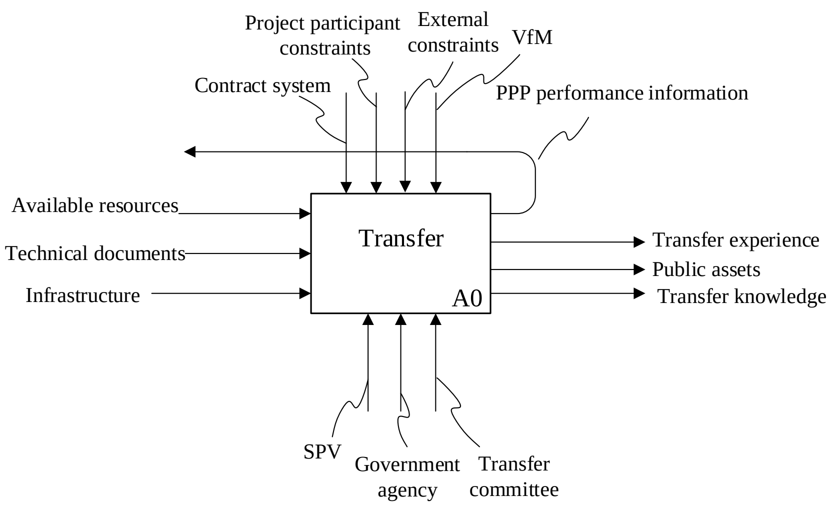


Figure 4.2 A-0 level of the as-is model

4.4.2 A0 level

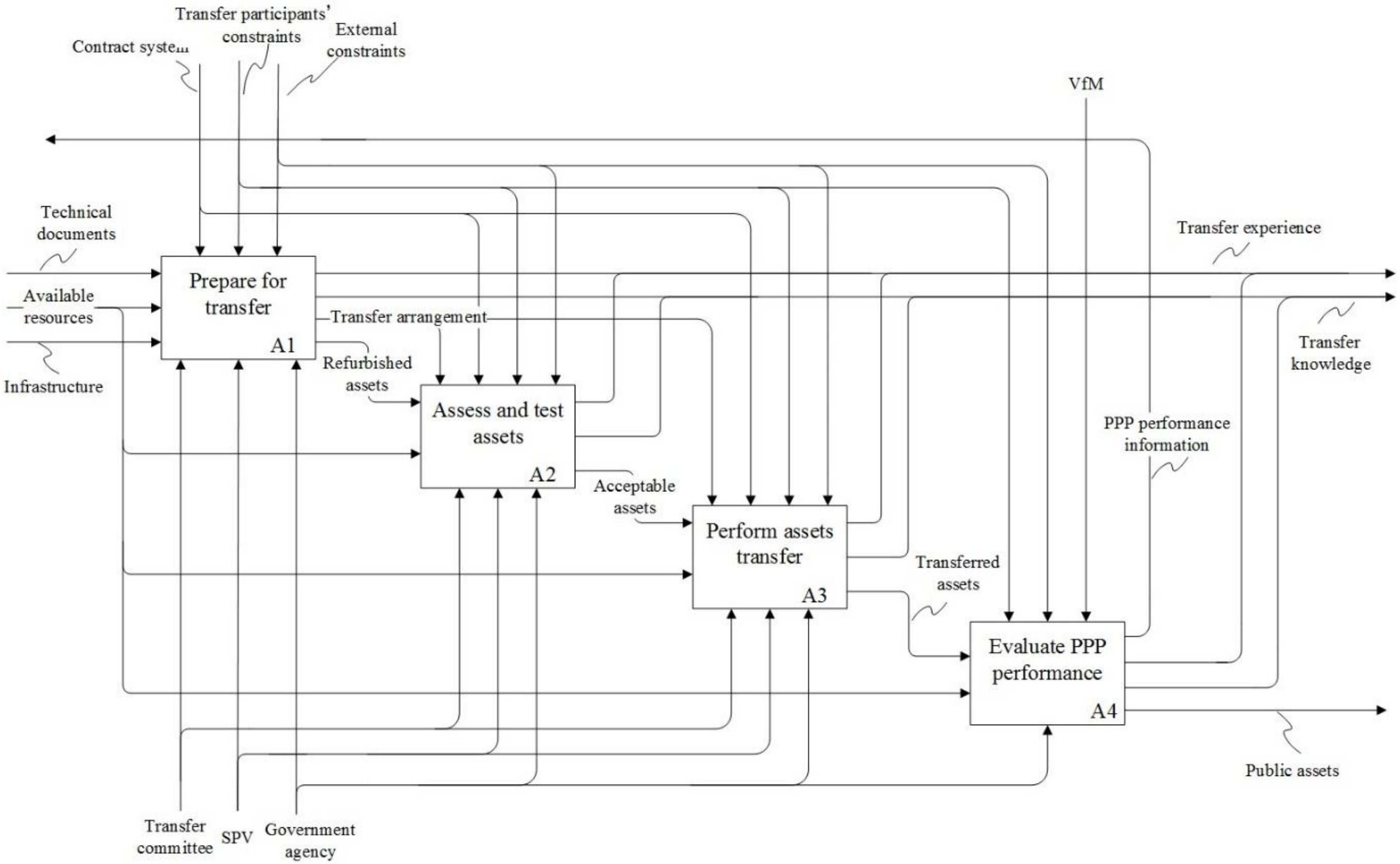
The second level (i.e. the A0 level) is the decomposition of transfer, consisting of four steps (MoF 2014) shown in Figure 4.3. These four steps are:

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.

Figure 4.3 A0 level of the as-is model



4.4.3 Analysis of process factors

There are 18 process 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 process 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 4.3, as well as represented by arrows in Figure 4. The definitions of the process factors are based on their sources (see Table 4.1), but necessarily rephrased to be in line with the characteristics of the TP.

4.4.3.1 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 4.3 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 fulfil 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.

4.4.3.2 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 4.3 and Figure 4.3). 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 4.3). 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** regard 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 tend 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.

4.4.3.3 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 4.3). 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.

4.4.3.4 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).

4.5 Optimizing Transfer: the "To-be" Model

The "as-is" model that comprises a two-level hierarchical structure (Figure 4.2 and Figure 4.3) 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 4.4.

Table 4.4 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 regards the progress of the TP.	● To take good care of all the factors of the entire model before they are used.

4.5.1 Challenges for China's current TP management

4.5.1.1 Disordered transfer preparation process

As shown in Figure 4.3, 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 "one process (or step)" 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.

4.5.1.2 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.

4.5.1.3 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.

4.5.1.4 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.

4.5.1.5 Impracticality of evaluating PPP lifecycle performance

Performance evaluation is one of the significant activities 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 4.3).

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.

4.5.1.6 Low quality of process factors in the as-is model

The process 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 process factors matters to the success of a process. As for the transfer process of the water PPPs in China, the low quality of some process 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 process factors (Table 4.1) 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 analysed, 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. Moreover, challenges caused by low quality of process 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.

4.5.2 The "to-be" model: GTPM

Compared to the as-is model, the GTPM includes a total of five steps and 23 process factors (Figure 4.4). Relevant steps and process factors that were involved in the model modification are summarized in Table 4.5, and the detailed discussion follows.

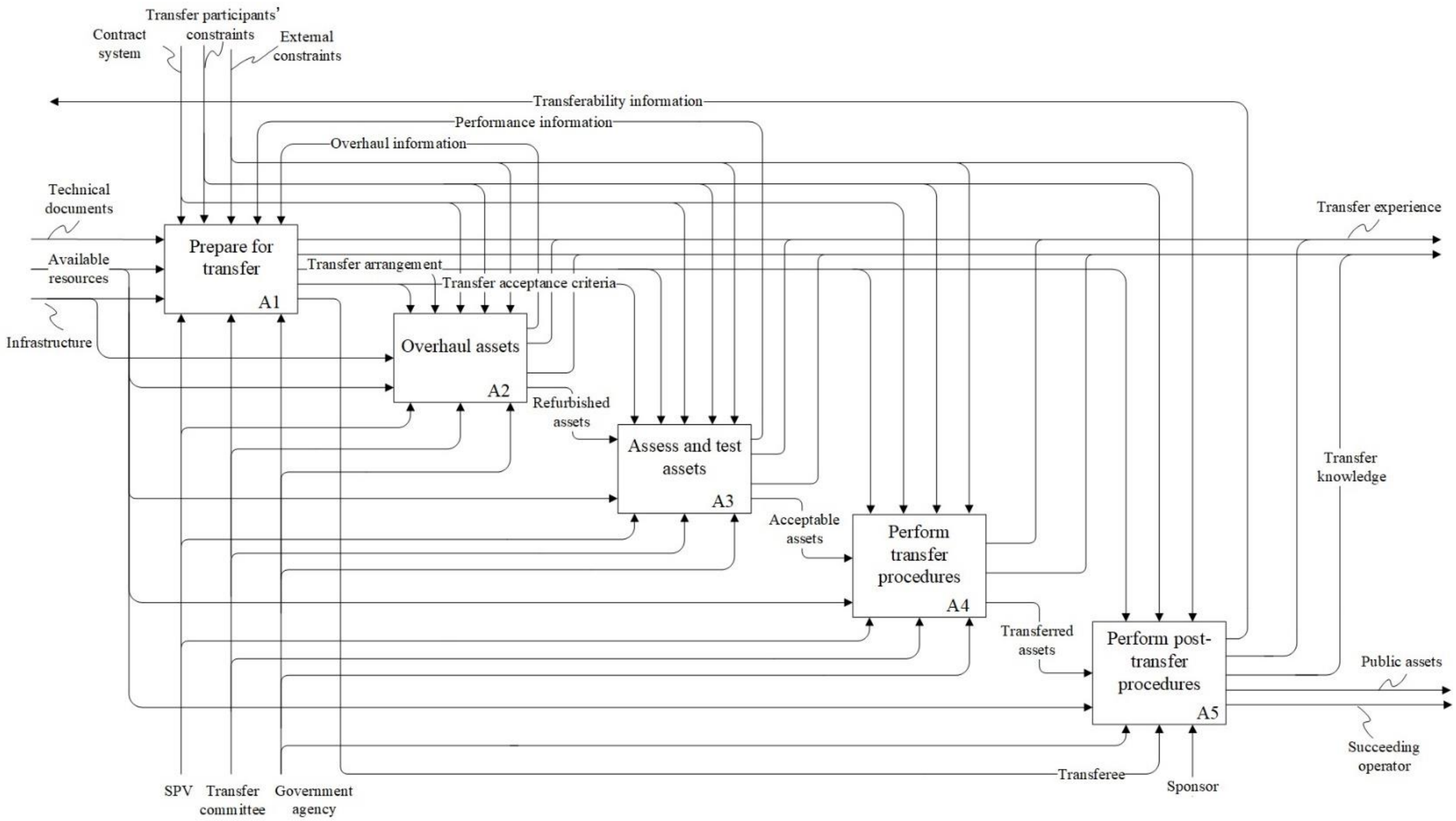


Figure 4.4 Transfer (A0): to-be model

Table 4.5 Steps and process factors related to model upgrade

Steps/Process 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 produced 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 to 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.

4.5.2.1 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.

4.5.2.2 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 4.5, 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 4.5 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 4.5) 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.

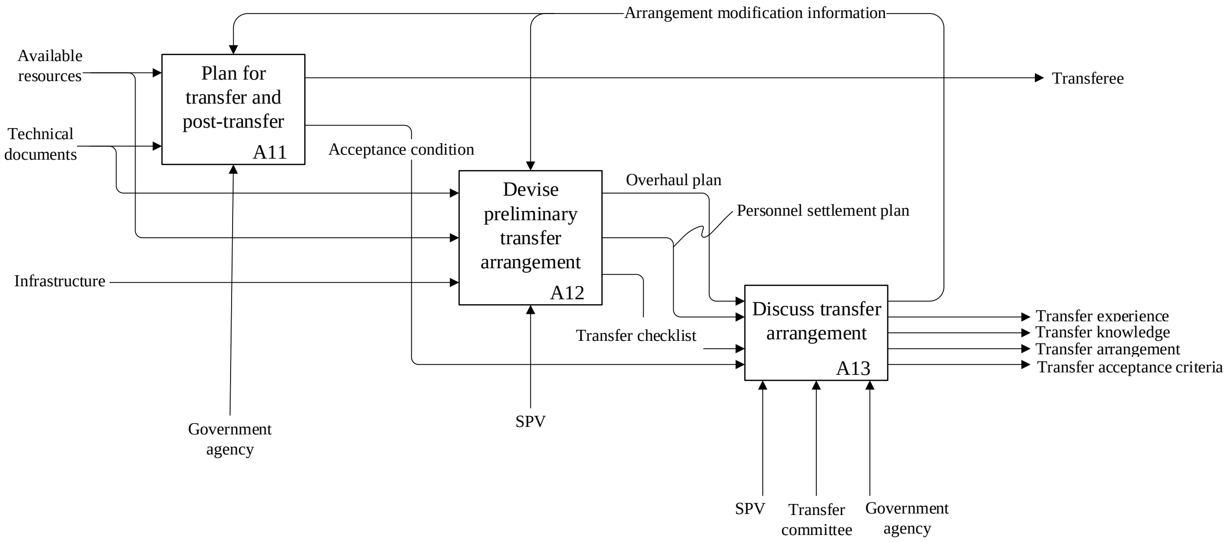


Figure 4.5 Prepare for transfer (A1): to-be model

4.5.2.3 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.

4.5.2.4 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.

4.5.2.5 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 4.3.

4.5.2.6 Improving the quality of the process factors

A total of 23 process factors are finally identified in the GTPM (refer to Tables 4.3 and 4.5 for detail). Analysis of the case showed that transfer success is closely related to the quality of these process 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.

4.6 Critical transfer success factors

The completeness of the five key steps and the relative criticality of the 23 process factors identified in the GTPM were investigated by the questionnaire survey. In general, 50 out of 52 expert respondents deemed that the five key steps were complete and indispensable to describe the entire process of the TP of China's water PPPs; The other two argued that, although the proposed five steps were necessary, some missing steps remained, such as new staff training, performance test and life cycle performance evaluation. In fact, the previous case study analysed the criticality of these activities for a successful transfer and consequently either defined them as outputs under certain steps (e.g. personnel settlement plan under step A1 of the to-be model) or proved them impractical to realise within the TP (e.g. life cycle performance evaluation). Therefore, the completeness and necessity of the five key steps were successfully confirmed by the survey results. The following parts mainly focus on the relative criticality of the 23 process factors and discuss the identified CTSFs accordingly.

4.6.1 Overview of data analysis results

Mean score analysis of the total survey response data determined the mean criticality values for the 23 process factors ranging from 3.94 to 3.12. Table 4.4 shows that seven factors' mean scores were over 3.9, 13 factors scored between 3.5 to 3.9 and the remaining three factors showed mean scores between 3.12 to 3.5. Of the seven factors with scores over 3.9, the top five shared the same score of 3.94. Many process factors sharing the same first ranking was a rare situation in past PPP studies. In fact, the difference among the top 11 factors, which are in grey background in the first two columns of Table 4.4, was slight, less than 0.17, indicating that the criticalities of the process factors of GTPM were similar to each other according to the evaluation of the expert respondents.

However, some interesting distinctions of the evaluations from different stakeholder types can be observed. As shown in Figure 4.6, the respondents from the academic community generally gave the highest evaluation to the criticality of the process factors (see the uppermost line of Figure 4.6), while the consultancy representatives gave the lowest (see the downmost line of the figure). The remaining respondents, most from the public and private sectors, provided evaluations close to the overall average (see the heavy line in the middle). Furthermore, looking at the five factors with the highest criticality scores under each of the four stakeholders (items with grey background under the four stakeholders in Table 4.4), most of the factors from the academia, public sector and private sector had scores more than 4.0, whereas all the five factors from the consultancy representatives scored below 4.0. Moreover, in terms of the specific name lists of five highest-criticality factors chosen by different stakeholders, the results from the academia and public sector were almost the same (e.g. SF6, SF7, SF12 and SF20), while the results from the private sector and consultancy roughly resembled each other (e.g. SF1, SF11, SF12 and SF17), as shown by factors with a grey background under each respondent type in Table 4.4.

Table 4.6 Mean scores and rankings for the criticality of process factors of the transfer process

	All respondents			**Academia**			**Public sector**			**Private sector**			**Consultancy**		
	N	**Mean**	**Rank**	**N**	**Mean**	**Rank**	**N**	**Mean**	**Rank**	**N**	**Mean**	**Rank**	**N**	**Mean**	**Rank**
Process control factors		*3.63*			*3.92*			*3.52*			*3.79*			*3.17*	
SF1: Contract system	52	3.94	1	11	3.91	17	9	3.78	10	18	4.11	4	11	3.82	1
SF2: Transfer committee	52	3.52	19	11	3.91	15	9	3.22	19	18	3.61	20	11	3.18	15
SF3: SPV	52	3.63	16	11	4.00	9	9	3.44	16	18	3.94	11	11	3.09	19
SF4: Government agency	52	3.71	14	11	3.91	16	9	3.89	7	18	3.83	17	11	3.18	16
SF5: Available resources	52	3.12	23	11	3.64	20	9	2.78	23	18	3.22	23	11	2.82	23
SF6: Infrastructure	52	3.94	1	11	4.27	2	9	4.22	1	18	4.00	7	11	3.18	14
SF7: Technical documents	52	3.90	7	11	4.36	1	9	4.00	3	18	3.89	15	11	3.36	8
SF8: Transfer experience	52	3.58	17	11	3.55	21	9	3.22	20	18	4.06	6	11	3.09	17
SF9: Sponsor	52	3.29	22	11	3.73	19	9	3.11	21	18	3.44	22	11	2.82	22
Product factors		*3.79*			*4.06*			*3.67*			*3.94*			*3.37*	
SF10: Refurbished assets	52	3.69	15	11	4.18	6	9	3.78	8	18	3.89	12	11	2.91	21
SF11: Acceptable assets	52	3.92	6	11	4.09	8	9	3.78	9	18	4.11	3	11	3.55	3
SF12: Transferred assets	52	3.94	1	11	4.27	4	9	3.89	5	18	4.06	5	11	3.45	5
SF13: Public assets	52	3.58	17	11	3.82	18	9	3.78	11	18	3.50	21	11	3.36	10
SF14: Transfer arrangement	52	3.77	10	11	4.18	5	9	3.56	13	18	3.89	14	11	3.55	4
SF15: Transfer knowledge	52	3.73	13	11	4.00	13	9	3.67	12	18	3.89	13	11	3.09	18
SF16: Transferee	52	3.77	10	11	4.00	12	9	3.44	17	18	4.00	10	11	3.36	7
SF17: Transfer acceptance criteria	52	3.94	1	11	4.09	7	9	3.56	14	18	4.17	1	11	3.73	2
SF18: Succeeding operator	52	3.75	12	11	3.91	14	9	3.56	15	18	4.00	9	11	3.36	6
Feedback factors		*3.87*			*4.09*			*4.00*			*4.00*			*3.30*	
SF19: Overhaul information	52	3.94	1	11	4.00	10	9	4.22	2	18	4.17	2	11	3.27	11
SF20: Performance information	52	3.88	8	11	4.27	3	9	3.89	4	18	4.00	8	11	3.27	12
SF21: Transferability information	52	3.79	9	11	4.00	11	9	3.89	6	18	3.83	16	11	3.36	9
Constraint factors		*3.45*			*3.50*			*3.22*			*3.81*			*3.14*	
SF22: Transfer participants' constraints	52	3.50	20	11	3.55	22	9	3.33	18	18	3.78	19	11	3.27	13
SF23: External constraints	52	3.40	21	11	3.45	23	9	3.11	22	18	3.83	18	11	3.00	20

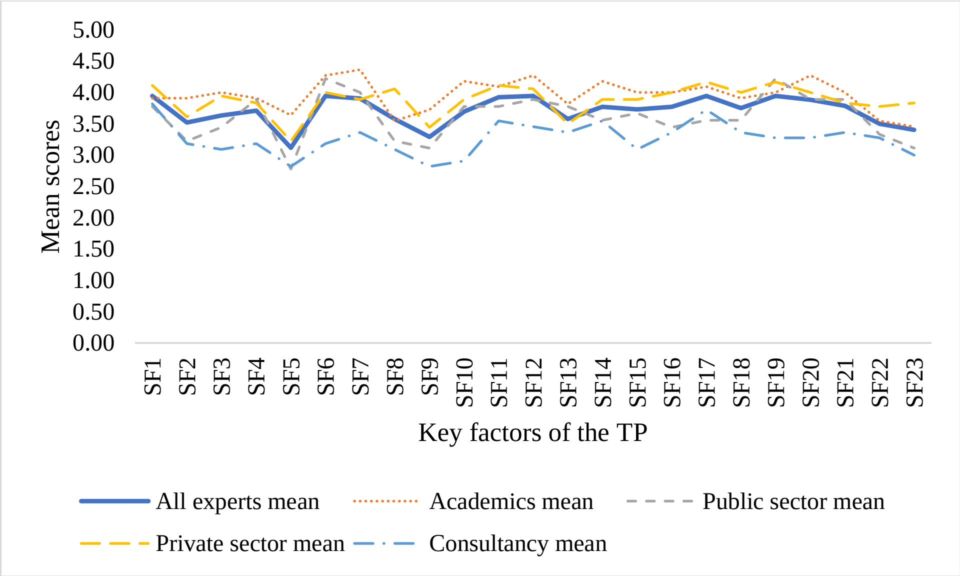


Figure 4.6 Line graph of the mean scores of the criticality of GTPM factors

4.6.2 Identification of CTSFs

One-sample t-test was conducted to examine if the overall means of the process factors of GTPM were statistically significant, at a 95% level of confidence with a 0.05 p-value and against a test value of 3.00, through which the CTSFs were identified. The null hypothesis, H_0, is that 'the mean score is not statistically significant', whereas the alternative hypothesis, H_1, is that 'the MS is statistically significant'. The null hypothesis should be rejected if the p-value is less than 0.05. In other words, if the $p < 0.05$, then the factor has significant criticality to the success of the transfer process and consequently can be defined as CTSF. Table 4.5 shows the summary of the test results on the relative criticality of the process factors of GTPM. As can be seen from the results, all p-values (shown as Sig. [two-tailed] in Table 4.5) produced by the one-sample t-test technique are less than 0.05 except the 'available resources' that have a significance level at 0.411, greater than 0.05. This result indicates that all process factors of the GTPM except ‘available resources’ are statistically critical to the success of the transfer process, implying that 22 CTSFs are identified.

Table 4.7 Summary of the test result for the criticality of the process factors of GTPM

Key factor	N	Mean	Rank	t	df	Sig. (2-tailed)
SF1	52	3.94	3	6.122	51	0.000
SF2	52	3.52	19	3.987	51	0.000
SF3	52	3.63	16	4.217	51	0.000
SF4	52	3.71	14	5.252	51	0.000
SF5	52	3.12	23	0.830	51	0.411*
SF6	52	3.94	5	6.807	51	0.000
SF7	52	3.90	7	6.824	51	0.000
SF8	52	3.58	18	4.093	51	0.000
SF9	52	3.29	22	2.174	51	0.034
SF10	52	3.69	15	4.989	51	0.000
SF11	52	3.92	6	7.032	51	0.000
SF12	52	3.94	1	6.945	51	0.000
SF13	52	3.58	17	3.946	51	0.000
SF14	52	3.77	11	5.890	51	0.000
SF15	52	3.73	13	5.019	51	0.000
SF16	52	3.77	10	5.646	51	0.000
SF17	52	3.94	2	7.091	51	0.000
SF18	52	3.75	12	5.173	51	0.000
SF19	52	3.94	4	7.248	51	0.000
SF20	52	3.88	8	6.623	51	0.000
SF21	52	3.79	9	6.367	51	0.000
SF22	52	3.50	20	3.838	51	0.000
SF23	52	3.40	21	2.589	51	0.013

Note: * The one-sample t-test result is insignificant.

4.6.3 Discussion

As stated earlier, the 22 identified CTSFs belong to four factor groups, namely, process control, product, feedback and constraint factors. By calculating the average of the mean scores of the factors in a particular factor group, one could acquire a mean of this group, which can indicate the relative criticality of the factor group (Ozorhon and Karahan 2017). In this study, the data analysis result shows that the feedback factor group ranked first with a mean of 3.87, followed by product factors (3.79), process control factors (3.63) and constraint factors (3.45) (Table 4.4). Considering the relatively low criticality of the constraint factors (probably because the TP is comparatively shorter than the pre-TP phases, offering few odds for the lack of transfer participants and bad external conditions), the rest of this section merely discusses the other three groups and relevant CTSFs in detail.

4.6.3.1 Feedback factors

The feedback factors, including SF19 overhaul information (3.94), SF20 performance information (3.88) and SF21 transferability information (3.79), appear as the most critical type of factors that affect the success of the TP according to the experts' assessment. This finding is contrary to the findings of Chan et al. (2005), in which the feedback information ranked at the end of all factors composing the entire process of developing PPP projects in China or CBGPM. The contradiction may reveal some unique features or challenges in managing TP, which are not encountered in dealing with other phases of PLC. Unlike the pre-TP phases, such as project identification and preparation, in which multiple stakeholders act proactively for the mutual goal—to having the project development completed—the TP happens at the end of the longest operational phase in which the project is actually controlled by the SPV and therefore, the government knows little about the actual situation of the project. In this case, the information generated during the TP stands out as the most significant reference for the government to re-learn the actual situation of the project to be transferred. However, as discussed previously, according to the TCE theory (Rindfleisch and Heide 1997; Williamson 1981; Williamson 1999), effectively evaluating whether the feedback information is in line with the actual performance of the SPV is not easy for the government. Specifically, the overhaul information indicates performance of the overhaul work; however, the difficulty in evaluating the overhaul information still remains as the technical criteria for performing overhaul is still missing. This deficiency can be confirmed by the prior case study of the Chengdu Project. To evaluate the performance information, sound transfer acceptance criteria should be established (Bao et al. 2018), yet such criteria are not. Obtaining transferability information seems even more arduous given the limited number of water PPPs that have undergone the TP.

4.6.3.2 Product factors

The product factors are the second most critical factor group. Out of the total nine factors, five seemed more critical, with each one being ranked among the top five by at least two stakeholders (Table 4.4). These five factors were SF12 transferred assets (3.94), SF17 transfer acceptance criteria (3.94), SF11 acceptable assets (3.92), SF14 transfer arrangement (3.77) and SF16 transferee (3.77). This result also differs from the situation of the pre-TP phases. According to Chan et al. (2005), the product factors (i.e. output factors in their work) of the CBGPM mainly refer to the outcomes of the project operation, such as products/services, revenue and environmental impact. Nonetheless, the findings of this study show that the TP shifts the focus to a batch of new product factors that are exclusively produced in this phase. Given the newness of these product factors in the TP, both the industry and the academia have little knowledge and experience in dealing with them and hence have experienced much trouble in guaranteeing the quality of these product factors (Yuan et al. 2015), which could also be seen from the Chengdu Project case study. In particular, the experts deemed the transferred assets and transfer acceptance criteria as the most critical product factors with the highest mean score of all the 22 factors. The transferred assets are critical to the success of the TP given that their good condition is the basis for the continuing provision of products or services in the post-TP (World Bank 2016), whilst the transfer acceptance criteria are also critical because they determine whether the assets are acceptable for transfer. Similarly, the acceptable assets, which are assets overhauled and tested as acceptable, are also deemed critical because their quality is in fact the quality of the transferred assets. The mean scores of the transfer arrangement and transferee are close, implying that the entire TP needs to be arranged and the transferee needs to be identified in advance, which was also clearly indicated by the Chengdu Project case study.

4.6.3.3 Process control factors

The process control factors ranked third in terms of relative criticality, showing that some factors of this group did not seem as critical as the ones in the former two groups. However, the analysis result still displayed some unique features of the TP, which differ from the phases prior to the TP. Three factors, SF1 contract system, SF6 infrastructure, and SF7 technical documents, were given high scores of 3.94, 3.94 and 3.90, respectively (Table 4.4). These factors were deemed significant factors regardless of the PLC phases. The contract system plays an unquestionably essential role in governing PPPs because it integrates all possible important aspects, such as public interest, commercial benefit and community acceptance through contractual terms and conditions that articulate the expectations of everyone concerned during the PLC (Clifton and Duffield 2006). Infrastructure refers to the physical assets of the project. As the main object where the investment goes into and the basis for production, the criticality of infrastructure is without question. Technical documents regard the data assets of PPPs, whose criticality is mainly represented by the reference value facilitating the assessment of the performance during the PLC (ADB 2008). For the process control factors of the phases before the TP, the participants (e.g. public sector, bidders and private sector) were considered as interface factors with the top criticality because their versatile capacities are important to overcome all possible obstacles for maintaining long-term cooperation (Chan et al. 2005). By contrast, when a water PPP project enters the TP, the capacities of the participants in maintaining the cooperation are fully confirmed and are thus no longer problems that restrict the management of TP. Instead, in the TP, problems caused by bounded rationality, opportunism, asset specificity and uncertainty, that is, the TCE issues, emerged as the main issues. Therefore, factors referring to participants such as SPV, sponsor, government agency and transfer committee were given relatively low scores by the experts. However, the author would like to emphasise that this conclusion should be accepted with caution because it was based on the precondition that all participants are equally viewed as contracting parties with varied managerial tasks in providing product/service for end-users. However, aside from being a contracting party, the government agency in a PPP also represents the public and has a major responsibility to protect public interests (Wu et al. 2016). Especially in the TP, the government should pay more attention to protecting the public interests (e.g. public assets) because the private sector tends to opportunistically use them as a last chance to pursue self-interest (World Bank 2016).

4.7 Summary of the chapter

This chapter reported in detail the process of developing the GTPM, which was designed to mitigate the adaptation issue in the TP (RO1). The entire modelling process mainly comprised three steps, that is, to design the as-is model; to identify challenges; and to design the to-be model. With the use of IDEF0 language and an extensive literature review, the as-is model was developed to simulate the status quo of the transfer management regime in China. As shown in the as-is model, the PPP authority of China suggested a four-step procedure connected with 18 transfer process factors that were grouped as process control, product, feedback and constraint factors. However, the case study on the Chengdu Project clearly revealed six challenges in the as-is model under the current condition, namely, disordered transfer preparation process, problem in making the overhaul plan, late determination of the transferee, lacking emphasis on personnel settlement, impracticality of evaluating the PPP life cycle performance, and the low quality of the transfer process factors. On the basis of a continuous observation of the TP of the Chengdu Project, the measures for tackling the current challenges were proposed and translated into the to-be model, GTPM, by IDEF0. Unlike the as-is model, the GTPM proposed an upgraded transfer process with five steps and 23 process factors. These steps and factors were further evaluated by experts of water PPPs in China through a questionnaire survey. From an analysis of the survey data, 22 out of the 23 factors were identified as statistically critical to the success of the TP and thus defined as CTSFs. Unlike the pre-TPs that normally emphasised factors that belong to the process control and product factor groups, the TP paid special attention to the feedback factor group followed by the product, process control, and constraint factor groups due to its unique features. The results can help practitioners adopt appropriate strategies when managing the TP due to the identified uniqueness of this phase. The next chapter will analyse the risks in the TP, and the results will fulfil the second research objective RO2.

CHAPTER 5 MANAGING THE TRANSFER RISKS

5.1 Introduction

This chapter examines the risks in the TP to achieve the second research objective RO2. Section 5.2 reviews past studies on general risks of PPP infrastructure projects and risks specifically in water PPPs of China. Section 5.3 reports the two ways—literature review and qualitative interview—to form the initial transfer risk checklist of water PPPs in China. In Section 5.4, the results of the data analysis with regard to the identified initial transfer risks are reported. Consequently, the CTRCs are identified and discussed in detail. Aside from risk identification and evaluation, managerial implications for mitigating the transfer risks are proposed in Section 5.5. In Section 5.6, the findings of the study on transfer risks are integrated as the sub-model TRMS.

5.2 Risks in PPPs: a literature review

One of the main reasons for adopting the PPP mode to develop infrastructure projects is its effectiveness to share various risks between the public and private sectors (Ham and Koppenjan 2001). For a complex PPP project, risks can never be completely avoided but can be efficiently managed (World Bank 2014). Therefore, how to deal with risks has long been a hot topic in the PPP domain. In Chapter 2, some literature on PPP risks is analysed from a life cycle perspective, while in this chapter, the focus is narrowed down to China's water sector. Specifically, the following two subsections (i.e. 5.2.1 and 5.2.2) present a brief literature review on general PPP risks and risks related to China's water sector, by which the basis for identifying transfer risks of water PPPs in China is established.

5.2.1 General risks of PPP infrastructure projects

The list of general risk factors of PPPs has been changing continuously as research time and sectors change. Between the end of the 1990s and the beginning of the 2000s, PPPs were mainly applied in a limited number of areas. At this pilot stage, research on risk of PPPs was of an exploratory nature, using typical case study as the major method. Wahdan (1995) identified eight categories of risks with the case of the Prince Edward Island Fixed Link Project in Canada. Zhang et al. (1998) discussed 12 risks in the Yan'an Donglu Second Tunnel project in Shanghai, China. Grimsey (2002) examined Almond Valley and Seafield waste water treatment project in Scotland to show how nine common risks of PPP infrastructure projects can be evaluated. Then, as PPPs became increasingly popular around the globe, the lists of PPP risks evolved and became longer and varied. Li et al. (2005) reviewed a number of PPP projects and risk management literature, coming up with a total of 46 risk factors in relation to PPPs in the context of the UK. By adopting the risk list developed by Li as the benchmark, Ke et al. (2010) compared risk allocation preference in China and Hong Kong. Ameyaw and Chan (2013) referred to the literature and cases to identify 40 risk factors that influence water PPPs in Ghana. Alkaf and Karim (2011) mapped past research relevant to PPP risks and revealed a surprising 81 risk factors.

The existing literature, as presented above, proved the distinction of PPP risk factors in different jurisdictions and sectors. With such distinction, the process of identifying PPP risks in a certain sector of a country, for example, China's water sector for this study, should naturally take into consideration the uniqueness of the particular national and industrial conditions (Chan et al. 2015).

5.2.2 Risks of water PPPs in China

As previously mentioned, water PPPs in China constitute a significant proportion of the total PPP infrastructure projects. However, the experience of PPPs in China's water sector has exhibited many problems, reminding us that more attention should be paid to the identification of different risks in this sector (Zhong et al. 2008). Indeed, a few academic researchers have realised the urgent demand for handling PPP risks in China's water sector and have made great contributions to this issue through multiple research methods. Some typical research studies are reviewed as follows.

Chen (2009) conducted an in-depth case study of the Chengdu Project, which had been commercially run for several years at that time. In his work, five risk categories, namely, political, construction, operating, market and revenue, and financial risks, were identified as the main risks of the Chengdu Project. Under each risk category, more detailed risk factors were identified and allocated between the public and private sectors based on the arrangement of the concession agreement. Although useful information could be obtained from the project, he claimed that the risk allocation of the Chengdu Project may not yet be the optimum due to the compromise of the government. Xu et al. (2011) adopted case study to analyse the risks of the water PPPs in China. Unlike Chen (2009) who focused on a crucial case, they studied nine cases from eight provinces of China, thereby improving the generality and diversity of their findings. Their analysis identified 11 critical risks that influence the performance of China's water PPPs: (1) political risk; (2) legal risk; (3) government credit risk; (4)

market demand change risk; (5) inflation risk; (6) product price risk; (7) inaccurate market forecast risk; (8) contract risk; (9) financing risk; (10) lack of supporting infrastructure risk; and (11) technical risk.

Cheung and Chan (2011) compared the risk factors of PPPs in China between the water, power and transportation sectors by using an industry-wide questionnaire survey. A list of 20 risk factors used for the survey was stemmed from the literature review and rated by 38 PPP experts from different sectors. According to the research findings, the most critical risk factors in the water sector of China refer to financing risk, completion risk, subjective project evaluation method, government intervention, public credit and poor decision-making process. They concluded that, in the Chinese context, the major risks of PPPs were mainly related to the government. Similarly, Chan et al. (2015) investigated the critical risk factors for water PPPs in China by using multiple empirical methods, including literature review, Delphi survey and face-to-face interviews. The list of risk factors used for the Delphi survey was based on an earlier research of Ke et al. (2010) who proposed a comprehensive checklist of PPP project risk factors of China in general. Finally, they revealed 16 critical risk factors for the water PPPs of China.

A recent research on this topic was conducted by Shrestha et al. (2017). In their work, the past pertinent studies, including the abovementioned, were systematically reviewed and knowledge gaps were identified. The main knowledge gap of the past literature on risks of water PPPs in China referred to the lack of the local government's perspective. According to their analysis, this perspective required particular attention as the government should be strongly capable of identifying and managing PPP risks because failure to do so may lead to high project costs that would finally be borne by taxpayers and lead to economic leakage. The risk list consisted of 15 risk factors, 13 of which were adapted from the literature introduced above (e.g. (Chan et al. 2015; Xu et al. 2011)), and two, namely, information risk and opportunism risk, were added due to their apparent relevance from the government's perspective. With the 15 risk factors identified, Shrestha et al. developed a structured questionnaire that was used for subsequent data collection. They probed these risk factors within each PLC stage and across different stages in consideration of the unique characteristics of each and every stage.

In summary, as time went by, some risks for the water PPPs in China have emerged as the critical ones that frequently appeared in different studies, the research methods have been increasingly diverse and the perspectives adopted by researchers have become increasingly specific. For instance, Shrestha et al. (2017) achieved some new findings from the government's perspective and through triangulation research. Although existing literature seemingly focused more on the period before the TP, their trackable findings provided a solid basis for the current study to derive the risk factors related to the TP, which will be presented in detail in the next section.

5.3 Forming checklist for transfer risks

As previously stated, little attention from the academia has been paid to the TP of China's water PPPs. This situation led to difficulty in identifying risks that may occur in the TP given that no literature has offered those kinds of risks directly. To address this problem, the process for identifying transfer risks was divided into two steps.

1. Relevant literature was comprehensively reviewed and the risks in general were summarised and adapted to the nature of the TP. This step was necessary and helpful for two reasons. Firstly, various researchers all these years have continuously proven the validity of the PPP risks identified in China's water sector. Secondly, the TP is part of the entire PLC. Thus, a reasonable inference was that risks which were deemed influential to the PLC were likely to affect the TP as well; and
2. The list of adapted risks was then given to eight experts for confirmation and improvement (refer to Section 3.4.4 for details). Given the uniqueness of the TP, some special risks may have been overlooked in the original risk list or some inappropriate ones may need to be removed. Experienced and knowledgeable experts could help fix these two possible issues to make the risk list accurate and complete to the greatest extent.

5.3.1 Risks based on literature

A total of 14 risks were finally identified from the literature as potential transfer risks. Prior to being given to experts for further adjustment, these risks were redefined to be in line with the nature of the TP. Some obviously inappropriate risks were excluded from the list. For instance, risks related to the construction phase are deemed critical to the water PPPs of China (Shrestha et al. 2017), but are evidently not applicable to the TP given that the construction of a water PPP project entering the TP ended a long time ago. Table 5.1 presents all 14 risks and their detailed descriptions.

Table 5.1 Potential transfer risks based on the literature (adapted from (Chan et al. 2015; Chen 2009; Cheung and Chan 2011; Ke et al. 2010; Shrestha et al. 2017; Xu et al. 2011; Yuan et al.

2015))

No.	Risk categories	Risk descriptions
1	Residual value risks	Risks referring to the low residual value of the project assets that may result from improper behaviours of the private sector such as overuse, poor maintenance, and lack of facility renewal.
2	Contract risks	Risks caused by incomplete contracts in which the descriptions of detailed transfer arrangement, such as transfer responsibility, transfer process, and transfer risks, are inapplicable.
3	Political risks	Risks related to governments' lack of understanding of the transfer, change of officials participating in transfer, or government intervention during transfer etc.
4	Legal risks	Risks associated with legal systems referring to transfer, such as immature laws, lack of regulations, or change in relevant laws and regulations.
5	Unethical behaviour risks	Risks due to either government's or private sector's unethical behaviours during transfer such as extorting or offering bribes.
6	Information risks	Risks arising from information during transfer such as information asymmetry, and lack of mechanism for information sharing.
7	Opportunism risks	Risks related to opportunistic behaviours of the government or the private sector during the transfer phase.
8	Credibility risks	Risks stemming from the government or the private sector not performing, or lacking sufficient ability to perform, contractual responsibilities during the transfer phase.
9	Environmental risks	Risks regarding environmental disruption that is caused by, or negatively affect, the transfer phase.
10	Financial risks	Risks due to inflation, change of exchange rate, and change of interest rate during the transfer phase.
11	Demand risks	Risks associated with the decrease of demand for the product or service due to external changes at the transfer phase such as the change of macroeconomics, population, or market share.
12	Product price risks	Risks led by the fluctuation of the product price at the transfer phase.
13	Supporting infrastructure risks	Risks caused by the invalidation of the supporting infrastructure facilities at the transfer phase.
14	Operation risks	Risks related to the smooth operation of the project under transfer process such as extreme weather, decrease of raw water quality, facility failure, and so on.

5.3.2 Risks based on experts' viewpoints

The possible influence of the above 14 risks to the TP of water PPPs of China could be understood as they have been frequently verified by various researchers focusing on the PPP application in China's water sector. However, the completeness of the risk list should be further examined given some possible missing risks originating from the uniqueness of the TP, which has not been fully considered when these risks were discussed in the literature. To do so, qualitative interviews to eight experts were conducted and are discussed in more detail as follows.

5.3.2.1 Interview results

Overall, eight interviewees confirmed that all 14 risks adapted from the literature could probably occur in the TP and consequently affect the smooth transfer of the project. Hence, as suggested by the interviewees, further investigation is necessary to assess the significance of each risk before risk mitigation measures are taken. In addition to the original 14 risks, the interviewees suggested five more categories of risks that may uniquely appear in the TP (Table 5.2). These additional risks include succeeding operator, staff, technology, overhaul and post-transfer operation risks, which are discussed in more detail in the following parts.

Table 5.2 Additional transfer risks based on experts' viewpoints

No.	Risk categories	Expert interviewees							
		1	2	3	4	5	6	7	8
1	Succeeding operator risks	x			x	x			x
2	Staff risks		x	x	x			x	x
3	Technology risks	x	x		x		x	x	x

4	Overhaul risks		x		x	x	x	x	x
5	Post-transfer operation risks	x			x	x			

- ***Succeeding operator risks***

This category of risks refers to the delegation of the succeeding operator of the transferred project, such as belated determination of the succeeding operator, incompetent succeeding operator and disputed selection process of succeeding operator. As discussed in Section 4.4.2, the succeeding operator serves as the entity who will operate the project after transfer. In the GTPM, this factor is the output of the last step of the TP and flows into the post-transfer life of the project. The significant responsibility in providing ongoing, high-quality public product or service means requires the succeeding operator to be equipped with adequate technical and managerial competencies; otherwise, stable product provision cannot be guaranteed. Therefore, the succeeding operator of a water PPP in China should be identified wisely and in a timely manner, which still seems challenging for some local governments, especially for low-level local governments, who may lack necessary experience and expertise to manage it. As a result, succeeding operator risks are deemed to be possible for relatively less developed areas of China.

- ***Staff risks***

This kind of risks is related to the arrangement for the staff of the project, especially for the frontline staff. Possible risk events may include staff panic, strike and affected staff benefits. According to MoF (2014), how to settle the staff is a flexible issue, depending on specific project situation and requiring the consensus of the three parties, namely, the government, the private sector and the staff themselves. The settlement of the staff should be planned in the early stage of the TP (World Bank 2016). Nonetheless, due to the conflicts of interest between the three parties, the process of reaching a consensus on the staff settlement could take time, giving opportunities for adverse events such as rumours, staff objections and strikes. However, if the staff settlement is determined hastily, then some staff's benefit could be harmed by the inconsiderate decision, and consequently, staff objections could arise as well. Regardless of the reasons, risks caused by staff settlement could occur and inversely affect the transfer process and the project operation.

- ***Technology risks***

These risks are related to the transfer of the technology-related items such as work instruction, know-how and technical patent. For the transfer of China's water PPPs, these technology-related items matter because the many existing PPPs were constructed and operated by international water companies with self-developed technology (e.g. the Chengdu Project). Using advanced technology and skills of the private sector appeared to be one of the motivations for the government to adopt PPPs (Zhang et al. 2016), and this situation was also true for most of the Chinese local governments and their authorised market entities, who had relatively little experience and knowledge in managing water projects (Zhong et al. 2008). Unfortunately, apart from offering an opportunity for cooperation, the technology gap between the public and private sectors may become a problem when the project enters the TP given that the ongoing project operation could suffer technical difficulties if risks such as incomplete technology transfer happen.

- ***Overhaul risks***

This type of risks is associated with the main task of the private sector, that is, to thoroughly overhaul relevant facilities and equipment before the project is transferred. In the GTPM, overhauling assets is the second key step of the entire transfer process. Normally, the concession period of a water PPP project will last for decades in which the entire project assets are actually in the control of the private sector (Yuan et al. 2015). As stated previously, the government has difficulty learning how the project assets are maintained due to the existence of the performance evaluation issue. Therefore, the government must require the private sector to perform a final thorough overhaul of those project assets. Nevertheless, knowledge on effectively conducting the overhaul process remains limited (Bao et al. 2018), leading to the overhaul being exposed to many potential risks such as disputes, delay and low performance.

- ***Post-transfer operation risks***

This category of risks is related to the ongoing operation of the project after the transfer, such as asset performance being below expectation, reduced operating productivity and increased operating cost. From a life cycle perspective, post-transfer can be seen as an individual phase following the TP (Bao et al. 2018). But in practice, some procedures linked with project transfer need to be performed after the transfer date to guarantee the ongoing operation of the project in the charge of the succeeding operator. In other words, the cooperation between the government and the private investor is actually extended for a while after the transfer. Typically, this period at least contains the so-called 'defects liability period' in a concession agreement. Despite the existence of contract terms defining the responsibilities of both sectors, including all situations that may occur during the initial period of the post-transfer operation is impossible (Rindfleisch and Heide 1997). Moreover, the defects liability period is normally limited within, say, 12 months or so, whereas the occurrence of risks in the post-transfer operation has no such time limitation.

5.4 Identifying critical transfer risk categories

Through the questionnaire survey, all 19 transfer risks identified from both literature and experts' viewpoints were evaluated in two dimensions: risk probability and risk severity. The mean scores of these risks were then calculated with Formula 3.1, and the risk significance index of each risk was acquired through Formula 3.2 (refer to Section 3.4.6). All risk significance indexes were further analysed to identify the CTRCs and to conduct other statistical analyses in relation to the CTRCs. The results of the data analysis are presented in detail as below.

5.4.1 Overview of data analysis results

As shown in Table 5.3, all the respondents' mean scores for the significance of the 19 transfer risks ranged from 3.79 to 2.80. In particular, four risks, from R1 to R4, scored over 3.5, while another four, covering R16 to R19, scored below 3. The remaining 11 risks' mean scores lay between 3.00 and 3.37. A comparison of the top 5 risks ranked by all respondents to those by different respondent groups (areas with grey background in Table 5.3) shows that the first four—overhaul, contract, post-transfer and residual value risks—seemed to have relatively high significance to most, if not all, of the respondents. However, disagreement was expressed with regard to the fifth one, political risks. When observed separately, the main four groups of respondents were roughly divided into two (see Figure 5.1). Specifically, in Figure 5.1, the heavy line representing the total means separated the upper two lines symbolising the academic and private sector respondents to the lower two for the public sector and consultancy respondents. This result might suggest that the PPP academics and industry practitioners in China are more concerned about the transfer risks of water PPPs than the governments and consulting companies are. Interestingly, the same pattern could be found in Figure 4.6, where four lines display different respondent groups' evaluation to the criticality of the process factors of the TP. The academics are generally deemed as neutral, being more knowledgeable and reliable in issues related to PPP domain (Chan et al. 2011), and the private sector is the only one that actually encounters a certain PPP project over its entire life cycle. Moreover, most local governments and consultancies in China remain in their infancy in dealing with PPPs. As a result, the comparatively higher scores given by the academics and industry practitioners to the criticality of the transfer process factors and significance of the transfer risks of water PPPs in China may remind the local governments and their main source for professional advice—the consultancies (Shrestha et al. 2017)—to pay more attention to the issues regarding the TP of water PPPs.

Table 5.3 Mean scores and rankings for the significance of transfer risks

Risks	All respondents			Academia			Public sector			Private sector			Consultancy		
	N	**Mean**	**Rank**	**N**	**Mean**	**Rank**	**N**	**Mean**	**Rank**	**N**	**Mean**	**Rank**	**N**	**Mean**	**Rank**
R1: Overhaul risks	52	3.79	1	11	3.87	4	9	3.79	1	18	4.04	1	11	3.32	2
R2: Contract risks	52	3.64	2	11	3.96	3	9	3.41	2	18	3.81	3	11	3.27	3
R3: Post-transfer operation risks	52	3.62	3	11	4.01	2	9	3.25	5	18	3.84	2	11	3.23	4
R4: Residual value risks	52	3.60	4	11	4.03	1	9	3.36	3	18	3.65	8	11	3.33	1
R5: Political risks	52	3.37	5	11	3.41	11	9	3.14	6	18	3.78	4	11	3.11	8
R6: Information risks	52	3.36	6	11	3.58	8	9	2.94	13	18	3.65	7	11	3.18	5
R7: Succeeding operator risks	52	3.32	7	11	3.70	5	9	2.74	18	18	3.69	6	11	2.93	12
R8: Opportunism risks	52	3.28	8	11	3.67	7	9	3.31	4	18	3.31	12	11	2.97	10
R9: Credibility risks	52	3.27	9	11	3.58	9	9	3.01	11	18	3.37	11	11	3.18	6
R10: Legal risks	52	3.23	10	11	3.35	13	9	2.81	17	18	3.48	9	11	3.14	7
R11: Staff risks	52	3.17	11	11	3.36	12	9	2.58	19	18	3.76	5	11	2.72	19
R12: Environmental risks	52	3.14	12	11	3.34	14	9	2.83	16	18	3.42	10	11	3.04	9
R13: Technology risks	52	3.12	13	11	3.69	6	9	2.91	14	18	3.19	13	11	2.73	18
R14: Operation risks	52	3.11	14	11	3.42	10	9	3.02	10	18	3.16	14	11	2.89	13
R15: Supporting infrastructure risks	52	3.00	15	11	3.12	16	9	3.03	9	18	3.11	15	11	2.81	15
R16: Unethical practices	52	2.98	16	11	3.09	17	9	3.09	7	18	3.03	18	11	2.96	11
R17: Financial risks	52	2.95	17	11	2.92	19	9	2.99	12	18	3.08	16	11	2.76	16
R18: Product price risks	52	2.93	18	11	3.14	15	9	2.84	15	18	3.06	17	11	2.83	14
R19: Demand risks	52	2.80	19	11	2.96	18	9	3.04	8	18	2.73	19	11	2.74	17

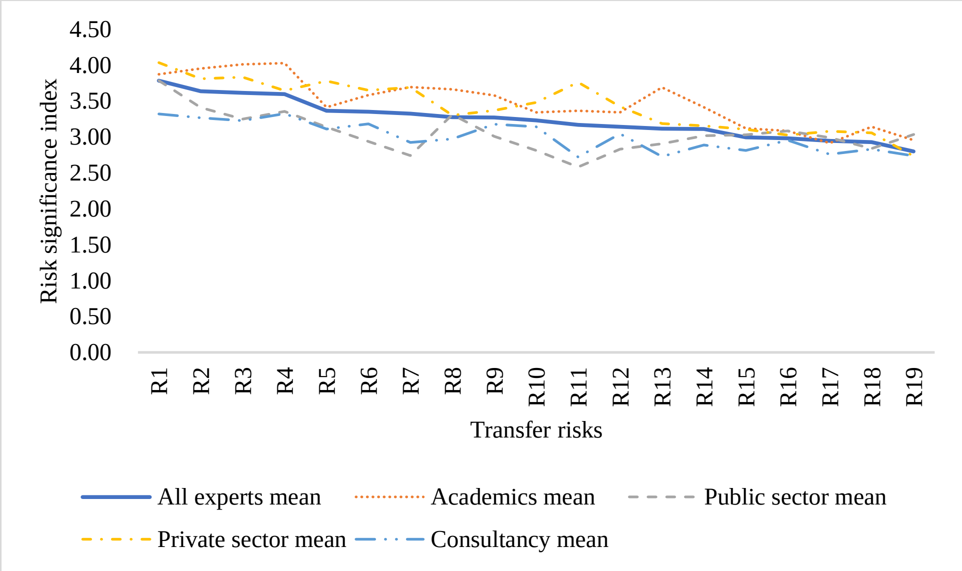


Figure 5.1 Line graph of the mean scores of the transfer risk significance

5.4.2 Identification of CTRCs and discussion

Similar to the identification of CTSFs, one-sample t-test was conducted to examine if the overall means of the transfer risks were statistically significant at a 95% level of confidence with a 0.05 p-value and against a test value of 3.00, through which the CTRCs were identified. The null hypothesis, H_0, is that 'the mean score is not statistically significant', whereas the alternative hypothesis, H_1, is that 'the mean score is statistically significant'. The null hypothesis should be rejected if the p-value is less than 0.05. In other words, if the $p < 0.05$, then the risk has critical significance to affect the smooth TP and can consequently be defined as CTRC. Table 5.4 shows the summary of the test results on the relative significance of the transfer risks. As can be seen from the results, seven risks' p-values (shown as Sig. [two-tailed] in Table 5.4) produced by the one-sample t-test technique are less than 0.05, while all the other risks have significant levels greater than 0.05. This result indicates that seven transfer risks identified from both the literature and experts' viewpoints are statistically significant in the TP of water PPPs in China, implying that seven CTRCs are identified.

Table 5.4 Summary of the test result for the significance of the transfer risks

Transfer risk	**N**	**Mean**	**Rank**	**t**	**df**	**Sig. (2-tailed)**
R1	52	3.79	1	6.218	51	0.000
R2	52	3.64	2	4.331	51	0.000
R3	52	3.62	3	4.150	51	0.000
R4	52	3.60	4	3.984	51	0.000
R5	52	3.37	5	2.355	51	0.022
R6	52	3.36	6	2.294	51	0.026
R7	52	3.32	7	2.341	51	0.023
R8	52	3.28	8	1.914	51	0.061*
R9	52	3.27	9	1.895	51	0.064*
R10	52	3.23	10	1.623	51	0.111*
R11	52	3.17	11	1.107	51	0.274*
R12	52	3.14	12	0.994	51	0.325*
R13	52	3.12	13	0.818	51	0.417*
R14	52	3.11	14	0.696	51	0.490*
R15	52	3.00	15	-0.009	51	0.993*
R16	52	2.98	16	-0.114	51	0.909*
R17	52	2.95	17	-0.349	51	0.729*
R18	52	2.93	18	-0.434	51	0.666*
R19	52	2.80	19	-1.426	51	0.160*

Note: * The one-sample t-test result is insignificant.

A seemingly surprising result is that only seven out of 19 transfer risks were identified as CTRCs. However, as stated previously that the TP may have unique risks given its different characteristics in comparison with other PLC phases, the results fully proved this point. Among the seven CTRCs, three were proposed by the experts on the basis of the traits of the TP under the Chinese context, namely, overhaul, post-transfer operation and succeeding operator risks. The other four CTRCs, namely, contract, residual value, political and information risks, came from the regular PPP risk categories discussed in the literature. The remaining 12 risks that have been frequently emphasised by PPP researchers focusing on the other PLC phases were deemed to be not as significant as the abovementioned seven CTRCs in the TP, which was possibly due to the dual attributes of the TP. On the one hand, the TP contains the same usual producing tasks as the operation phase does, in which the project risks can be managed conventionally. On the other hand, additional tasks that are expected to keep the project transition smooth are also included in the TP. Apparently, risks resulting from those additional tasks in the TP require more attention. Therefore, the discussion below mainly focuses on the seven CTRCs.

5.4.2.1 Overhaul risks

Overhaul risks (R1), or the final thorough overhaul risks, were ranked first with a mean value of 3.79, indicating that the overhaul of a water PPP project has crucial significance to the TP and is filled with many challenges. For instance, the initial step of the overhaul, developing the overhaul plan, could be challenging. Strictly speaking, the overhaul of a PPP project normally needs to be conducted by the SPV regularly, say, every five years, during the whole operation period, which produces high cost to the private sector (Xu et al. 2012). Compared with regular overhauls, the final overhaul is naturally more burdensome and costlier because it involves the most, if not all, assets. This fact leads to essential conflicts between the government and the private sector. The government would prefer for all assets to be covered by the overhaul plan to improve the project condition before they take over, whereas the private sector will try to build a plan that includes as few project assets as possible to reduce the cost. Hence, a time-consuming, dissentious bargaining process can be expected before the overhaul plan could be set. The case analysis of the Chengdu Project fully proved the dispute in building the overhaul plan between CMG and CGMW, who took nearly one year to reach an agreement (refer to Chapter 4). If too much time is spent on endless negotiation, then the time for practical overhaul actions could reduce accordingly, thereby delaying the transfer schedule and/or failing to guarantee the performance of the overhaul. In addition, other factors such as information asymmetry (Robinson and Scott 2009) and lack of partnership spirit (Zhou et al. 2013) could lead to more risks during the overhaul process. The possible risk factors of overhaul risks include

- Disputes about the overhaul plan;
- Lack of overhaul technical criteria;
- Unrealistic expectation about the overhaul scope; and
- Poor execution of the overhaul task.

5.4.2.2 Contract risks

Contract risks (R2) took the second position with a mean score of 3.64, implying that, in China, the contracts for water PPPs currently fail to provide complete instruction to the management of the TP. This type of risks has frequently been identified by previous studies on PPP risks in China (Chan et al. 2015; Cheung and Chan 2011; Shrestha et al. 2017; Xu et al. 2011). According to their findings, contract risks usually ranked in the middle of the risk checklist, for example, eighth out of 37 risk factors summarised by Chan et al. (2015) and 14th out of 20 risk factors by Cheung and Chan (2011). However, Shrestha et al. (2017) found that the contract risks became the most significant risk category when the risks of China's water PPPs were analysed under the TP, yet they did not indicate why this interesting change appeared. The findings of the current study confirmed the significance of contract risks in the TP and, more importantly, revealed some reasons that resulted in the change. Essentially, contract risks stem from the adaptation issue, which is caused by the combination of environment uncertainty and bounded rationality (Rindfleisch and Heide 1997; Williamson 1999) (refer to Section 1.1.2). As discussed previously, this adaptation issue could be more severe in the TP because the change of the environment accumulated to the greatest extent at this phase over time. This inference was confirmed by several expert respondents, who firmly asserted that designing a concession agreement that provides a detailed and applicable instruction for the TP in advance of several decades is impossible. To some degree, contract risks seem to be inevitable to the TP. Hence, how to mitigate these risks should be carefully considered by practitioners in advance. Potential risk factors of the contract risks include

- Poorly written contract clauses about the transfer;
- Inappropriate distribution of transfer responsibilities; and
- Insufficient introduction for the TP.

5.4.2.3 Post-transfer operation risks

Post-transfer operation risks (R3) received a mean score of 3.62, which means that it ranks third in the transfer risk list, indicating that the post-transfer operation of the project could be filled with many uncertainties. The expert interviews indicate that the first source of uncertainty in the post-transfer operation could be the low performance of the transferred assets. As for the reason, the experts focused on the uncertain process of project transfer. In their opinions, the performance of the transferred project assets cannot be guaranteed if the TP itself is unclear and poorly managed. Consequently, disputes between the government and the private sector could occur if the asset performance is below standard. The post-transfer operation could also be influenced by other uncertainties such as low operating productivity, operation cost overruns and high maintenance cost (Chan et al. 2015; Li et al. 2005). One may argue that these operation risks may be more significant to the normal operation phase within the concession period than to the relatively short post-transfer operation period. However, considering that the latter is under the control of an entirely new administrative system that needs time to become familiar with the project operation, the significance of these operation risks could increase during the transition period, in which new relationships between the operator and other stakeholders need to be established and maintained. In summary, possible risk factors of the post-transfer operation risks include

- Low performance of the transferred assets;
- Low-quality productivity;
- Operation cost overruns; and
- High maintenance cost.

5.4.2.4 Residual value risks

Residual value risks (R4) occupied the fourth position with a mean score of 3.60, implying that the residual value of the project assets to be transferred could be problematic after being run by the SPV for several decades. This kind of risks could occur at any stage of the PLC and has been identified by many past PPP risk studies (Chou and Pramudawardhani 2015; Hwang et al. 2013; Ke et al. 2010; Yuan et al. 2016; Yuan et al. 2015). Similar to contract risks, R4 seems to be relatively moderate when the project is in the early phases of the PLC, but its significance will gradually cumulate to a critical level when approaching the TP (Yuan et al. 2016). Yuan et al. (2015) identified a series of residual value risk factors referring to the product/service performance, facility function, and financial and financing situation and claimed that the interaction of these risk factors throughout the PLC led to cumulative effects to the loss of the residual value. However, prior to using these findings to manage R4 in the water PPPs of China, a basic issue mentioned by some expert interviewees of this study should be highlighted. For most of the existing water PPPs in China, the project will revert to the government for free upon the expiry of the concession period. In other words, the book value of the assets to be transferred equals zero from the economics perspective. This fact results in the determination of the actual residual value of China's water PPPs depending only on ad hoc negotiation between two sectors. Therefore, the primary task for the residual value risk management of China's water PPPs should be to reach an agreement about the definition and contents of the residual value for guaranteeing ongoing project operation afterwards. In a nutshell, the risk factors of the residual value risks may include:

- Lack of necessary maintenance of the assets;
- Abusive use of the facilities; and
- Lack of technology update.

5.4.2.5 Political risks

This type of risks (R5) ranked fifth with a mean score of 3.37, indicating that the smooth transfer of the water PPPs in China could be affected by the government's actions. Given the critical role of the government in a PPP arrangement, political risks have been evaluated as one of the major risk categories by numerous past studies on various PPP sectors of different jurisdictions (Ke et al. 2010; Li et al. 2005; Ng and Loosemore 2007). China was deemed as especially susceptible to this kind of risks due to its unique political, economic, cultural and legal circumstance (Chan et al. 2011). In particular, Shrestha et al. (2017) found that the significance of political risks ranked second in the TP, which is the highest ranking throughout the PLC. Generally, primary political risks in China include change in law, delay of approval, corruption, creditworthiness of the government and expropriation (Wang et al. 1999). Except for these ordinary risk factors, improper draws against the maintenance bond to be provided by the SPV in the TP pursuant to relevant contractual articles was also identified by the expert interviewees as a possible risk factor particularly in the TP. Possible risk factors of political risks include:

- Government agencies' poor understanding of transfer;
- Delay of approval;
- Immature institutional environment for transfer; and
- Government intervention and expropriation.

5.4.2.6 Information risks

Information risks (R6) were assessed as the sixth significant risk category with a mean score of 3.36, implying that whether the authentic information can be effectively exchanged between the government and the private sector may significantly affect the TP. In a PPP project, the government and the private sector serve as principal and agent, respectively (Wang and Liu 2015). In a principal–agent relationship, a strong assumption is that the principal is relatively ignorant of the agent's behaviour due to asymmetric information (Rwelamila et al. 2015). In a PPP context, the government therefore could have less or worse quality of information than the private sector, which may use its information advantage to deceptively pursue profit. In Chapter 4 of this thesis, the information factors are highly critical to the success of the TP (refer to Section 4.5.3 of this thesis). Consequently, the information risks were reasonably identified as the critical risk category in the TP. The significance of information risks in the TP was also confirmed by Shrestha et al. (2017), who revealed this risk category ranked fifth in the transfer stage out of the 17 risks. To sum up, possible risk factors belonging to the information risks include

- Information asymmetry;
- Inefficient communication mechanism;
- Inauthentic information; and
- Government's low ability to dispose information.

5.4.2.7 Succeeding operator risks

Succeeding operator risks (R7) were the last CTRC with a mean score of 3.32, indicating that the selection of succeeding operator of the transferred project has a significant influence on the ongoing post-transfer operation. Stakeholders are individuals or organisations that either have an impact on or are impacted by project development (El-Gohary et al. 2006); thus, the operator or SPV of a PPP project is an important stakeholder. In the TP, the SPV will secede from the project stakeholder groups and be replaced by the succeeding operator. This change could be risky from a stakeholder management perspective because it means that the original stable interaction between stakeholders have to be re-established, which could be a dynamic, time-consuming process (De Schepper et al. 2014). Moreover, the case study and expert interviews of this study indicated that in China, selecting an appropriate succeeding operator could be fraught with uncertainties. The succeeding operator of the Chengdu Project was designated by the transferee, the Xingrong Group, which is a major water company that is influential in Chengdu. However, some expert interviewees doubted the replicability of the Chengdu Project given that many other relatively small cities with water PPPs to be transferred lack such potential succeeding operators. All in all, the specific risk factors of the succeeding operator risks may include

- Lack of eligible candidate operators;
- Late delegation of the succeeding operator;
- Incapable transferee; and
- Procedural noncompliance of operator selection.

5.4.3 Comparative analysis between stakeholders

To test whether a difference exists in assessing the CTRCs between different stakeholders that were represented by several respondent groups in this study, the Kruskal–Wallis test was used. The Kruskal–Wallis test is an appropriate way to compare three or more groups when the dependent variables are ordinal (Abu-Bader 2011). It ranks scores for each group, computes the mean rank for each group and then determines whether a statistically significant difference exists between at least two means rank. In this study, the null hypothesis H_0 is that no statistically significant difference exists in assessing the CTRCs between the main respondent groups (i.e. the academia, public sector, private sector and consultancy). The criteria for rejecting the H_0 were set at 0.05.

The test results are summarised in Table 5.5, which presents the chi-square value (shown as chi-square), the degrees of freedom (shown as df) and the statistical significance (shown as Asymp. Sig). The detailed scores for each respondent groups are presented in Appendix B. The table shows that only R7, succeeding operator risks, was statistically significant with a p-value (0.031) less than 0.05. This result indicates that, for CTRCs from R1 to R6 (refer to Table 5.3), their respective significance makes no statistical difference to the four main stakeholders, whereas for the R7, the succeeding operator risks, evaluations of its significance are statistically different.

Table 5.5 Kruskal-Wallis test results for the CTRCs across four main respondent groups

Test Statistics[a,b]							
	R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**
Chi-Square	4.885	3.364	5.757	3.143	3.643	3.181	8.889
df	3	3	3	3	3	3	3
Asymp. Sig.	.180 [c]	.339 [c]	.124 [c]	.370 [c]	.303 [c]	.364 [c]	.031

a. Kruskal-Wallis Test

b. Grouping Variable: Affiliation

c. The Kruskal-Wallis test result is insignificant.

To figure out which stakeholders are different in understanding the R7, the Mann–Whitney U-test was conducted. The Mann–Whitney U-test is one of the most popular nonparametric tests that examine differences between two groups (Abu-Bader 2011). It ranks the scores of each group and then computes mean rank for each group and compares the difference between the two mean scores. This method also allows the ordinal dependent variables, as well as a small sample size. In this study, the null hypothesis H_0 is that no statistically significant difference exists in assessing the succeeding operator risks between two respondent groups. The criteria for rejecting the H_0 were set at 0.05.

The Mann–Whitney U-test results are presented in Table 5.6, which includes six pairs of comparisons between different stakeholders. The table shows that four p-values referring to academia versus public sector, academia versus consultancy, private sector versus public sector and private sector versus consultancy (see row Asymp. Sig. [two-tailed]) are less than 0.05, indicating that the H_0 of these four comparisons should be rejected. The results of the Mann–Whitney U-test are shown in Appendix C.

Table 5.6 Mann-Whitney U-test results for the succeeding operator risks between every two stakeholder groups

Test Statistics[a]						
	1 V.S. 2	**1 V.S. 3**	**1 V.S. 4**	**2 V.S. 3**	**2 V.S. 4**	**3 V.S. 4**
Mann-Whitney U	21.000	90.000	29.500	40.000	45.500	55.000
Wilcoxon W	66.000	156.000	95.500	85.000	90.500	121.000
Z	-2.213	-.411	-2.067	-2.126	-.306	-1.994
Asymp. Sig. (2-tailed)	.027	.681[c]	.039	.033	.759[c]	.046
Exact Sig. [2*(1-tailed Sig.)]	.031[b]	.707[b]	.040[b]	.035[b]	.766[b]	.049[b]

1-Academia; 2-Public sector; 3-Private sector; 4-Consultancy.
a. Grouping Variable: Affiliation
b. Not corrected for ties.
c. The Mann-Whitney test result is insignificant.

The results of the Mann–Whitney U-test on the significant statistical difference in the mean score of the succeeding operator risks divides the four main stakeholders into two major groups: the group with higher evaluation consisting of the academia (3.70) and private sector (3.69), and the lower containing public sector (2.74) and consultancy (2.93). In other words, in terms of the succeeding operator risks, the PPP academics and private investors in China's water sector were more concerned than the PPP officials and consultants. This finding could offer an important reference to China's water PPPs under the current circumstance of China. Primarily, it indicates that the government and the consultancy in China should pay more attention to the succeeding operator risks when developing a TP for water PPPs. The negative effect of the insufficient care to the succeeding transfer operator could be seen from the Chengdu Project case study in Chapter 4. The above finding could also make sense beyond the particular risk category of the TP or even water sector. That is to say, the government and the consultancy in China's PPP market should work together to improve their expertise in the PPP domain. This suggestion is proposed because most of the local governments and consultancies that are currently active in China's PPP market are actually new players who joined the market after 2013 when PPPs suddenly boomed in China (Cheng et al. 2016). By contrast, PPP academics as a whole have been studying PPP domain for nearly 30 years and have extensive research findings (Bao et al. 2018), and the private investors related to the TP of water PPPs have also accumulated considerable experience and expertise through long periods of project operation. Therefore, the disparity identified in this section could serve as a reflection and reminder to the PPP participants of China that the capability of different stakeholders in dealing with PPPs varies and requires increased development as soon as possible.

5.5 Implications for transfer risk management

The above analysis reveals that the safeguarding issue in the TP of the water PPPs in China contains some unique characteristics. The major one is that the project assets in the TP could be threatened by some unique risk categories that have never been identified in other PLC phases, such as overhaul, post-transfer operation, and succeeding operator risks. Simultaneously, some traditional risk categories such as contract, residual value, political and information risks could also harm the project assets. Particularly, insufficient concern of the public sector and consultancy to the succeeding operator risks was identified. On the basis of these findings plus information from qualitative expert interviews and the prior case study, implications for the transfer risk management of the water PPPs in China are proposed as follows. The main points are summarised in Figure 5.2.

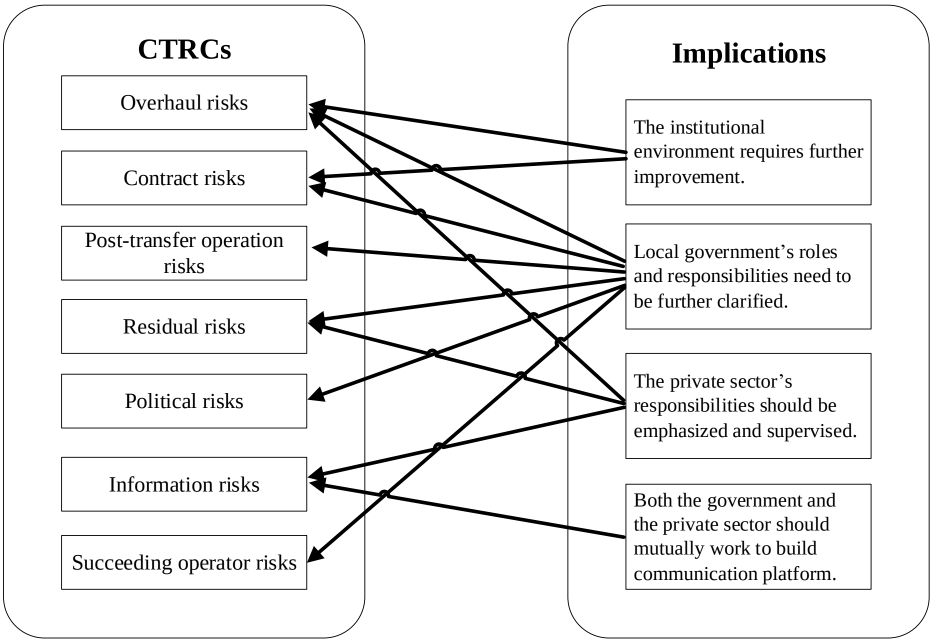


Figure 5.2 Implications for the management of the CTRCs

- The institutional environment requires further improvement. The institutional environment contains multiple elements, including contractual rules, formal institutions and informal institutions, that are closely related to the performance of PPPs (Zhang et al. 2015). As discussed earlier, the adaptation issue, which refers mainly to the contractual rules, seems to be very likely to happen in the TP, leading to a strong possibility for risks to occur, such as overhaul and contract risks. In this context, institutional environment can play a crucial role in keeping the TP going properly. For instance, if overhaul negotiation tends to occur, then a better institutional environment with well-established formal and informal institutions related to the overhaul (e.g. overhaul technical criteria and rules of procedure) could at least lead to an efficient and effective negotiation process.
- The local government's roles and responsibilities need to be further clarified. In the TP, the project responsibility shifts from the SPV to the local government.

Hence, the local government should play its role more actively in the TP to avoid any misconduct of the SPV that tends to do so for the sake of cost saving (Bao et al. 2018). In fact, its role could be defined from the risk management perspective. In particular, the local government should mainly try to figure out (1) the rational expectation for the final overhaul scope, (2) the applicable contract clauses related to the transfer, (3) the full preparation for post-transfer operation, (4) the clear criteria for assessing residual value, (5) the boundary of its supervisory authority and (6) the appropriate selection of the succeeding operator.

- The private sector's responsibilities should be emphasised and supervised. According to TCE theory, measuring the performance of the private sector is difficult. However, this hardship could be reinforced if the government fails to be clear about the private sector's responsibilities. To avoid this situation, these responsibilities should be highlighted and supervised with care. From the risk management perspective, these responsibilities include but are not limited to (1) developing a complete overhaul plan, (2) conducting regular asset maintenance to maintain the residual value and (3) proactively reporting authentic project operation information.
- Both the government and the private sector should mutually work to build a communication platform. Regular and effective communication between the government and private sector helps in learning each other's demands and concerns (Liu et al. 2016), thereby facilitating information exchange between the two parties. In so doing, the possibility of the critical information risks in the TP could be reduced. To deal with the TP of water PPPs in China, the normal communication platform for the government and private sector is the meeting of the transfer committee, which has been identified as one of the CTSFs in Chapter

4. Although the communication platform exists, its capability in ensuring efficient communication is still limited, which can also be noticed from the Chengdu Project case study (Bao et al. 2018). Considering that the transfer committee consists of members from public and private parties, mutual efforts from the two are required for the improvement of the communication platform.

5.6 Managing transfer risks using TRMS

Combining the GTPM and the above findings could develop the TRMS, as shown in Figure 5.3. According to PMI (2013), the process of managing project risk can be divided into several steps, including risk identification, risk analysis (qualitative and quantitative), risk response, and risk monitoring and control. In the current study, the management of transfer risks follows this typical process in general, but some unique points identified in this chapter are also incorporated. The TRMS adopts process-based philosophy, that is, the entire risk management process is closely related to the GTPM. Given the space limitation, the TRMS mainly focuses on special contents distinct from managing PPP risks in other phases. Some existing knowledge about PPP risk management, such as the detailed inputs, tools and techniques and outputs of each risk management step, is also significant for risk management but could be easily acquired from popular guidelines like PMI (2013) and EIB (2012).

In particular, three steps are highlighted in TRMS, involving identifying, analysing and mitigating risks, which are discussed in detail as follows:

- **Step 1: Identifying risks**

The transfer risk management process starts with identifying the specific risks of a particular water PPP project. Considering the relatively short term of the TP, this step should be performed before the formal start of the TP, that is, at the pre-transfer period. This step is crucial given some unique risk categories in the TP. Moreover, in transfer risk management in practice, the conditions of different water PPPs are not necessarily the same, and therefore, the details of the risk register could vary from one another. Distinctions may be caused by multiple reasons, such as the project scale, project status quo, contract requirement or different project location (Bao et al. 2018). Hence, the local government, which is the weaker side of the information asymmetry, should try to be aware of these aspects in advance through various contract management strategies during the project operation phase (EIB 2012). Through this step, the unique, actual transfer risk register of a water PPP can be revealed to offer a basis for subsequent risk management steps.

- **Step 2: Analysing risks**

The next step for transfer risk management is to analyse risks identified in the prior step. The significance and specific risk factors of the transfer risks identified in a certain water PPP (e.g. R1 in Figure 5.3) could be known according to the research findings of this study (refer to Section 5.4). However, given the possible unrevealed uniqueness of some water PPPs, the risk significance and factors allow re-evaluation according to the practice if necessary. For each risk in the determined register, the following crucial task is to link it with relevant GTPM elements (i.e. steps and SFs). In so doing, the risk and its management process are directly correlated with the transfer management process. The attempt to manage a transfer risk by referring to the pertinent SFs can be expected because the success of a project could be guaranteed if all SFs can be met (Sanvido et al. 1992). Obviously, the key for analysing transfer risks is how to determine the specific correlation between one transfer risk and its relevant GTPM elements, which is introduced in detail in Chapter 7.

- **Step 3: Mitigating risks**

After determining the relevant GTPM elements of a transfer risk, how to mitigate the risk should be considered. Accordingly, the risk mitigation process also relies on the support of the GTPM. For instance, if a SF, say, SF1 in Figure 5.3, has been identified as one of the closely correlated factors of a certain risk, say, R1, then the next task is to judge the condition of the SF1 on the basis of the project operation information. If the condition is satisfactory, then the decision makers could continue dealing with this factor in the same way and move to the examination of the next SF; if not, then related stakeholders should be convened to develop improvement strategies. To develop efficient strategies, the implications in Figure 5.2 could be referenced. After carrying out the strategies, the condition of SF1 could be examined again, and according to the examination, the practitioners could decide what to do subsequently. Following the same procedure, all the transfer risks could be analysed and mitigated during the transfer process.

In summary, with the information provided by the GTPM, the risk management plan could be adjusted dynamically and in a timely manner. In the meantime, the information from the transfer risk management process could in reverse facilitate the update of the model. In addition, the above analysis mainly shows the prevention of the transfer risks to a water PPP project. For the situation in which some kind of risk occurs, the TRMS can also offer useful direction by relating the risks that happened to the GTPM elements and developing measures accordingly to reduce the severity of the consequences.

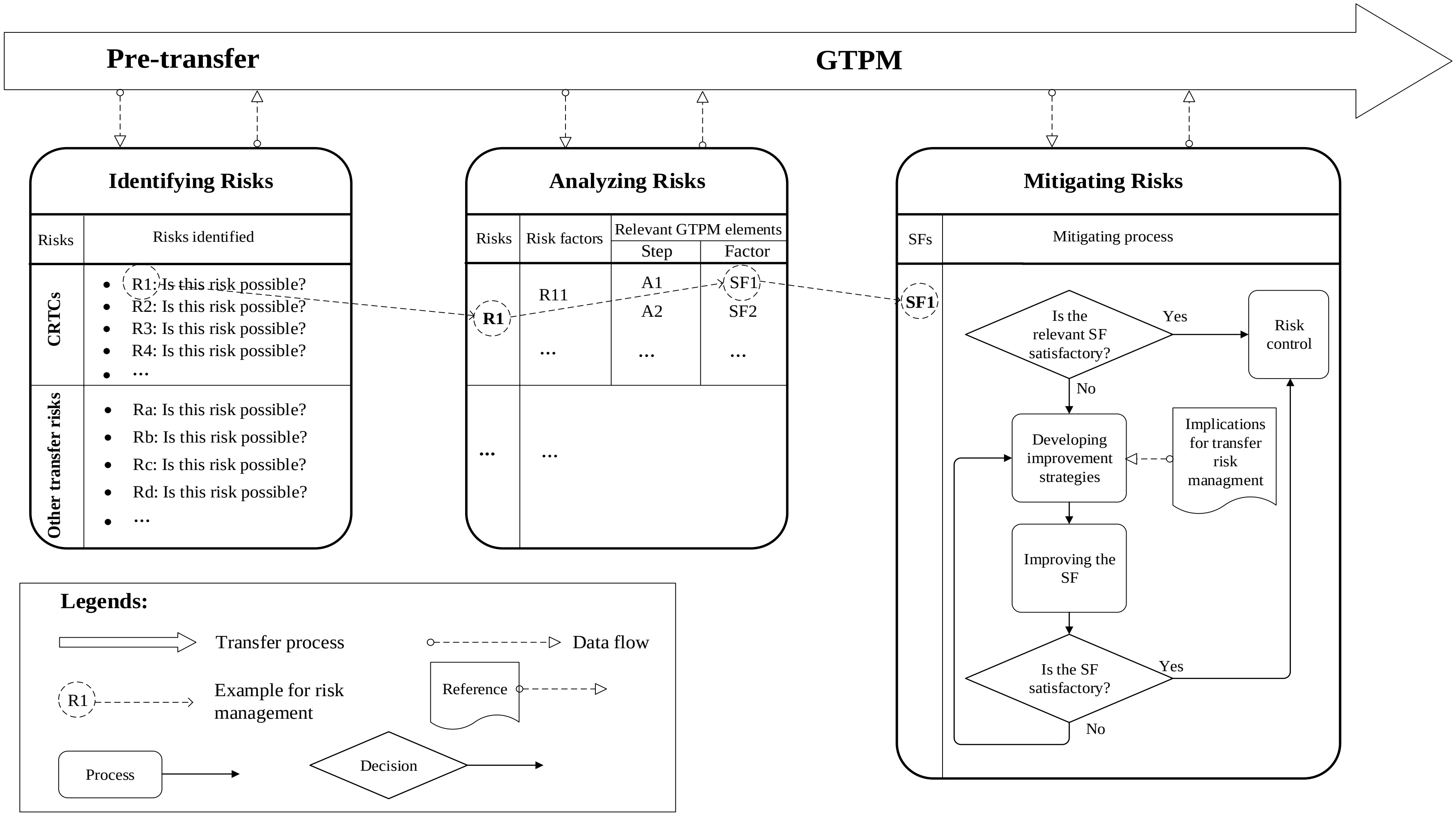


Figure 5.3 Transfer risk management system

5.7 Summary of the chapter

This chapter investigated risks that might adversely impact the TP of the water PPPs in China to tackle the safeguarding issue (RO2). Literature that studies risks in the TP in a straightforward manner is lacking. Thus, the identification of transfer risk categories followed two steps. The first step referred to a literature review on PPP risks, by which the primary transfer risk categories were adapted from the common PPP risks. Then, experts' viewpoints were sought to complement the list of the primary transfer risk categories adapted from the literature. The complete transfer risk checklist included 19 risk categories, in which 14 were adapted from literature and five were newly suggested by the experts considering the nature of the TP. These five new risk categories were succeeding operator, staff, technology, overhaul and post-transfer operation risks. The significance of the transfer risk categories was then evaluated through a questionnaire survey to identify the CTRCs. On the basis of the data analysis results, seven risk categories were finally identified as CTRCs, regarding overhaul, contract, post-transfer, residual value, political, information and succeeding operator risks. Compared with the pre-TPs, the TP was deemed to have relatively less critical risk categories; however, three out of the seven CTRCs appeared exclusively in the TP. Another finding is that the local governments and the consultancies in China's PPP market should try to deepen their understanding of the transfer risks due to their insufficient emphasis on particular risk category such as succeeding operator risks. To reduce the probability of the occurrence of the seven CTRCs, managerial implications regarding the institutional environment, local government's roles, private sector's responsibility and the cooperation of the above two sectors were proposed in the context of China's water PPPs. On the basis of the abovementioned findings, the TRMS, which connected the risk management process to the GTPM, was developed in the last section of this chapter. The next chapter will deal with the performance measurement of the transfer management, and the results will fulfil the research objective RO3.

CHAPTER 6 MEASURING THE TRANSFER PERFORMANCE[5]

6.1 Introduction

This chapter examines the method of measuring the performance of the entire transfer management process of China's water PPPs. The research findings refer to the third objective of this study, or RO3. Specifically, Section 6.2 provides a brief review of past research on performance measurement of PPPs. Section 6.3 defines the performance measurement framework for the TP of water PPPs in China. Section 6.4 presents the results of the questionnaire survey on the effectiveness of the identified transfer success criteria. Section 6.5 reports the development of the performance measurement system for the transfer management of water PPPs in China.

6.2 Performance measurement of PPPs: a literature review

Performance measurement is generally defined as a process in which organisations or individuals determine the extent of their success in reaching their desired objectives after a series of management actions (Bititci et al. 1997; Kagioglou et al. 2001; Neely et al. 2002). This definition indicates that performance measurement of a project is closely connected to the concept of project success. As for the PPP domain, PPP

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[5] Part of this chapter has been published in **Bao, F.**, Chen, C., and Chan, A. P. C (2017). Transfer Success Criteria for Public-Private Partnership Infrastructure Projects. *Proceedings of 22nd International Conference on Advancement of Construction Management and Real Estate [C].* Melbourne, Australia: CRIOCM 2017 Organising Committee. ISBN 978-0-6480742-4-3.

success as a topic does in fact have a broader sense that encompasses not only performance measurement of PPPs but also other topics such as CSFs (Bao et al. 2018). Conducting performance measurement of a PPP before the concept of PPP success is comprehensively understood is impossible because the critical success criteria is the prerequisite to judge the performance of a project at all stages (Al-Tmeemy et al. 2011). Therefore, this section reviews the literature of PPP performance measurement from two aspects, that is, success criteria for PPPs and performance measurement framework of PPPs.

6.2.1 Success criteria for PPPs

No unanimous definition for success has yet been reached. Some tentative definitions for success tend to be viewed as ambiguous from either the perspectives of stakeholders or the stages of the project's life cycle (Sanvido et al. 1992). Over the past 60 years, cost, time and quality, which are called the iron triangle, have become the most common criteria for measuring the success of project management (Atkinson 1999). This concept is understandable because time and cost may be the most perspicuous parameters for calculating the performance of a project when nothing much is known about the project. Quality can also be used to measure the performance of functional and technical specifications (Baccarini 1999). However, the truth that projects continue to fail has demonstrated that using only the iron triangle criteria cannot guarantee the success of a project. This reality indicates that a much wider range of considerations on project success criteria is necessary. To name a few, Chan and Chan (2004) specified the success criteria of construction projects by presenting an integrated framework containing iron triangle, commercial value, environment performance, user satisfaction, participants' satisfaction, and health and safety.

Relying on LFM, Baccarini (1999) promoted project success definition by defining its two components: product success, which refers to the project goal and purpose, and project management success, which focuses on the process of the project.

PPP infrastructure projects are complicated and involve not only the construction stage but also operation and maintenance. To resolve research difficulties raised by the complexity, prior researchers analysed PPP success criteria by focusing on distinct phases of PLC. Aziz (2007) summarised eight principles for PPP implementation at the program level. Ng et al. (2012) explored important critical success factors (CSFs) for feasibility assessment. For the procurement phase, CSFs that influence procurement success have been investigated by many researchers (Jefferies et al. 2002; Tiong 1996; Zhang 2005). Chou and Leatemia (2016) investigated the critical process and factors for successful ex-post evaluation of PPP projects. Some previous research discussed success from comprehensive perspectives, of which life cycle perspective is a critical one. For example, Yuan et al. (2009) identified performance objectives, KPIs for PPP from the life cycle perspective as well as other perspectives. Henjewele et al. (2014) compared the life cycle performances of PPP projects in different sectors in the UK and concluded that not a few PPP projects suffered time and cost overruns as well as requirement changes. On the basis of the previously mentioned LFM concept, Liu et al. (2015) analysed the life cycle success of PPP projects and proposed process-based CSFs. Analysis of literature indicates that CSFs and success criteria were utilised interchangeably by most of the previous research. Nevertheless, Osei-Kyei et al. (2017) emphasised and clarified the difference between CSFs and success criteria, and proposed a set of PPP success criteria through an international expert survey.

Several studies on general PPP success have partly referred to the TP. For instance, Yuan et al. (2009) claimed that a successful transfer of PPP projects may need factors such as training of new employees, transfer price and standards of project facilities upon transfer. Lin et al. (2001) presented three CSFs for transfer, namely, technology transfer, operation in good condition and overhauling guarantees. However, no existing research has yet systematically examined success of this phase.

To conclude, the brief literature review shows two major deficiencies in existing research on success for PPP infrastructure projects: (1) most existing success criteria were presented dispersedly, with some of them even being confused with CSFs; and (2) the TP lacks systematic research on success criteria.

6.2.2 Performance measurement framework of PPPs

Performance measurement is viewed as a revolution in management, deriving from the business area and extensively spreading out to other industries (Bassioni et al. 2004; Neely 1999). As stated previously, in the construction industry, performance was once mainly represented by several factors, such as cost, time and quality, which were soon found insufficient to comprehensively describe a complex construction project (Kagioglou et al. 2001; Ward et al. 1991). Consequently, certain performance measurement frameworks, which comprise a set of indicators or measures, have been formed and adopted in the construction industry. Yang et al. (2010) summarised three frequently applied categories of frameworks, namely, (1) the European Foundation for Quality Management (EFQM) excellence model; (2) the Balanced Scorecard (BSC) model; and (3) the KPIs model.

The abovementioned three frameworks have varied application levels despite the absence of absolute difference in their capability to evaluate a project (Liu et al. 2015; Yang et al. 2010). Performance measurement commonly refers to three levels, namely, (1) project, (2) organisational and (3) stakeholder levels (Yang et al. 2010). The EFQM model is suitable for project and organisational levels; the BSC model focuses on the organisational level; and the KPIs model is the only one applicable among all the three levels (Yang et al. 2010).

To measure PPP performance, Liu et al. (2015) critically reviewed relevant research and found that, even in countries with a mature PPP system, many PPP projects were not comprehensively monitored or evaluated in terms of their implementation, which resulted in problems with the delivery of PPPs in different sectors. Noticeably, most current performance measurement methods were considerably simplified in practice, ignoring many significant aspects when describing the success of PPPs (Liu et al. 2015). The difficulty in measuring the performance of PPPs is understandable as their execution intricately involves multiple stakeholders with significant conflicts of interest and varied phases unlike one another in terms of characteristics and tasks (EIB 2012). To deal with this complexity, some latest studies in the PPP domain suggested multiple evaluation perspectives, including phase (life cycle)-based perspective, as well as stakeholder and process-based perspectives (Liu et al. 2015; Liu et al. 2016; Liyanage and Villalba-Romero 2015; Yuan et al. 2009). Thus, considering the need to focus on multiple levels of performance, these studies mainly adopted the KPIs model as the performance measurement framework.

Following the precedent, this study adopts the KPIs model as its framework. The next subsection reports in detail about how to define transfer success and in turn to build the performance measurement framework of the TP.

6.3 Defining transfer success using LFM

The above analysis shows that two issues should be addressed to establish the performance measurement framework for transfer. The first issue refers to the absence of an appropriate definition of transfer success, which consists of a series of success criteria for performance measurement. Inspired by the literature, this issue is addressed in this section through LFM. The second issue is about the identification of the KPIs framework of the TP, which is presented in the next section.

6.3.1 Defining transfer success

Accordingly, this study defines transfer success of water PPPs in China with two hierarchical levels: transfer product success (TPS) and transfer management success (TMS) (Figure 6.1). TPS deals with the final effect of the transfer management, pertaining to the goal and purpose of the transfer. Transfer goal is related to the long-term objective of the transfer. From the long-term perspective, the TP serves as a transition period in which the responsibility of the project is returned to the government; afterwards, water PPPs are expected to maintain the same smooth operation as before. Therefore, the transfer goal should be in line with the initial main objectives for developing the project, which are normally related to the improvement of public interests, for example of the water sector, to solve water problems and to keep pace with urbanisation and economic growth (Zhong et al. 2008). To accomplish the transfer goal, the most emergent task is to keep the transferred project in good condition and along with all necessary physical and data items supporting the smooth post-transfer (EIB 2012). Hence, the transfer purpose or the near-term objectives of transfer should focus on the direct results of the transfer management by which the condition of the transferred project is guaranteed.

TMS concerns the process of transfer management. Baccarini (1999) suggested three key components that constitute the project management process: (1) time, cost and quality (project outputs and inputs); (2) project management process quality; and (3) stakeholders' needs. These three perspectives have been accepted and adopted by various researchers focusing on PPP success, such as Liu et al. (2015) and Liyanage and Villalba-Romero (2015). As for the transfer of water PPPs, the definition of TMS also included the above three perspectives in general, but necessary revisions were made to accord with the characteristics of the TP. For instance, unlike the prior phases with physical outputs (e.g. construction phase with water plant and operation phase with treated water), no physical products are actually newly generated by the transfer process. As a result, only time and cost requirements are considered as the first perspective in the TP. Specifically, the three aspects of the TMS are (1) time and cost requirements; (2) efficiency of the transfer process; and (3) stakeholder satisfaction, as shown in Figure 6.1.

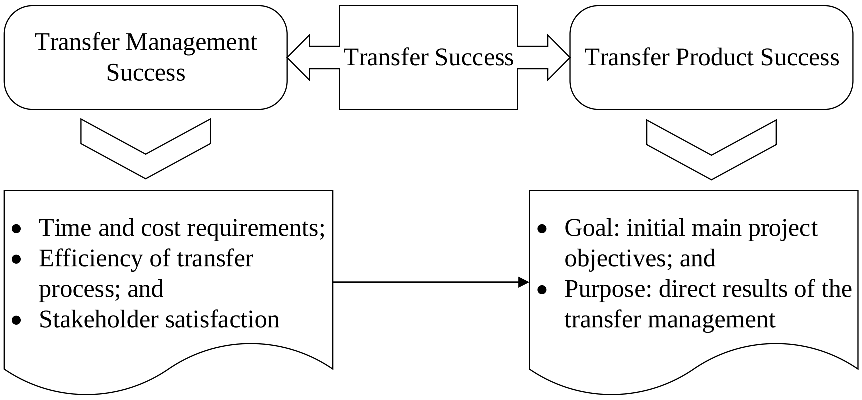

Figure 6.1 Logic framework of transfer success (adapted from Al-Tmeemy et al. (2011); Liu et al. (2015))

6.3.2 Criteria for measuring transfer success

On the basis of the logic framework of transfer success, two kinds of transfer performance objectives were established, that is, TPS and TMS. The next significant step for defining transfer success is to identify specific success criteria belonging to each of the two objectives. The process for identifying these criteria and its results are presented below.

6.3.2.1 Process for criteria identification

Similar to the identification of the transfer risks, no existing literature could be directly referenced to form the checklist of the transfer success criteria. Therefore, both literature review and qualitative interview were adopted to identify the criteria. The process included two steps. Firstly, relevant literature was comprehensively reviewed, and some general success criteria for PPPs were found and adapted to be line with the nature of the TP. Secondly, the list of the transfer success criteria was submitted to eight experts in the water PPP domain for comments (refer to Section 3.4.4 for detail).

The experts were requested to evaluate the appropriateness of the listed criteria and, if necessary, to make adjustments to the listed items (revision, augment or removal) based on their understanding.

The above process led to 14 criteria included in the final list of the transfer success (Table 6.1), 13 of which were adapted from relevant literature and rephrased appropriately (Chan and Chan 2004; Liu et al. 2015; Liyanage and Villalba-Romero 2015; Osei-Kyei et al. 2017). These criteria have been frequently discussed by various researchers, and their effectiveness in measuring PPP success has also been verified by international PPP experts (Osei-Kyei et al. 2017). Therefore, they were adopted by the present study to measure the transfer success. In addition, one criterion, *timely designation of eligible succeeding operator*, was proposed by expert interviewees because they deemed that the succeeding operator is critical to not only the post-transfer operation but also the smooth execution of the TP. According to the logic framework of the transfer success definition, eight criteria were classified into TPS, and the remaining six were classified into TMS. The details of the criteria definitions and classifications are shown in Table 6.1 and further discussed as follows.

Table 6.1 Success criteria for transfer of water PPPs in China (adapted from Chan and Chan (2004); Liu et al. (2015); Liyanage and Villalba-Romero (2015); Osei-Kyei et al. (2017) as well as the proposal of the expert interviewees)

Performance objectives	**Success criteria**	**Definitions**
TPS	Complete technology transfer	Technical knowledge, operation instruction, know how, etc. are entirely transferred to the public sector.
	No environmental damage	Transfer does not impact the safety of the employees, end users or environment.
	Extended cooperation	Cooperation could remain over the quality warranty period after the transfer completion.

	Satisfactory asset performance	Assets transferred satisfy the requirements on residual value and serviceability.
	Ongoing product provision	Product quantity and quality during and after the transfer are maintained at the same level as before.
	Stable profitability	Steady income is achieved during and after the transfer process.
	Ongoing contributing to local economy	The project is continuously beneficial to local economy during and after the transfer.
	Timely designation of eligible succeeding operator	The succeeding operator of the project is capable and designated in time.
TMS	Reduced changes and disputes	Concession agreement changes and disputes are minimized throughout the transfer process.
	Reduced employee objections	Employees' objections to the transfer due to the concern of employee benefit infringement are minimized.
	Reduced public objections	The public objections to the transfer due to the concern of public benefit infringement are minimized.
	Effective risk management	Risks in transfer process are appropriately identified and managed.
	Adherence to transfer budget	The transfer process is completed within budget.
	Adherence to transfer schedule	The transfer process is completed within schedule.

6.3.2.2 Criteria for TPS

As stated previously, TPS has the final effect on transfer management, and its performance objectives contain the transfer goal and purpose. Normally, TPS is deemed more important than TMS according to the logic framework of project success (Baccarini 1999). This theory has been confirmed by practical cases in which sometimes, the government has to accept the PPP project even when it knows of its failure in meeting lower objectives, such as transfer efficiency or poor project condition, to achieve higher ones, such as maintaining the provision of public products (Abdul-Aziz 2001). To measure TPS, eight out of the 14 criteria should be considered due to their connection to the long-term project objectives (Table 6.1), of which three belong to the transfer goal and five to the transfer purpose.

Transfer goal. Transfer is the end of the concession agreement and also the start of the post-transfer operation (Bao et al. 2018). This attribute of the TP actually reflects the difference between the transfer goal and transfer purpose. In particular, the transfer goal, or the long-term objective of the transfer, refers mainly to the post-transfer operation, while the transfer purpose concerns the relatively short-term one, the end of the concession period. Therefore, the criteria representing the transfer goal are those that are in line with the initial drivers for operating the PPP project. As mentioned before, these drivers normally regard public interests and financial factors. For the water PPPs, efficient, high-quality water provision is of course an important driver for the local governments. The local governments in China also wish to use the PPP model to reduce administrative cost so that more public funds could be invested in other areas for the development of the local economy (Chan et al. 2009). But none of these purposes could be achieved without the active participation of the private sector. Accordingly, to attract investments from the private sector, water PPPs should also be able to offer stable profit during the long concession period. Therefore, from the long-term perspective, three transfer success criteria that are closely related to the initial project objectives are classified into transfer goal, namely,

- Ongoing product provision;
- Stable profitability; and
- Ongoing contribution to the local economy.

Transfer purpose. As mentioned earlier, the way to achieve the transfer goal is the transfer purpose which is related to the near-term objectives of the transfer process. From a near-term perspective, the TP should end with the good condition of the transferred project. Furthermore, the good condition of the project transferred is represented by the immediate results of the transfer management (Figure 6.2). Hence, the criteria that belong to transfer purpose are those that are directly produced by transfer management. The identification of this type of criteria could be facilitated by the GTPM, which clearly shows all key product factors of the TP (refer to Section 4.4.2 of this thesis). Specifically, the identification could be completed by comparing the transfer success criteria list to the element list of the GTPM and deciding which criterion could be linked with transfer purpose. For example, performance-improved *public assets* are no doubt one of the immediate results of the TP; in the meantime, a criterion called *satisfactory asset performance* is included in the transfer success criteria list. Given the obvious connection between the process factor, *public assets* and the criterion, *satisfactory asset performance*, this criterion can be classified into transfer purpose category. Similarly, several other pairs of connections were also identified, namely, *complete technology transfer* vs. *transfer knowledge*; *extended cooperation* vs. *public assets*; and *timely designation of eligible succeeding operator* vs. *succeeding operator*. In addition, no environmental damage was included in the transfer purpose, given that this criterion is related to the project production, which is also ongoing during the TP (Chan et al. 2005). In summary, five transfer success criteria can be classified into transfer purpose:

- Satisfactory asset performance;
- Complete technology transfer;
- No environmental damage;
- Extended cooperation; and

- Timely designation of eligible succeeding operator.

6.3.2.3 Criteria for TMS

TMS emphasises the management of the transfer process of the water PPPs (Liu et al. 2015), which can be measured by three categories of the objectives, namely, time and cost requirements; efficiency of the transfer process; and stakeholder satisfaction (refer to Figure 6.2). In light of this definition, the remaining six criteria were categorised successfully.

Time and cost. Arranging the transfer process in an orderly manner is important, because many tasks such as overhaul, asset assessment and performance tests should be completed within a relatively short term (typically one to two years) in advance of the concession expiry date (EIB 2012). Otherwise, adherence to the schedule could fail, indicating the breach of the concession agreement. A further consequence could be that all following plans need to be postponed accordingly. Aside from considering the time, managing project transfer also requires financial investment from the public and private sectors to fuel the fulfilment of the tasks, but normally, the major expenditure (e.g. the cost for the overhaul task) is borne by the private party (Bao et al. 2018). Evidently, the budget for the transfer management should be carefully planned and enforced. As a result, to measure TMS, two criteria need to be considered:

- Adherence to budget; and
- Adherence to schedule.

Efficiency. While the time and cost requirements measure the effectiveness of the transfer process, the efficiency of the transfer process requires consideration as well (de Wit 1988). Factors that represent the efficiency of the project management process vary, covering all kinds of events that impact the continuity of the process such as lacking resources, coordination problems between stakeholders and unexpected changes (Baccarini 1999). Changes have been frequently found as the source of conflicts or disputes in various PLC phases (Chou et al. 2016). Furthermore, critical changes may cause renegotiation, which could negatively affect the efficiency of the project management process (Javed et al. 2014). Unfortunately, given the essential complexity of developing PPPs (Grimsey and Lewis 2002), changes can hardly be avoided. This situation necessitates effective risk management during the long-term partnership between the government and the private sector. One key point in managing PPP risks effectively is to do it from a process-based perspective because different PLC phases require different risk management strategies (Shrestha et al. 2017). According to the above analysis, two criteria are classified into the efficiency of TMS:

- Reduced changes and disputes; and
- Effective transfer risk management.

Stakeholder satisfaction. Stakeholder opposition is one of the main reasons for PPP failure (El-Gohary et al. 2006). The multiple stakeholder groups participate in a PPP project for different purposes that will be realised through the same project development process (Yuan et al. 2010). When a water PPP project is under the TP, most stakeholders may have successfully attained their objectives through the entire concession period, and some of them, such as construction subcontractors and creditors, have even finished or are ready to finish their involvement in the project

(Bao et al. 2018). For those stakeholders, the transfer process has limited influence. But for stakeholders such as project employees and the publics, their benefits could be significantly impacted by the transfer. The employees' benefits could be harmed because some of them may not be accepted by the transferee (Bao et al. 2018), while the publics' benefits are always critical for the water PPPs because the water sector refers to the basic health of the water users. Therefore, objections to the transfer may arise from these two groups of stakeholders if they anticipate that disadvantages to themselves may occur in the TP. Reversely, the occurrence of the objections from relevant stakeholders may harm the success of the transfer management process. As a result, two criteria related to two critical stakeholders of the TP are included in the TMS:

- Reduced employee objections; and
- Reduced public objections.

6.4 Identifying and employing key transfer performance indicators

After the definition of the transfer success and the classification of the 14 transfer success criteria, the next step is to investigate the effectiveness of these criteria in measuring the transfer success so that the KTPIs could be determined. The quantification of the effectiveness of the criteria is based on the data collected via the questionnaire survey. The details for data collection and processing techniques are introduced in the methodology part of this thesis, and this section reports the results of data analysis and proposes the quantitative method for evaluating the identified KTPIs.

6.4.1 Overview of data analysis results

From Table 6.2, all the respondents' mean scores ranged from 3.83 to 3.15, with a roughly smooth descending trend. The highest score, 3.83, was obtained by the SC5, ongoing product provision, followed by SC1, complete technology transfer, scoring 3.81. SC4 and SC8 ranked third and fourth, respectively, both with scores over 3.70 (3.79 and 3.73). Three criteria, SC2, SC14 and SC12, scored between 3.60 and 3.70, taking the fifth to seventh positions. One criterion, extended cooperation (SC3), scored 3.58 and ranked eighth, while the remaining six criteria including SC9, SC11, SC13, SC10, SC6 and SC7 were all given mean scores below 3.50, sequentially occupying the last six positions of the effectiveness rank of the 14 transfer success criteria.

Comparing the four main respondent groups' preferences for the top 5 effective transfer success criteria shaded with grey colour in Table 6.2, one could find that the assessments of the respondents from the academia and the private sector are almost identical in terms of the sequence of the rankings, except for the only disparity, SC10, reduced employee objections, which were ranked fifth by the respondents from the private sector and 14th from the academia. The consensus of their assessments is also shown in Figure 6.3 by the top two roughly parallel dotted lines that denote the mean scores given by the academics and private investors. Figure 6.3 also clearly displays that the lines representing the academics and private investors are obviously higher than those for the governments and the consultancies, indicating the possible insufficient attention of the latter two to the transfer success criteria. Back to the previous sections about the transfer process factors and the transfer risks (refer to Figure 4.6 and Figure 5.1), the academics and private investors have higher assessments on the whole to the process factor criticality and risk significance. This recurring situation may serve as a serious reminder to China's local governments and the consultancies who are involved in the development of water PPPs that they should make the effort to reinforce communication with PPP academics and the private investors and pay more attention to the understanding of the issues in the project transfer process.

Table 6.2 Mean scores and rankings for the effectiveness of transfer success criteria

Criteria	All respondents			Academia			Public sector			Private sector			Consultancy		
	N	Mean	Rank	N	Mean	Rank	N	Mean	Rank	N	Mean	Rank	N	Mean	Rank
SC1: Complete technology transfer	52	3.81	2	11	4.18	3	9	3.78	1	18	3.94	3	11	3.45	1
SC2: No environmental damage	52	3.65	5	11	4.00	6	9	3.78	1	18	3.61	11	11	3.45	1
SC3: Extended cooperation	52	3.58	8	11	3.91	8	9	3.56	3	18	3.72	8	11	3.18	8
SC4: Satisfactory asset performance	52	3.79	3	11	4.27	2	9	3.56	3	18	4.11	2	11	3.09	10
SC5: Ongoing product provision	52	3.83	1	11	4.36	1	9	3.44	5	18	4.22	1	11	3.18	8
SC6: Stable profitability	52	3.19	13	11	3.73	11	9	3.11	9	18	3.33	13	11	2.55	14
SC7: Ongoing contribution to local economy	52	3.15	14	11	3.73	12	9	3.00	12	18	3.33	13	11	2.64	13
SC8: Timely designation of eligible succeeding operator	52	3.73	4	11	4.18	4	9	3.33	6	18	3.94	4	11	3.45	1
SC9: Reduced changes and disputes	52	3.46	9	11	3.64	13	9	3.33	6	18	3.50	12	11	3.45	1
SC10: Reduced employee objections	52	3.33	12	11	3.64	14	9	3.00	12	18	3.83	5	11	2.82	11
SC11: Reduced public objections	52	3.46	9	11	3.91	9	9	3.11	9	18	3.72	8	11	3.27	7
SC12: Efficient transfer risk management	52	3.62	7	11	4.00	7	9	3.33	6	18	3.78	7	11	3.36	5
SC13: Adherence to transfer budget	52	3.35	11	11	3.82	10	9	3.00	12	18	3.67	10	11	2.82	11
SC14: Adherence to transfer schedule	52	3.65	5	11	4.18	5	9	3.11	9	18	3.83	5	11	3.36	5

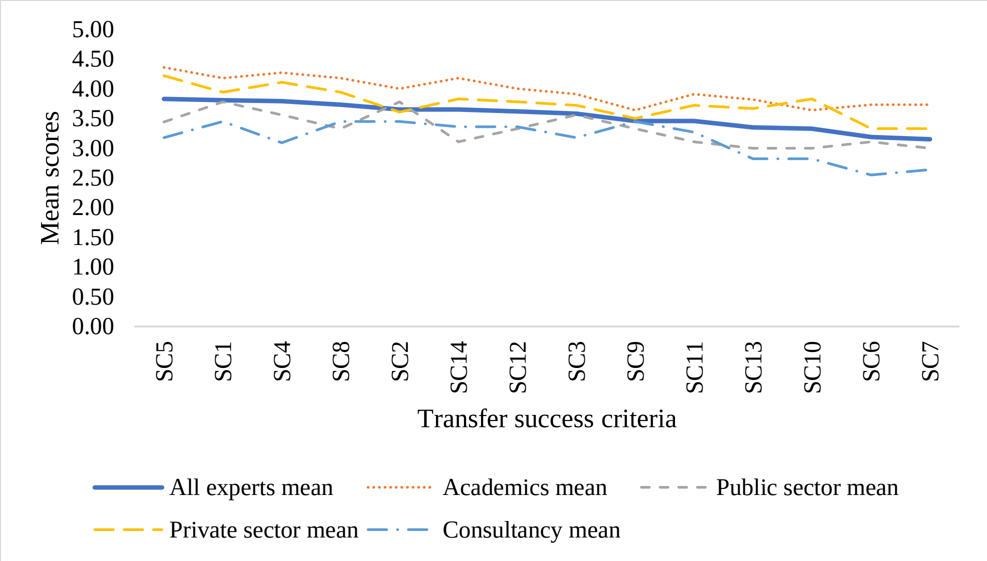

Figure 6.2 Line graph of the effectiveness mean scores of the transfer success criteria

6.4.2 Identification of KTPIs

The one-sample t-test was conducted to identify the KTPIs. The identification process is the same as that for identifying CTSFs and CTRCs, that is, the overall means of the transfer success criteria were examined to see whether they are statistically significant at a 95% level of confidence with a 0.05 p-value and against a test value of 3.00. The null hypothesis, H_0, is that 'the mean score of is not statistically significant', whereas the alternative hypothesis, H_1, is that 'the mean score is statistically significant'. The null hypothesis should be rejected if the p-value is less than 0.05, and consequently, the relevant success criterion can be defined as one KTPI. Table 6.3 shows the summary of the test results on the relative effectiveness of the transfer success criteria. As shown in the table, only two p-values referring to SC6 and SC7 are over 0.05, while the rest all have significance levels less than 0.05. A conclusion that can therefore be drawn is that 12 out of the total 14 transfer success criteria are critical in effectively measuring the success of the TP of China's water PPPs and can thus be defined as

KTPIs. The exclusion of SC6 and SC7 out of KTPIs shows the uniqueness of the TP again. Similar to the situation of the CTRCs, stable profitability and contribution to the local economy of PPPs are deemed critical in measuring the success of the PLC phases prior to the TP (Osei-Kyei et al. 2017), but the case in the TP of China's water PPPs may differ. In practical, most existing Chinese water PPPs after the Chengdu Project adopted, to some extent, the benchmark provided by the Chengdu Project, such as its contract structure and risk allocation scheme (Chen 2009), which meant the profitability of the private investors should not be a major problem because the revenue risk was mainly borne by the government (Bao et al. 2018). Therefore, it was understandable for the expert respondents who were knowledgeable to this practice to give a relatively low score to the criteria for project profitability. As for criterion SC7, its low score should not be seen as evidence of its insignificance in the TP. Instead, the main reason is that the impact criterion of project success like SC7 in this study is difficult or takes a long time to be correctly evaluated (Frey 2013), which is beyond the relatively short period of the TP.

Table 6.3 Summary of the test results for the significance of the transfer success criteria

Success criteria	**N**	**Mean**	**Rank**	**t**	**df**	**Sig. (2-tailed)**
SC1	52	3.81	2	5.554	51	0.000
SC2	52	3.65	5	4.217	51	0.000
SC3	52	3.58	8	3.814	51	0.000
SC4	52	3.79	3	4.900	51	0.000
SC5	52	3.83	1	5.619	51	0.000
SC6	52	3.19	13	1.399	51	0.168*
SC7	52	3.15	14	1.158	51	0.252*
SC8	52	3.73	4	4.849	51	0.000
SC9	52	3.46	9	3.096	51	0.003
SC10	52	3.33	12	2.148	51	0.037
SC11	52	3.46	9	3.045	51	0.004
SC12	52	3.62	7	4.081	51	0.000

SC13	52	3.35	11	2.306	51	0.025
SC14	52	3.65	5	3.975	51	0.000

Note: * The one-sample t-test result is insignificant.

6.4.3 Discussion on KTPIs

Theoretically, product success is more significant than the project management success (Baccarini 1999), which leads to the assumption of the present study that the TPS is more significant than the TMS. On the basis of the overall mean of each KTPI, the group means of the TPS and TMS can be calculated as 3.73 and 3.48, respectively. The mean of a factor group can indicate the relative criticality of the very group (Ozorhon and Karahan 2017); thus, the calculated group means of the TPS and TMS, 3.73 versus 3.48, confirmed the assumption about the effectiveness difference. Aside from the above finding, the data analysis also obtained other findings that confirmed the effectiveness difference of the KTPIs between various transfer objective categories (see Figure 6.4). More details are discussed in the rest of this subsection

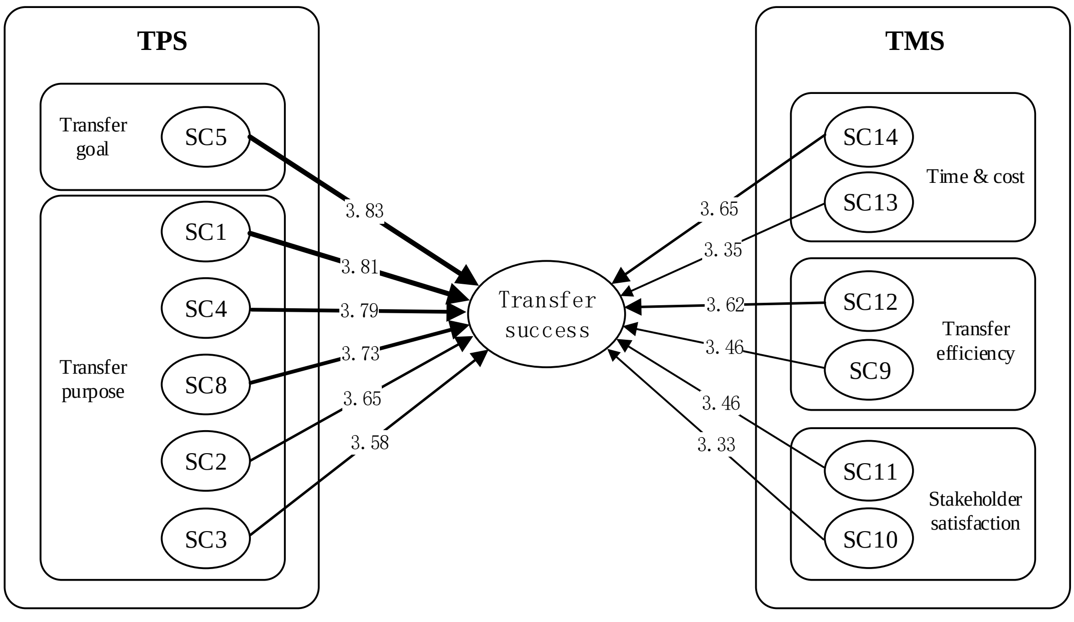

Figure 6.3 Effectiveness of KTPIs under hierarchical transfer objectives

As shown in Figure 6.4, TPS consists of two objectives, namely, transfer goal and transfer purpose. In LFM theory, the former has a higher hierarchy of effectiveness in measuring transfer success. According to the data analysis results, ongoing product provision (SC5), which was identified as the only KTPI that belongs to the transfer goal, ranked first among all the 12 KTPIs, with a mean of 3.83. The highest score successfully proved the prior theory related to the transfer goal and transfer purpose. In measuring the PPP success prior to the TP, previous studies, including Osei-Kyei et al. (2017), identified reliable and quality product provision as the critical success criterion, whose score was merely less than two criteria, effective risk management and meeting output specifications. As for the transfer success, ongoing product provision ranked first among all criteria given that this objective would encounter more challenges in the TP, in which many process factors related to product generation, such as project operator and contract system, would change (Chan et al. 2005). This finding of the present study implies that, when developing a project transfer scheme, the government should always prioritise maintaining stable and quality product provision during the transfer process.

The five criteria under transfer purpose were all identified as KTPIs, namely, SC1 (3.81), SC4 (3.79), SC8 (3.79), SC2 (3.65), and SC3 (3.58). According to LFM theory, these five criteria can be seen as the ways to achieve the transfer goal. To be specific, complete technology transfer (SC1) was given the highest effectiveness among the five criteria, with a very close score to SC5. In the water sector, technology advantage of the private sector such as specific know-how is one of the important reasons for the government to adopt the PPP model (Cheng and Tiong 2005). However, after the TP, the dependence of the private sector's technology advantage has to cease because the government needs to take over the project. Under this occasion, technological items related to the project operation should be completely transferred from the project company to the government or its agent entity through the TP to maintain the stable product provision. Aside from the criticality of the technology per se, the factors closely related to the technology are also critical, such as well-conditioned assets (refer to SC4), to which the technology is applied, and the eligible succeeding operator (refer to SC8), who is expected to apply the technology. For water PPPs, environmental issues such as pollution of raw water are significant risks that impact project operation, especially from the government's perspective (Shrestha et al. 2017). This study confirmed that the government should continue to bear in mind the significance of environmental protection (refer to SC2) in the TP. In addition, to guarantee stable and quality product provision after transfer, another effective means is to set a period, say, quality warrant period, in which the private sector is required to offer the government some security to ensure its fulfilment of transfer obligation (World Bank 2016), which also means that the cooperation of the two sectors should be extended for a certain time after the TP (refer to SC3).

The three categories of TMS objectives, including six criteria, are shown in Figure 6.4. The figure shows that the effectiveness of these six criteria are generally lower than that of the criteria under TPS objectives, which is in line with LFM theory. Under the hierarchical structure of the transfer success, these six criteria measure the management process of the transfer and serve as the way to achieve the above five transfer purposes. Transfer schedule (refer to SC14) and transfer risk management (refer to SC12), which belong to *time and cost* and *transfer efficiency* categories, were considered the top two criteria to effectively measure the transfer process, with almost the same scores of 3.65 and 3.62, respectively. This result shows that the experts primarily emphasise the contractual expiry date and control of risks over the transfer management process. In fact, time requirement has always been deemed as the fundamental measurement of any construction project success (Chan and Chan 2004), and risk management is highlighted in measuring PPP success because the PPPs are accompanied with more risks than traditional construction projects and require different risk management strategies (Jin and Zhang 2011). The other two criteria from the *transfer efficiency* and *stakeholder satisfactions* categories were also emphasised by the experts, that is, reduced changes and disputes (SC9) and reduced public objections (SC11), sharing the same score of 3.46. In this study, reduced changes and disputes ranked ninth among all 12 KTPIs. Interestingly, Osei-Kyei et al. (2017) found that this criterion also ranked ninth in measuring the PPP success prior to the TP. According to the previous analysis, changes and disputes are likely to occur due to the adaptation issue, and their impact could be reduced by developing the GTPM. Reduced public objections ranked 10th in this study but ranked last in Osei-Kyei et al.'s findings, implying that the odds for the occurrence of public objections may be improved in the TP. The last two criteria, adherence to transfer budget (SC13) and reduced employee objections (SC10), were given relatively low scores. In the TP, budget objective is not as critical as it is at the project construction phase (Chan and Chan 2004), and seemingly, the probability that employee objections will occur is low. However, these issues also deserve attention from practitioners, especially for the proper settlement of employees, given that employee-related issues could be sensitive in China's water PPP domain (Bao et al. 2018).

6.4.4 Evaluation method for the KTPIs

As discussed previously, several researchers, including Yuan et al. (2009) and Liu et al. (2015), have attempted to develop performance measurement frameworks for measuring PPP success and have identified extensive success criteria within these frameworks. Following the precedence, this study defined transfer success by LFM theory and identified 12 KTPIs for measuring it. Although past researchers have provided inspiring insights into the evaluation of the PPP performance, most of their research outcomes cannot quantify the performance of PPPs. Thus, the conclusions of these existing performance measurement frameworks tend to be too general to diagnose specific deficiencies of the project or to compare the performance between PPPs. To address this problem, Liyanage and Villalba-Romero (2015) proposed some aspects of quantitative measures to quantify the KPIs and performance measures in the areas of transport PPPs. Their method was easy to understand but failed to give different weightings to KPIs. Osei-Kyei and Chan (2017) made the latest efforts in PPP performance measurement by developing a project success index (PSI) model that includes three major success criteria groups with distinct weightings based on the FSE method. Inspired by these past studies, this study attempts to build a transfer success index (TSI) method that is easy to use and focuses on the effectiveness difference of KTPIs and KTPI groups (KTPIGs).

On the basis of the identification of KTPIs and their assessments of effectiveness from expert respondents, the remaining procedure for building the TSI method is set as follows (Ameyaw and Chan 2016; Osei-Kyei and Chan 2017):

1. The weightings for each KTPI or KTPIG are established. The weighting (W) is determined by the overall mean score (Figure 6.4) obtained from the questionnaire survey using following equation:

$$W_i = \frac{M_i}{\sum_{i=1}^{n} M_i} \; 0 \le W_i \le 1, \; \sum W_i = 1 \qquad (6\text{-}1)$$

in which W_i = weighting; M_i = mean score of i^{th} KTPI or KTPIG; n = the number of the criteria within a KTPIG, or the number of KTPIG; and $\sum W_i$ = summation weightings within a group.

2. A fuzzy evaluation matrix $R_i = (r_{ij})_{m \times n}$ is determined, where r_{ij} represents the degree to which the i^{th} criterion (i.e. SCi) is satisfied at the j^{th} alternative of the five-point Likert scale of criterion effectiveness. FSE is adopted to formulate the TSI because it can greatly reduce the subjectivity of human judgment (Ameyaw and Chan 2015).
3. The final FSE evaluation matrix for a KTPIG is determined by taking into consideration the weightings (refer to step 1) and fuzzy evaluation matrix (refer to step 2) using the equation below:

$$D = W_i \circ R_i \qquad (6\text{-}2)$$

in which D = final FSE evaluation matrix; and ° = fuzzy composition operator.

4. The TSI for a KTPIG is obtained by multiplying the final FSE evaluation (refer step 3) matrix to the five-point grade alternatives as follows:

$$TSI = \sum D \times L \tag{6-3}$$

in which L denotes the value vector of the grade alternatives (i.e. 1, 2, 3, 4, and 5).

Following the above four steps, the transfer success could be quantified into different performance levels, that is KTPI, KTPIG and overall levels. The results of the data analysis are presented below.

6.4.4.1 Calculating weightings

The weightings are calculated by using Eq. (6-1). The transfer purpose group is given an example. Figure 6.4 shows that this KTPIG consists of five KTPIs with mean scores of 3.81, 3.79, 3.73, 3.65 and 3.58. Hence, the weighting of SC1, complete technology transfer, can be achieved as follows:

$$W_{sc1} = \frac{3.81}{3.81 + 3.79 + 3.73 + 3.65 + 3.58} = \frac{3.81}{18.56} = 0.205$$

Similarly, the weightings of all KTPIs and KTPIGs can be calculated, as shown in Table 6.4.

Table 6.4 Weightings for the KTPIs and KTPIGs of transfer success

KTPI or KTPIG	Mean	Weightings for KTPI	Total mean score for KTPIG	Weightings for KTPIG
SC5	3.83	1.000	--	--
Transfer goal	--	--	3.83	0.089
SC1	3.81	0.205	--	--
SC4	3.79	0.204	--	--
SC8	3.73	0.201	--	--
SC2	3.65	0.197	--	--
SC3	3.58	0.193	--	--
Transfer purpose	--	--	18.56	0.428
SC14	3.65	0.521	--	--
SC13	3.35	0.479	--	--
Time & cost	--	--	7	0.162
SC12	3.62	0.511	--	--
SC9	3.46	0.489	--	--
Transfer efficiency	--	--	7.08	0.164
SC11	3.46	0.510	--	--
SC10	3.33	0.490	--	--
Stakeholder satisfaction	--	--	6.79	0.157
Total mean for KTPIGs	--	--	43.26	--

6.4.4.2 Establishing membership functions

The fuzzy evaluation matrix is composed of membership functions (MFs) for the KTPIs. The MF for a KTPI is derived from the gradings given by the expert respondents to this KTPI. As introduced in the methodology chapter, the grading for a KTPI could be any integer from one to five, representing the effectiveness of this criterion from extremely low (E_1) to extremely high (E_5). For instance, among 52 expert respondents, 3.8% rated the effectiveness of SC1 as extremely low, 5.8% as low, 25% as moderate, 36.5% as high and 28.9% as extremely high. As a result, the MF for SC1 can be obtained as follows:

$$MF_{SC1} = \frac{0.038}{E_1} + \frac{0.058}{E_2} + \frac{0.25}{E_3} + \frac{0.365}{E_4} + \frac{0.289}{E_5}$$

The above function can also be expressed as (0.038, 0.058, 0.25, 0.365 and 0.289). Following the same way, the MFs for all the KTPIs can be determined, and then the fuzzy evaluation matrix for a KTPIG can also be obtained by listing all its MFs, as shown in Table 6.5. On the basis of the fuzzy evaluation matrix and the weightings of KTPIs (Table 6.4), the MFs for KTPIGs can be calculated using Eq. (6-2). Taking transfer purpose group (TPG) as an example, its MF is computed as follows:

$$MF_{TPG} = (0.205, 0.204, 0.201, 0.197, and\ 0.193) \times \begin{vmatrix} 0.038 & 0.058 & 0.25 & 0.365 & 0.289 \\ 0.038 & 0.115 & 0.212 & 0.288 & 0.347 \\ 0.019 & 0.115 & 0.288 & 0.269 & 0.309 \\ 0.019 & 0.154 & 0.269 & 0.269 & 0.289 \\ 0.038 & 0.135 & 0.25 & 0.365 & 0.212 \end{vmatrix} = (0.03, 0.11, 0.26, 0.31, and\ 0.29)$$

In a similar approach, the MFs for all KTPIGs are calculated and shown in Table 6.5.

Table 6.5 Membership functions for the KTPIs and KTPIGs of transfer success

KTPI or KTPIG	**MFs at KTPI level**					**MFs at KTPIG level**				
SC5	0.019	0.096	0.25	0.307	0.328	--	--	--	--	--
Transfer goal	--	--	--	--	--	0.02	0.09	0.25	0.31	0.33
SC1	0.038	0.058	0.25	0.365	0.289	--	--	--	--	--
SC4	0.038	0.115	0.212	0.288	0.347	--	--	--	--	--
SC8	0.019	0.115	0.288	0.269	0.309	--	--	--	--	--
SC2	0.019	0.154	0.269	0.269	0.289	--	--	--	--	--
SC3	0.038	0.135	0.25	0.365	0.212	--	--	--	--	--
Transfer purpose	--	--	--	--	--	0.03	0.11	0.26	0.31	0.29
SC14	0.038	0.154	0.231	0.269	0.308	--	--	--	--	--
SC13	0.038	0.192	0.308	0.308	0.154	--	--	--	--	--
Time & cost	--	--	--	--	--	0.04	0.17	0.27	0.29	0.23
SC12	0.038	0.115	0.269	0.346	0.232	--	--	--	--	--
SC9	0.019	0.154	0.404	0.192	0.231	--	--	--	--	--
Transfer efficiency	--	--	--	--	--	0.03	0.13	0.34	0.27	0.23
SC11	0.019	0.212	0.25	0.327	0.192	--	--	--	--	--

SC10	0.038	0.231	0.231	0.365	0.135	--	--	--	--	--
Stakeholder satisfaction	--	--	--	--	--	0.03	0.22	0.24	0.35	0.16

With the MFs for the KTPIGs having been known, the TSIs for KTPIGs can be calculated by using Eq. (6-3). For example, the TSI of the TPG is calculated as follows:

$$TSI_{TPG} = (0.03, 0.11, 0.26, 0.31, and\ 0.29) \times \begin{pmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \end{pmatrix} = 3.72$$

In the same manner, the TSIs for the other four KTPIGs are obtained and shown in Table 6.6.

Table 6.6 TSI for the KTPIGs of transfer success

KTPIG	**TSI for KTPIG**	**Coefficients***
Transfer goal	3.83	0.213
Transfer purpose	3.72	0.207
Time & cost	3.5	0.195
Transfer efficiency	3.54	0.197
Stakeholder satisfaction	3.39	0.188
Total	17.99	1

*Coefficient = TSI for KTPIG/Σ TSI for KTPIG

After achieving the TSIs for each KTPIG, the model for calculating the overall TSI, which is used to evaluate the overall performance of the transfer management of water PPPs in China, could be established. To simplify the evaluation process, a linear and additive model is adopted in this study. The effectiveness of a linear and additive model for performance measuring has been verified by previous studies in the construction management and PPP domains (Osei-Kyei and Chan 2017; Yeung et al. 2009). To develop the model, the TSIs for all KTPIGs are firstly normalised and defined as the effectiveness coefficients of the model variables (see Table 6.6). Then, the overall TSI model is expressed as follows:

$$\text{TSI} = 0.213 \times \text{Transfer goal} + 0.207 \times \text{Transfer purpose} + 0.195 \times \text{Time \& cost} + 0.197 \times \text{Transfer efficiency} + 0.188 \times \text{Stakeholder satisfaction} \quad (6\text{-}4)$$

Eq. (6-4) clearly shows that the transfer goal objective has the highest effectiveness, which is represented by its effectiveness coefficient of 0.213, in evaluating the overall performance of the TP of water PPPs in China, followed by transfer purpose (0.207), transfer efficiency (0.197), time and cost (0.195) and stakeholder satisfaction (0.198). To measure the transfer success, practitioners could rate each KTPI through a five-point Likert scale, which indicates the success degree from extremely low, low, average, high and extremely high. The means of the five KTPIGs (i.e. five model variables in Eq. [6-4]) could then be obtained. Substituting the KTPIG means for the variables in Eq. (6-4) could acquire the overall success of the TP with a precise value, by which the transfer success can be measured in a more accurate, practical way. Moreover, the model offers a platform for practitioners to compare the success levels between different water PPPs. This approach will be helpful to draw more lessons and experience from the previous water PPP practices of China.

6.5 Measuring transfer performance using TPES

In general, project evaluation includes two parts: ex-ante evaluation and ex-post evaluation. Ex-ante evaluation aims to measure the project's financial feasibility to assist the investment decision, while ex post evaluation focuses on measuring the final outcomes and performance (Bulathsinhala 2015). These two evaluations normally occur at the two ends of the project life cycle and are therefore mainly product oriented, offering no opportunity for effective and efficient process control when the project operation is still in progress (Haponava and Al-Jibouri 2012). To make the performance evaluation helpful to the development process of PPPs, Liu et al. (2015) developed a dynamic life cycle performance measurement framework model, in which two more evaluation nodes are located in the interfaces between project initiation and procurement, as well as the procurement and implementation phases. With this process-based performance measurement model, criteria indicators are analysed and evaluated in different evaluation nodes, and then issues could be identified on a real-time basis to ensure that corresponding actions for improvement could be taken in a timely manner.

Adopting the same manner, this study proposes the TPES, a dynamic process-based transfer performance evaluation system. As shown in Figure 6.5, the TPES contains three evaluation nodes, of which evaluations 1 and 3 are conducted in the ex-ante and ex-post stages of the TP, respectively, while evaluation 2 is placed at the interface between steps *assess and test assets* and *perform transfer procedures*. Similar to the TRMS, the utilisation of the TPES is closely related to that of the GTPM, and simultaneously, the information generated by the three performance evaluations are beneficial to the operation of the TRMS. More details about the TPES are presented as follows.

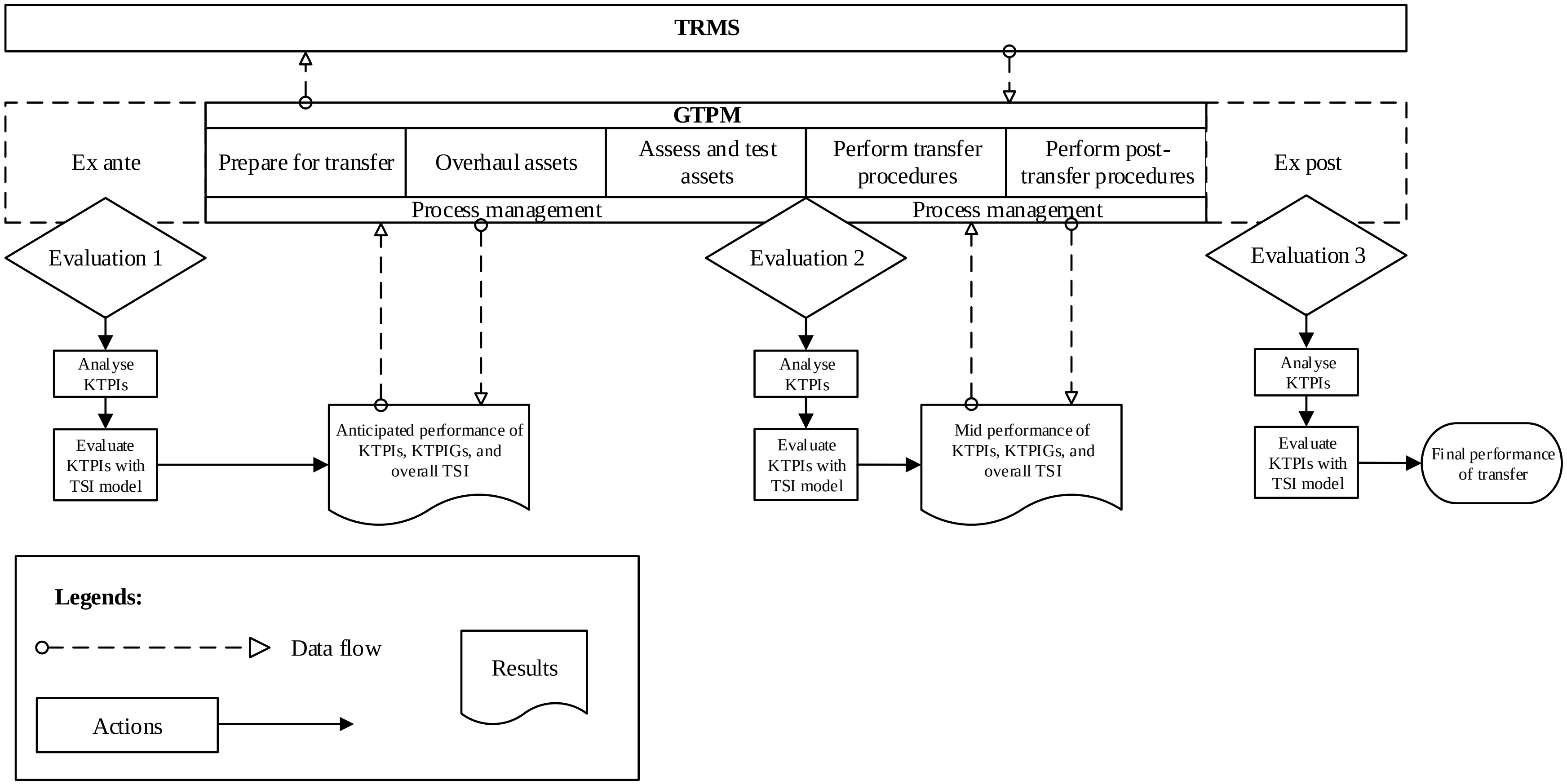

Figure 6.4 Transfer performance evaluation system

Evaluation 1 is performed before the formal start of the TP (i.e. the first transfer committee meeting), serving as an ex-ante evaluation to the coming transfer of a water PPP project. Given the unique tasks of the TP, this ex-ante evaluation does not focus on the financial viability of the project. Instead, its main purpose is to examine the holistic condition of the project, thereby ensuring that the performance information with regard to the transfer can be obtained in advance. For the government to conduct evaluation 1, the first step is to comprehensively analyse the KTPIs of the TP on the basis of the historical documents recorded during the long operational period. Comparing the possessed knowledge about the project operation and the expected outcomes of the transfer management, practitioners are able to form preliminary judgment about the condition of the project and then offer their evaluation to each KTPI. With the use of the TSI model, the anticipated success degree of the project to be transferred can be calculated. Through the above process, the performance information about the KTPIs, KTPIGs and the overall TSI is revealed, providing assistance in making the overall transfer arrangement and in how to efficiently use the limited time and resources to improve the possible weak points of the transfer process. The effect of the evaluation 1 results from the assumption that the anticipated performance information of the KTPIs can be correlated to specific CTSFs. This performance information would in turn benefit the entire transfer risk management through the connection between the GTPM and the TRMS. Obviously, the key here is to figure out how close the correlations between the KTPIs and the CTSFs are, which are discussed in more detail in Chapter 7.

Evaluation 2 occurs after the finalisation of the assessment of the overhauled assets (see Figure 6.5). This point needs to be set as an evaluation node given that the government needs to rationally decide whether to accept the project or not based on the outputs of the prior step *assess and test assets* (Bao et al. 2018). By conducting evaluation 2, the government is able to confirm that all issues identified in the last evaluation node have been successfully addressed and the condition of the project has reached the expected level. Consequently, the remaining steps of the TP could be performed. The reason for the suitability of performing evaluation 2 at this point is that the government is deemed to have learned the latest actual condition of the project through the past transfer steps, thereby guaranteeing the objectivity of the evaluation to the greatest extent. The way of conducting the evaluation is similar to that of evaluation 1, and the generated performance information would also facilitate the management of the subsequent procedures. The government could make different decisions according to the evaluation results, for example, to require the SPV to continue overhaul work or provide financial compensation if facilities are found to perform worse than expected.

Evaluation 3 is performed when all transfer objectives have been completed, offering a reflection of the entire transfer process and providing lessons and experience for future transfer management. In this case, the output of this evaluation could be part of what has been defined in the GTPM, that is, the transferability information. A detail that is worth noticing is that evaluation 3 mainly focuses on the performance of the transfer management. In other words, it cannot be seen as the ex-post evaluation of the whole development of the PPP project. Therefore, as discussed previously, some objectives that regard the entire PPP life cycle, such as profitability and economical contribution, are not included in this evaluation but should be measured from a more comprehensive perspective and by different criteria. For evaluation 3 of the TPES, the basic procedures are the same as those of the prior two evaluations, that is, the KTPIs are analysed firstly, then the performance of the KTPIs are evaluated by using the TSI model and the final performance of the TP of the water PPPs in China is obtained. Performance information of the KTPIs is also connected to the GTPM and TRMS. A comparison of the results with those of the former two evaluations obtains multiple knowledge and experience about the PPP transfer process, aiding the smooth transfer of the water PPPs in China in the future.

6.6 Summary of the chapter

This chapter built the performance evaluation system for the transfer process to solve the performance evaluation issue in the TP (RO3). To begin with, the criteria for the general PPP success and the performance measurement frameworks used in the PPP domain were summarised through a literature review. According to the results of the literature analysis, the LFM and KPIs were selected as effective tools for defining and measuring transfer success. With the use of the LFM concept, transfer success was defined as a hierarchical structure that includes a higher-level objective, the TPS, and a lower one, the TMS. The former includes two dimensions, that is, transfer goal and purpose; the latter refers to three dimensions, namely, time and cost, efficiency, and stakeholder satisfaction. Through the literature review results and experts' viewpoints, 14 transfer success were identified and classified into the five dimensions of the definition of the transfer success. To learn their effectiveness in measuring the transfer success, these 14 success criteria were further evaluated by the experts through a questionnaire survey. The data analysis results indicated that 12 transfer success criteria were deemed statistically significant and thus were defined as KTPIs. The data analysis results also confirmed that the TPS was more effective in evaluating the transfer success than the TMS, given that the means of the criteria belonging to the former were greater than those of the latter. On the basis of the FSE, the TSI model was then developed to help practitioners quantitatively evaluate the transfer success of water PPPs in China. Finally, with the relationships among the KTPIs, GTPM and TRMS taken into consideration, the process-based transfer performance evaluation system, TPES, was developed. The next chapter will integrate the three sub-models developed in Chapters 4, 5 and 6 into an overall model, the DFTMS, and the findings will attain the last research objective, RO4.

CHAPTER 7 DEVELOPING DYNAMIC FRAMEWORK MODEL FOR TRANSFER

7.1 Introduction

This chapter provides an explicit demonstration on how to synthesise the prior findings into an integrated management system that could dynamically manage the transfer of water PPPs in China, by which the RO4, the last research objective, of this study is attained. Section 7.2 presents hypotheses referring to the existence of significant correlations between three sub-models (i.e. GTPM, TRMS and TPES). Section 7.3 verifies these hypotheses by statistically analysing the data collected through the questionnaire survey. On the basis of the verified correlations, Section 7.4 proposes the dynamic framework management system for the transfer of water PPPs in China, that is, the DFTMS. Finally, the experts' evaluation on the effectiveness of the DFTMS in addressing TCE issues in the TP is introduced.

7.2 Correlation hypotheses

Through the prior three chapters, three models are proposed to address different TCE issues in the TP. GTPM, the transfer process model that aims to mitigate the adaptation issue, provides the practitioners the detailed steps and factors composing the entire TP. TRMS, which is built to tackle the safeguarding issue, shows how to identify, analyse and mitigate the critical risks existing in the TP. TPES, which solves the performance evaluation issue, displays the procedure to dynamically evaluate the transfer performance through three evaluation nodes. The fourth research objective of this study is to integrate the three models into a holistic management system. From the theoretical perspective, this effort is supported by the hypothesis that the three models are significantly statistically correlated to each other. Therefore, to propose the holistic system, the correlations of the three models should be confirmed firstly. This section presents three hypotheses about the correlations, providing a basis for further data analysis in the next section.

7.2.1 GTPM and TRMS

As mentioned previously, the elements of the GTPM can be defined as a series of interface factors that are derived from the transfer process (Chan et al. 2005). From the system thinking perspective, an obvious correlation exists between interface management and risk management of the construction projects. For instance, interface management factors can facilitate risk analysis among underlying interface problem factors (Weshah et al. 2013). In addition, identifying interface points and anticipating potential risks around them are believed to result in less rework and conflict in construction projects (Shokri et al. 2016). From the literature, a fact can be observed is that the critical interface factors of a construction project are frequently deemed as the factors that are exposed to various project risks.

From the risk management standpoint, effectively managing project risks would be impossible without the involvement of certain process model elements. For example, risk allocation of PPPs is conducted mainly between the public and private sectors, who are definitely critical factors of the PPP process model (Chan et al. 2005). Some typical PPP risks, such as political, construction and operation risks, can also be naturally connected to corresponding factors of the long PPP process (Ke et al. 2010). Even for the same risk, its severity and probability change with the evolvement of the project process (Shrestha et al. 2017), which means the project process factors would definitely impact the significance of PPP risks.

According to the above reasons, this study deduces that the transfer process model, GPTM, and the TRMS are significantly associated with each other, and the management of transfer risks could rely on the GTPM elements. Therefore, this study proposes the following hypothesis:

***H1**: The GTPM is significantly correlated with the TRMS.*

7.2.2 GTPM and TPES

Connecting the process model built by IDEF0 to project success is not a novel concept. Nearly 30 years ago, Sanvido and Medeiros (1990) introduced the IDEF0 method into the construction domain, proposing the process model of the construction project. Then, Sanvido et al. (1992) defined the categorised process model factors as CSFs for a construction project given that they believed that a construction project success could be ensured if all process model factors are met. Afterwards, defining process model factors as CSFs has also been adopted in other domains, such as emergency management (Bevilacqua et al. 2012). Inspired by the literature, this study claims that the fulfilment of all GTPM factors could lead to transfer success and thus defines CTSFs on the basis of the GTPM (refer to Chapter 4).

However, considering that CSFs is not the same as the success criteria (Osei-Kyei et al. 2017), the correlation between process model factors (i.e. CSFs) and success criteria is not yet empirically known. Particularly, the CSFs of PPPs are the conditions and facts that facilitate PPP success, whereas success criteria are the project outcomes that measure PPP success. Hence, we can deduce that, although different, the CSFs and success criteria of PPP projects are closely related to each other (Osei-Kyei et al. 2017). Nonetheless, the connection between CSFs and success criteria has not yet been verified by statistical data.

From the literature, this study hypothesises that a tight connection exists between the CTSFs of the GTPM and the KTPIs of the TPES, and based on this opinion, proposes the process-based TPES. In other words, this study proposes the following hypothesis:

***H2**: The GTPM is significantly correlated with the TPES.*

7.2.3 TRMS and TPES

In PPP literature, the terms *success* and *risks* often appear simultaneously in one research paper whether the research focus is PPP success or risk. For research on PPP success, effective risk management is normally deemed one of the CSFs or success criteria of PPPs (Liu et al. 2015; Liyanage and Villalba-Romero 2015; Osei-Kyei et al. 2017). For research on PPP risk, guaranteeing PPP success is usually mentioned as the main purpose for conducting risk management (Ameyaw and Chan 2015; Shen et al. 2006). Therefore, the correlation between the PPP success and risk management has generally been widely recognised by most PPP researchers and practitioners. However, the understanding of this correlation is still in the qualitative stage. For example, the following questions still exist: What exact risks and success criteria are correlated? How significant are these correlations? In other words, the correlation between the specific PPP risks and success criteria has not been empirically verified by research studies.

As for the TP, the correlation between the TRMS and TPES can also be understood according to the logic presented in the above analysis. Similarly, this correlation lacks empirical evidence. Given that this study aims to develop a transfer management system that considers both transfer risk and transfer performance evaluation, shedding light on the correlation between the specific transfer risks and transfer success criteria is necessary. To do so, the following hypothesis is proposed:

H3: *The TRMS is significantly correlated with the TPES.*

7.3 Correlation analysis and discussion

As stated previously, Spearman's rank correlation analysis was adopted to deal with the data collected through the questionnaire survey. The relationship between factors was determined by the value of the Spearman's rank correlation coefficient, with the statistical significance set at 5% (Elliott and Woodward 2006). Moreover, the relationship with a coefficient less than 0.4 was considered weak, that between 0.4 and 0.6 was moderate and more than 0.6 was strong (Campbell and Swinscow 2009).

7.3.1 GTPM and TRMS

7.3.1.1 Data analysis results

The results for the relationships between the GTPM and TRMS are shown in Figure 7.1, in which all statistically significant correlations are indicated by three types of double-arrow lines with different thickness or colour depth representing the strength of the correlation from weak to strong. Considering the seven CTRCs and 22 CTSFs, the total correlations could be 154 (7 × 22). According to the data analysis results, 148 correlations were deemed statistically significant, taking up 96.1% of the total 154. Among the 148 significant correlations, eight were strong, 100 were moderate and 40 were weak, indicating that more than 70% of the correlations were statistically significant and simultaneously had a strength above the moderate level. In Figure 7.1, the number of each factor's correlations is indicated above or beneath this very factor. For the CTRCs in the top half of the figure, R1, R2 and R3 possessed a significant correlation with all 22 CTSFs; the other two, namely, R4 and R6, were correlated with 21 CTSFs; and the fewest correlations, which is 20, occurred to R5 and R7. Among 22 CTSFs that placed in the bottom half of the figure, 18 were significantly correlated with all seven CTRCs, and the remaining four produced 22 correlations. Complete results of the correlation analysis between CTRCs and CTSFs are shown in Appendix D. In case some water PPPs may encounter transfer risks beyond the scope of CTRCs due to their unique circumstances, the results of correlation analysis between the non-CTRCs and CTSFs are presented in Appendix E.

From the above data analysis results, we can conclude that the GTPM and the TRMS are closely related to each other, that is to say, H1 proposed in the last section was supported in general. This conclusion successfully confirmed the legitimacy of using GTPM as basis for the run of TRMS, which is discussed in Section 5.6. To be more specific, the results indicate that transfer risks could be effectively managed by carefully considering the steps and factors of the transfer process due to the significant correlation between the two models. Note that correlations do not lead to causations (Elliott and Woodward 2006). However, where significant correlations between TRMS and CTSFs do exist, a rational deduction is that managing all CTSFs ensures that the transfer risks can be effectively controlled. The next subsection presents a more in-depth discussion about the relationship of the GTPM and TRMS as well as the implications for the management of the TP.

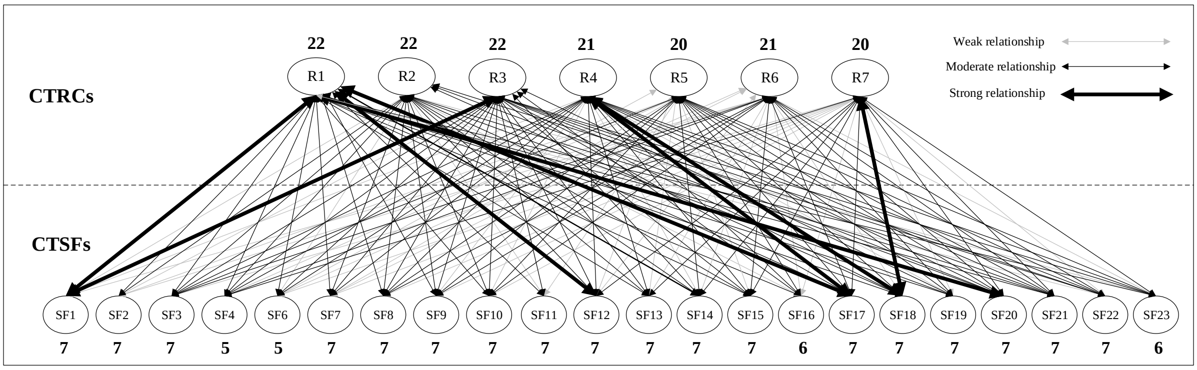

Figure 7.1 Correlations between CTRCs and CTSFs

7.3.1.2 Discussion

- ***Adopting system thinking when managing transfer risks***

The prevalent correlations between the factors of TRMS and GTPM offer solid evidence for the point that effective management of transfer risks of water PPPs in China relies on systematic consideration of the entire transfer process consisting of various steps and factors, or in other words, system thinking should be adopted in managing transfer risks of water PPPs in China. For complex systems such as PPPs, tracing risk to a singular element or event is difficult because multiple elements or events are normally interrelated with each other (Kapsali 2011). Similarly, because of the complexity of PPPs, the management of risks of a complex PPP project by one organisation alone is rarely possible (Lehtiranta 2013). As a result, system thinking has been suggested by researchers to deal with this complex situation in managing PPP risks. This approach emphasises relationships within the system rather than individual parts (Sterman 2000). In the context of transfer risk management, it means that an individual risk, say, overhaul risk (R2), cannot be managed by merely focusing on directly connected steps or factors, such as SPV, transfer acceptance criteria and transfer arrangement. Instead, the other steps and factors of the TP should be involved and be well managed for the effective management of the individual transfer risk because of the universal significant interrelatedness. The close correlation between GTPM and TRMS could serve as a reminder for practitioners to pay sufficient attention to all steps and factors of the entire transfer process because risks could be derived from any weak point of the TP. This viewpoint is in line with the finding of Soomro and Zhang (2016), who found that risks exist in the whole lifetime of the PPPs and possibly evolve into multiple drivers leading to the same kind of failure.

- ***Effective control of transfer risks***

The data analysis results also shed light on the various strengths by which the CTRCs and CTSFs are correlated. The distinction of the correlation strength lays the basis for the attempt to control one transfer risk by dealing with the most strongly correlated factors (the details of the approach are discussed in Section 5.6). One should notice that attention should be given not only to CTSFs with high criticality but also to some factors with normal significance (e.g. succeeding operator (SF18), ranking 12th in criticality) because they are strongly correlated with significant transfer risks. In particular, the data analysis results revealed six strong correlations between several CTRCs and CTSFs. As shown in Figure 7.1, the overhaul risks (R1) are strongly related to four CTSFs, namely, contract system (SF1), transferred assets (SF12), transfer acceptance criteria (SF17) and performance information (SF20), with correlation coefficients of 0.645, 0.647, 0.690 and 0.609, respectively. The other four strong correlations appear between post-transfer operation risks (R3) and SF1 (0.637), residual value risks (R4) and SF17 (0.608) and succeeding operator (SF18) (0.607), succeeding operator risks (R7) and SF18 (0.614).

As discussed previously, the overhaul risks ranked first in significance of the seven CTRCs, and the significance of this category of risks mainly lies in the conflict of interest between the government and the SPV. In this section, the results of the correlation analysis highlighted the role of transfer acceptance criteria in controlling overhaul risks. This idea reminds the government and the water companies to cooperatively develop special acceptance criteria for the transfer of PPPs, which is still absent in China's water sector (Bao et al. 2018). The correlation between transferred assets and overhaul risks was also emphasised by the results because good condition of transferred assets could be deemed as the final purpose of the overhaul procedure and simultaneously provides the basis for the post-transfer operation. As a result, through the transferred assets, overhaul risks could significantly impact the post-transfer operation. The third correlation highlighted by the results was between overhaul risks and contract system. This finding indicates that, in spite of its imperfection, the contract system is still important for the management of the overhaul risks because it serves as the most powerful tool to mitigate PPP risks (Marques and Berg 2011). Appropriately defining some basic arrangements (e.g. acceptance criteria and rules of procedure) of the overhaul work through by contractual clauses in advance in advance could be helpful. In addition, performance information represents the opportunity prior to formal transfer for the government to examine the overhaul outcomes. In this case, the reliable performance information could effectively and also lastly before transfer uncover the incompleteness of the overhaul work, thereby reducing the overhaul risks.

Contract system can hardly include complete details about the TP, but it has to offer significant information about how post-transfer procedures should be to maintain ongoing, normal post-operation (Bao et al. 2018). In other words, effective contract can provide directions for reducing uncertainties that could result from the transfer of the project operation right to allow the new operator to become accustomed to its new role as soon as possible and maintain the successful post-transfer operation. From this point of view, understanding the strong correlation between the post-transfer operation risks and the contract system is easy.

The residual value risks were strongly related to the succeeding operator and the acceptance criteria. This result revealed the critical roles of these two factors in controlling the residual value risks. The succeeding operator cares about the residual value of the project assets as its post-transfer operation relies on the assets, and it is also capable of assessing the residual value due to its expertise. This finding confirms a prior conclusion that the succeeding operator should be involved in the transfer early to facilitate the decision making. The transfer acceptance criteria are critical simply because they are necessary to conduct the residual value assessment. Another strong correlation highlighted by the data analysis result was between the R7, succeeding operator risks, and the SF18, succeeding operator. This pair of combination was actually self-explanatory. Again, the result emphasised the significance of the timely involvement of the succeeding operator during the TP, which fully supported the observation findings from the Chengdu Project case study.

7.3.2 GTPM and TPES

7.3.2.1 Data analysis results

Figure 7.2 shows the data analysis results of the relationship between the GTPM and TPES. In the same way, only correlations with statistical significance are included in the figure and are represented by three types of double-arrow lines according to the strength of the correlation between two factors. A total of 260 correlations were identified as significant and displayed in the figure, occupying 98.5% of the maximum 264 (12×22). Of the 260 significant correlations, 89% (i.e. 229 by number) have moderate or above strength; only 29 were deemed as weak correlations. As shown by the figures near the factor icons in Figure 7.2, the majority of factors from both KTPIs and CTSFs were significantly related to all their opposite factors. Complete results of the correlation analysis between KTPIs and CTSFs are presented in Appendix F.

The above data clearly manifest the extremely close connection between the KTPIs and CTSFs, through which the hypothesis H2 was supported. Therefore, the theoretical fundamental for developing dynamic TPES with the help of the transfer process described by the GTPM has proven to be solid. From many strong correlations, the practitioners of transfer management could benefit and an ongoing discussion about the relationship between the CSFs and success criteria of PPPs could be advanced to some extent. The rest of this section presents a detailed discussion of these two aspects.

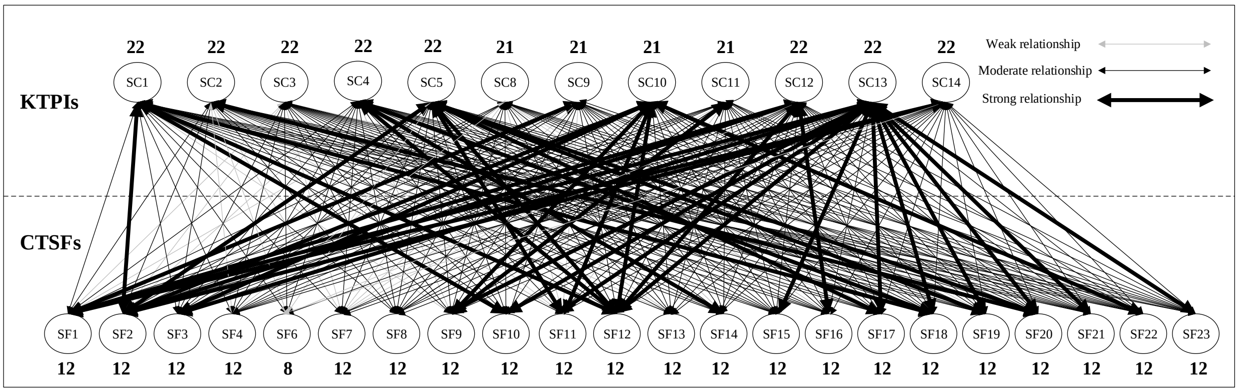

Figure 7.2 Correlations between KTPIs and CTSFs

7.3.2.2 Discussion

- ***Making the transfer management process more targeted***

In Chapter 6, the TPES was developed as a process that includes three evaluation nodes. In each node, the TSI approach was used to anticipate, monitor or evaluate the performance of transfer management. The information generated by distinct evaluations is expected to facilitate the process management of the transfer. This expectation assumed that a significant correlation exists between the TPES and the GTPM. The data analysis results in this section supported the assumption and further highlighted 41 strong correlations that could make the transfer management process more targeted. This section discusses only correlations regarding several KTPIs with the top effectiveness because of practical reasons.

The SC5, ongoing product provision, which ranked first among the KTPIs, was significantly related to all 22 CTSFs. Six CTSFs were strongly correlated to SC5, namely, SF2 (transfer committee), SF11 (acceptable assets), SF12 (transferred assets), SF17 (transfer acceptance criteria), SF19 (overhaul information) and SF20 (performance information), with correlation coefficients of 0.618, 0.637, 0.649, 0.644, 0.6 and 0.612, respectively. The correlation coefficients for both the SF12 and SF11 were relatively high, implying that ongoing product provision primarily requires the good condition of the project assets. This point is explicable for the water sector because qualified assets such as construction structures, machines and equipment are the base for producing high-quality water. The data analysis results also highlighted the SF17, whose importance in controlling transfer risks has been discussed previously. In this section, the importance of transfer acceptance criteria was confirmed again in terms of facilitating the number one transfer objective. Consequently, the practitioners of water PPPs in China should be reminded again that the current shortage of this factor needs to be solved as early as possible for the successful management of the TP. The next factor highlighted by the data analysis results is the SF2, transfer committee, which ranked 19th of the 22 CTSFs. This factor has not been discussed in much detail in Chapter 4 due to its relatively low score given by the experts. However, it is worth emphasising here given the strong correlation with the completion of the SC5. As previously stated, the main duty for this temporary task force lies in communication or coordination between the public and private sectors. If the transfer committee works inefficiently in the communication during the TP, then endless negotiations and disputes could be incurred. Under this circumstance, the ongoing product provision may be influenced as the project company may spend excessive attention in dealing with those unexpected disputes. This situation was partly observed from the Chengdu Project in which indecisive transfer committee meetings in the early stage of the TP were the subject of complaints by the staff of the project company (Bao et al. 2018).

The other two factors, SF19 and SF20, concern documental reports showing the process and results of two important transfer steps, namely, the overhaul step and the assessment and test step, which determine the condition of the projects assets to be transferred. For the government, learning the condition of the project assets directly and in a timely manner is impossible because the project is run by the SPV. In this context, the above two factors are mainly relied on by the government to evaluate the work of the SPV. If the information is acceptable to the government, then the SPV has fulfilled its responsibility and the project is in good condition for transfer and management in the post-TP. Therefore, from the local government's perspective, to learn the actual condition of the project assets, which plays a basic role in maintaining the ongoing product, the quality (e.g. authenticity and completeness) of the information factors matters. The transfer participants from the government agency should also improve their expertise for better comprehension of technical documents given that, based on the findings of this study, the capability for the government staff to deal with technical issues remains weak.

The SC1, complete technology transfer, which ranked second on the list, also has significant correlations with the entire 22 CTSFs, of which 21 were correlated with a moderate or strong strength, thereby implying that this target requires a comprehensive plan throughout the entire transfer process. Four correlations, namely, SF2, SF10, SF12 and SF18, were tested as strong. The criticality of these four CTSFs was discussed in detail previously and should be emphasised again for the target of the SC1. Similarly, the SC4, satisfactory asset performance, was correlated with all CTSFs and strongly with SF12, SF14 and SF18. Following the same manner, all KTPIs could be targeted by CTSFs with distinct correlation strengths. Table 7.1 summarise all strong correlations between KTPIs and CTSFs. The author suggests that these CTSFs deserve special concern when managing the transfer process due to their strong correlations with the KTPIs, although the other CTSFs require sufficient attention as well.

Table 7.1 CTSFs with strong relationships to KTPIs

KTPIs	**Rank of effectiveness**	**CTSFs strongly correlated**	**No. of strong correlations**
SC1	2	SF2, SF10, SF12 and SF18	4
SC2	5	SF20	1
SC3	8	--	0
SC4	3	SF12, SF14 and SF18	3
SC5	1	SF2, SF11, SF12, SF17, SF19 and SF20	6
SC8	4	--	0
SC9	9	SF1	1
SC10	12	SF2, SF3, SF9, SF11, SF12 and SF22	6
SC11	9	SF9	1
SC12	7	SF1, SF2, SF12 and SF16	4
SC13	11	SF1, SF3, SF9, SF10, SF11, SF12, SF15, SF17, SF18, SF19, SF20, SF21 and SF23	13
SC14	5	SF1 and SF2	2

- ***Verification of the relationship between "CSFs" and "success criteria" of PPPs***

Except for the implication to the transfer management of water PPPs in China, the identification of the significant correlation between the GTPM and the TPES also offers empirical contribution to the ongoing argument about the relationship between CSFs and success criteria. As mentioned earlier, mainly two types of PPP research exist in literature on success. The first type refers to the topic CSFs (e.g. (Chan et al. 2010; Jefferies 2006; Li et al. 2005; Zhang 2005; Zou et al. 2014)), while the second type is with respect to the topic 'success criteria' (e.g. (Liyanage and Villalba-Romero 2015; Osei-Kyei et al. 2017; Yuan et al. 2012)). In spite of numerous studies in each type, few have distinguished these two concepts. However, according to Lim and Mohamed (1999), an evident difference exists between the definition of 'criteria' and 'factor'. They explained project success criteria as a set of principles or standards for practitioners to judge the project success, whereas the project success factors are the set of circumstances, facts or influences that contribute to the project success. On the basis of Lim and Mohamed's viewpoint, Osei-Kyei et al. (2017) pointed out the distinction between success criteria and CSFs and proposed critical success criteria for PPP projects. As a result, previous researchers gradually realised the existence of differences between CSFs and success criteria of PPPs and have made some effort to qualitatively describe the possible close relationship between these two types of factors. However, this kind of relationship has not yet been verified by empirical evidence. In this study, the correlation analysis results empirically proved that, at least in the TP of the PPPs, a significant relationship does exist between the CSFs and success criteria. This conclusion, to some degree, supports the viewpoint that managing the CSFs of PPPs could contribute to the final PPP project success.

7.3.3 TRMS and TPES

7.3.3.1 Data analysis results

Figure 7.3 displays the relationship between the TRMS and TPES. In general, all 84 (7×12) correlations among the seven CTRCs and 12 KTPIs were tested as statistically significant, including 12 strong correlations, 68 moderate ones and four weak ones. Notably, a comparison of the three relationships among the GTPM, TRMS and TPES shows that the relationship between TRMS and TPES has the highest percentage of correlations with a strength above moderate (95%). Complete results of the correlation analysis between CTRCs and KTPIs are shown in Appendix G. The data presented above fully demonstrate the significance of the relationship between the TRMS and TPES. Therefore, H3 was confirmed to be true. This proven relationship between the TRMS and TPES offers a new angle to understand transfer risks—the transfer objective's angle—except for the two dimensions of risk severity and probability. The following part discusses this new angle in detail.

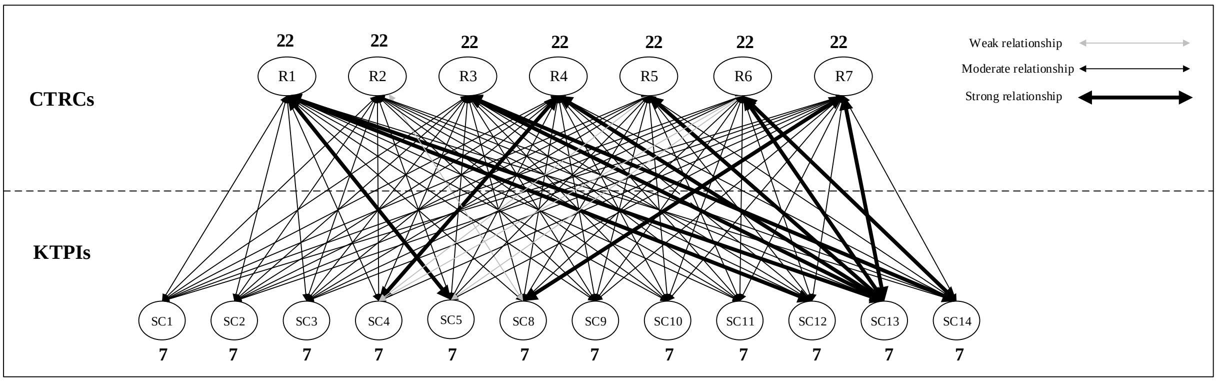

Figure 7.3 Correlations between CTRCs and KTPIs

7.3.3.2 Discussion

- ***Understanding transfer risks by transfer objectives***

Most, if not all, existing studies analysed PPP risks from two dimensions, namely, risk probability and severity (e.g. (Ameyaw and Chan 2016; Chan et al. 2011; Ke et al. 2010; Roumboutsos and Anagnostopoulos 2008)). Following the precedent, the present study defined transfer risk significance index to allow the transfer risks to be quantified and ranked by the significance. Inspired by the data analysis results, this section suggests that the transfer risks can also be analysed from the transfer objectives' perspective in addition to the two common dimensions. That is to say, besides being evaluated by the risk significance index, in this section, the transfer risks are illustrated through their correlations with the hierarchical transfer objectives. Indeed, this approach can be viewed as a result-oriented approach, which is useful when the project objectives refer to all aspects of the project environment (Malinen 1984).

Table 7.2 presents the results of rankings for CTRCs by the risk significance as well as by the correlation with KTPIs. A detail that can be easily observed is that the rankings of CTRCs according to correlation strength under 12 KTPIs vary and have no resemblance to the rankings by risk significance. To be simple, the top five KTPIs (i.e. SC5, SC1, SC4, SC8 and SC2) are taken as examples to do the illustration. For instance, the R1, overhaul risks, ranks first by significance, whereas under the top five KTPIs, it takes up the first, second, third, fourth and third positions, respectively. By contrast, the R7, succeeding operator risks, has the lowest significance among the seven CTRCs but ranks first according to its correlation with the SC8, timely designation of eligible succeeding operator. This finding indicates that, from a result-oriented perspective, not only should the risk significance be taken into account, but the priority of considering the CTRCs has to refer to the nature of the KTPIs per se. SC8 is taken as an example. This objective of the TP is related to the succeeding operator, who is responsible for the post-transfer operation of the project. Logically, one could infer that the SC8 may firstly refer to transfer risks regarding succeeding operator or post-transfer operation, while in practice, the data analysis showed that the CTRCs that are most strongly correlated with the SC8 include succeeding operator risks (R7) and post-transfer operation risks (R3). In this case, the data analysis results perfectly proved the logical deduction about the SC8 and its most closely related

CTRC.

Table 7.2 Comparison of CTRCs ranked by risk significance and by correlation with KTPIs

CTRCs ranked by significance	**CTRCs ranked by correlation**											
	SC5	**SC1**	**SC4**	**SC8**	**SC2**	**SC14**	**SC12**	**SC3**	**SC9**	**SC11**	**SC13**	**SC10**
R1	R1	R4	R4	R7	R2	R3	R1	R7	R3	R6	R1	R5
R2	R3	R1	R3	R3	R3	R6	R2	R2	R4	R3	R3	R1
R3	R4	R3	R1	R4	R1	R2	R3	R4	R6	R1	R7	R6
R4	R7	R7	R7	R5	R6	R1	R6	R1	R2	R5	R6	R3
R5	R2	R2	R2	R1	R5	R4	R4	R3	R7	R4	R4	R2
R6	R5	R6	R6	R6	R4	R7	R7	R6	R5	R7	R5	R7
R7	R6	R5	R5	R2	R7	R5	R5	R5	R1	R2	R2	R4

However, not all the relationships between the CTCRs and KTPIs are as self-explanatory as those between the R7 and SC8. Although completely understanding all correlations may require more in-depth investigations, the results so far indicate that transfer risk management of water PPPs in China could benefit from appropriate utilisation of the TPES. As shown in Figure 6.5, three evaluation nodes are included in the TPES for the anticipated, midterm and final performance of KTPIs, respectively. From the evaluation results, the KTPIs with low scores could be found, and in turn, their relevant transfer risks could be listed according to the correlation strength. In so doing, the connection between the performance evaluation process and transfer risk management process is established in practice.

Through this section, the three hypotheses related to the relationships of the three models (i.e. the GTPM, TRMS and TPES) were tested by data collected via questionnaire survey. The test results fully support the hypotheses, leading to implications that can facilitate the transfer management from multiple aspects. More importantly, the test results provide a solid basis for the further development of the holistic transfer management system, that is, the DFTMS, which is expected to synthetically address the latent three TCE issues in the TP. The following section presents the development of the DFTMS in more detail.

7.4 Managing the transfer of water PPPs in China by DFTMS

The statistical analysis proved the interrelatedness of the three models by identifying all significant correlations between three kinds of factors of the models. As shown in Figures 7.1, 7.2 and 7.3, the significant correlations of these three kinds of factors (i.e. KTPIs, CTRCs and CTSFs) have a distinct strength that can be generally divided as weak, moderate and strong. To be more specific, the values of the correlation coefficients are actually different from each other, even for those belonging to the same strength group. In this case, through a, say, KTPI, one could identify a series of, say, CTRCs with unique rankings of correlation strength (see Table 7.2). As stated previously, the correlation between two factors does not imply causality; however, the strong positive correlation can be used for effective control of one factor by dealing with the other (Shrestha et al. 2017). According to the above points, this study highlights two roles of the correlations between factors: (1) identifying correlated factors of one factor and (2) improving one factor by managing the correlated ones. Consequently, this study proposes to use the efficacy of the various correlations between three types of factors to establish the DFTMS.

7.4.1 Modules of the DFTMS

To attain the research objective RO4, the DFTMS should be able to offer holistic directions to transfer process management, transfer risk management and transfer performance evaluation of the water PPPs in China. In other words, the three sub-models developed for the RO1, RO2 and RO3 should be compatibly integrated in the DFTMS. To achieve this compatibility, three modules of the DFTMS are proposed firstly, and then the entire model is constructed at the end of this subsection.

7.4.1.1 Module one: pre-evaluation of the project for transfer

The first module focuses on the initial knowledge of the status of the project to be transferred. As shown in Figure 7.4, all documents, data or any other kind of materials relevant to the water PPP project need to be collected and analysed by the management team responsible for the transfer. From the local government's perspective, the participants of the transfer are normally officials from different departments related to the project, representing the government to deal with transfer issues. As for water PPPs, the related department may include the local water authority and the project approval authority (e.g. local Development and Reform Commission). If foreign investment is involved (e.g. the Chengdu Project), then the department that is responsible for the asset ownership (e.g. local State-owned Assets Supervision and Administration Commission) may also be included. Considering the limited industrial expertise of administrative officials in China, the key to develop an effective transfer team of the government side is to ensure the participation of technology experts with deep understanding of the water sector PPPs in the team (Bao et al. 2018).

After a preliminary review of the project by the data throughout the PLC, the next step for the government representatives is to pre-evaluate the project through the approach developed in Chapter 6. On the basis of the knowledge of the project status, the performance of the 12 KTPIs is rated and calculated by the process proposed in

Section 6.4.4. As a result, the anticipated transfer success can result from the scores of the KTPI, KTPIG and the overall TSI. According to the quantitative results, KTPIs with relatively low scores can be identified and linked with CTRCs and CTSFs according to the research outcomes of Sections 7.3.2 and 7.3.3. Subsequently, the identified CTSFs and CTRCs are further illustrated with reference to the research outcomes of Chapters 4 and 5, respectively, resulting in implications to facilitate normal transfer process management and transfer risk management. In particular, these implications from module one could be specified into each transfer step given the correlations revealed between the GTPM and other two models. As the example of the Figure 7.4, module one benefits the A1 step of the TP by offering specific information belonging to this very step.

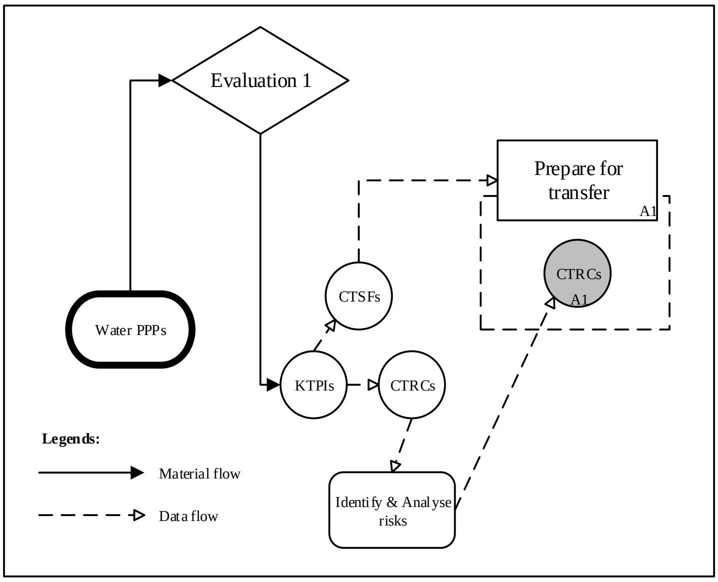

Figure 7.4 Pre-evaluation of the project for transfer

7.4.1.2 Module two: management of the transfer process

Module two handles the process management of the TP. According to the GTPM, the

TP is mainly divided into five steps in which the transfer tasks and risks vary. Therefore, each step requires special consideration to deal with the varied characteristics. Taking the A1 step as an example, Figure 7.5 expresses how module two works to dynamically complete this transfer step. The rest of the transfer steps could be managed following the same way.

Given the contribution of module one, ideally, the A1 step is equipped with necessary inputs for its operation. In other words, the government representatives possess the necessary information to make appropriate decisions when negotiating with the representatives from the private sector in the transfer committee meetings through which the overall transfer arrangement as well as other CTSFs are generated. The details about how to effectively manage the A1 step can be found in Chapter 4. However, due to the imperfections of the CTSFs, which is a more common situation under China's immature PPP development, transfer risks are likely to occur during the TP. From the case study of the Chengdu Project, the A1 step is problematic for China's water PPPs. Therefore, on the basis of the information from module one, the risk management plan is prepared and applied to the practice. To manage transfer risks, two scenarios are considered. In scenario one, no CTRC happened (to be concise, only CTRCs are displayed in Figure 7.5 and discussed here. For the other possible transfer risks, the method of managing them is the same). Hence, all the CTRCs identified in the A1 step are monitored along with the normal actions of the step. In this case, management strategies focus on control of the risks. In scenario two, CRTCs occurred. Accordingly, CTSFs relevant to the CRTCs that occurred are identified, and in turn, prepared measures are performed for these CTSFs to mitigate the CTRCs. In this scenario, the focus of the management strategies is shifted to the response of the risks.

The comprehensive analysis of transfer risks and their related CTSFs could benefit from the findings in Chapters 4, 5 and 7. Finally, the outputs of the A1 step are used by the A2 step, which could also be managed following the procedures of module two, and so on and so forth.

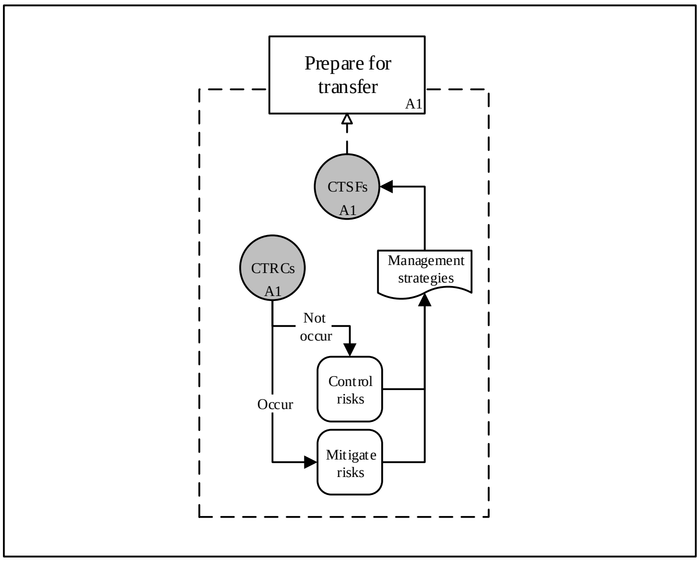

Figure 7.5 Management of the transfer process

7.4.1.3 Module three: evaluation of the transfer management results

Module three deals with the evaluation of the transfer management results during the TP. To fully take advantage of the TPES in process control of the transfer management, in Chapter 6, this study proposed three evaluation nodes during the TP, namely, evaluations 1, 2 and 3. While the first evaluation plays a central role in module one, the latter two evaluations are the key of module three. Evaluation 2 is taken as the example to explain the process of module three.

Through steps A1, A2 and A3, the performance of the project's physical assets is supposed to satisfy the requirements of the post-transfer operation. However, as stated in Chapter 6, satisfactory asset performance is only one criterion of the hierarchical transfer success criteria system. A more comprehensive evaluation based on the KTPIs is therefore necessary to determine the acceptance of the overall project before the formal transfer is performed. The inputs of the module include the latest physical and informative products generated by the former three steps of the TP. Relying on the assessment and test results of these latest products, government representatives can compare the new status of the project to the old one anticipated in module one, thereby acquiring more practical understanding of the overall project condition. With this updated understanding of the project condition, the KTPIs can be evaluated by the TPES developed in Chapter 6. The result of the evaluation could be acceptable or not acceptable. For an acceptable result, the project assets plus all other involved items are formally transferred from the private sector back to the local government as scheduled, and then the rest of the transfer steps continue; for an unacceptable result, which means the project does not meet the standard of acceptance from the government's perspective, the particular performance of the KTPIs should be carefully examined and those with low grades should be analysed in association with the CTRCs and CTSFs. In so doing, the management weaknesses of the past transfer steps could be identified, and hence, measures could be taken to fix the issues regarding certain CTRCs or CTSFs. Similar to the other two modules, module three also needs to systematically use the research findings from sections on transfer process management (Chapter 4), transfer risk management (Chapter 5) and transfer performance evaluation (Chapter 6). The outputs of module three flow into the next steps of the TP (or the post-transfer operation phase in the case of Evaluation 3), in which module two continues to work to maintain the smooth transfer process.

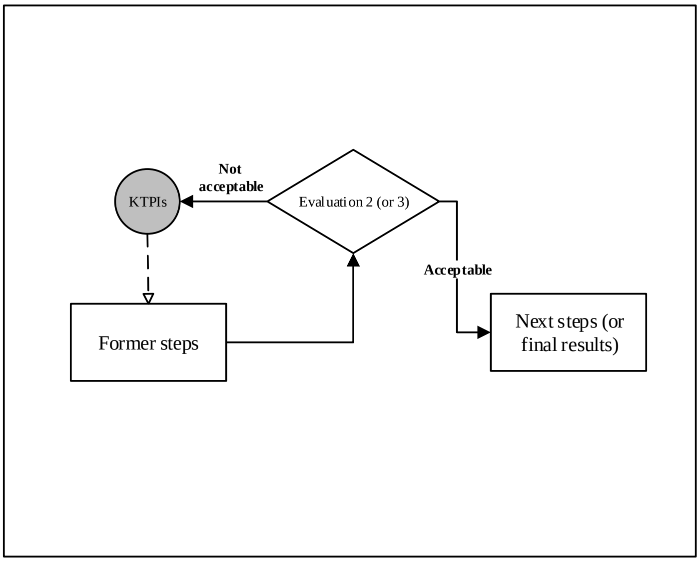

Figure 7.6 Evaluation of the transfer management results

7.4.2 Full view of the DFTMS

The DFTMS is acquired by organising the three modules in process-based pattern. As shown in Figure 7.7, the DFTMS consists of all key components of the transfer process. These components represent the key findings of the prior chapters and can be understood from the horizontal and vertical dimensions.

From the horizontal dimension, the transfer management starts from *module one*, through which more applicable transfer process and risk management plans are developed. Then, through running *five module twos*, which correspond with the A1, A2, A3, A4 and A5 steps of the transfer process, each and every transfer task will be completed. Within each step, the transfer risk management plan is implemented simultaneously. The transfer performance is evaluated in proper timings by *module three*, from which the decisions on whether to move on to the next step or to review the past steps for improvement are made. The first module three is placed between the A3 and A4 steps to learn the in-process performance of the transfer management, while the second module three is at the end for the final transfer management performance (refer to Section 6.5 for detail).

From the vertical dimension, the DFTMS is clearly compatibly constituted by the three sub-models, i.e. GTPM, TRMS and TPES. As shown in Figure 7.7, these three sub-models are visually placed in three levels to ease the understanding of the readers, but in essence, they are embedded in each other during the entire transfer process. The exchange and transmission of material and data among the three sub-models are realised via the significant correlations in between. In Figure 7.7, these correlations are presented by the connections among the KTPIs, CTRCs and CTSFs.

In summary, the DFTMS serves as a process-based model that compatibly integrates the transfer process management, transfer risk management and transfer performance evaluation, by which the three significant TCE issues in the TP are fully considered and effectively controlled during the entire transfer process.

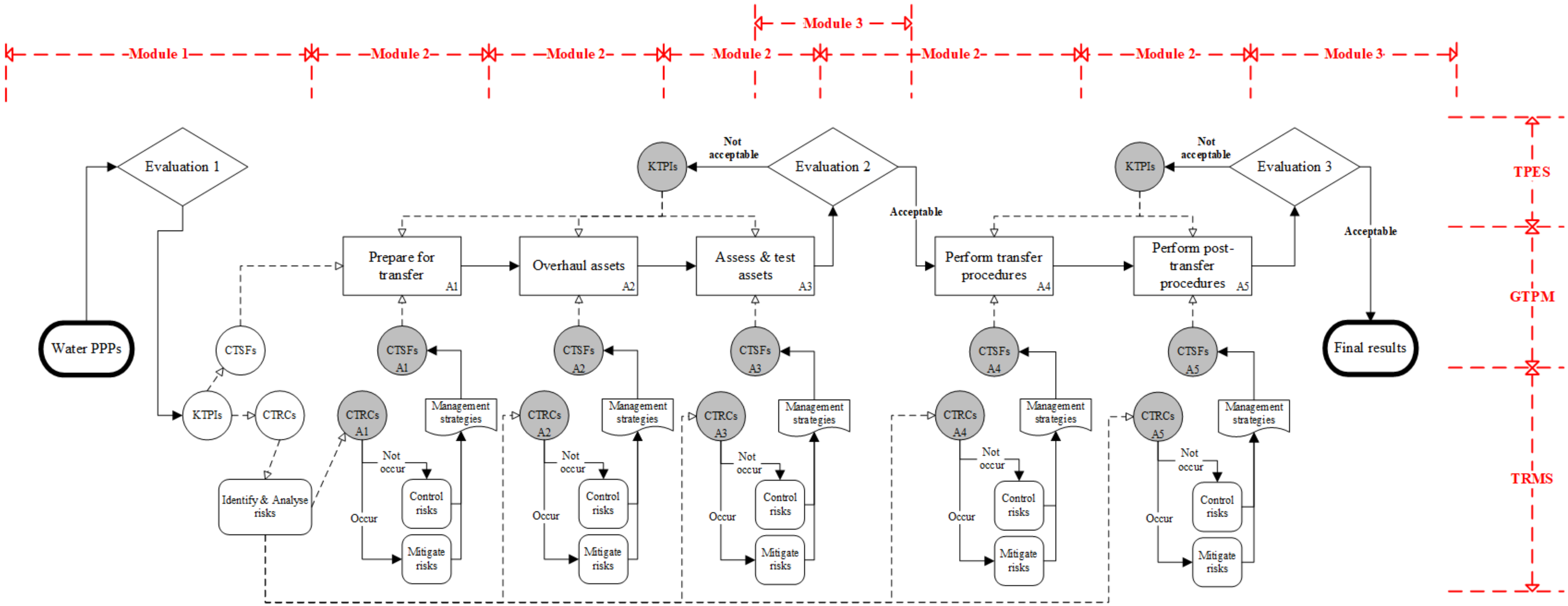

Figure 7.7 Dynamic framework transfer management system

7.5 Model validation

According to Hillston (2003), a model is an abstraction of the actual system it depicts. To develop a model, unnecessary details need to be eliminated to allow the model to concentrate on the key elements of the system that are important for the analysis of the model users. Nonetheless, the elimination process may also lead to inaccurate or even false description of the actual system. Therefore, validation is needed for a newly developed model before its application. In particular, model validation is the task to determine how well the model can represent the real-world system, and its ultimate goal is to prove that the model is able to offer accurate information about the system it represents to facilitate the decision making of the practitioners (Macal 2005). In this study, although the development of the DFTMS was based on a rigorous process and reliable data, model validation was also conducted to test its effectiveness in addressing the TCE issues of the TP and consequently facilitating the smooth transfer. The rest of this section presents the method, criteria, process and results of the validation of DFTMS.

7.5.1 Method and criteria

The final DFTMS was validated by interview. According to the research design, DFTMS was constructed mainly on the basis of the statistical analysis result. However, the construction course of the model unavoidably contained some individual insights of the author, which required further validation for reliable research outcomes. Several means have been adopted by prior studies to validate research outcomes in the PPP domain, such as case study (Zhang et al. 2016) and numerical example (Liu et al. 2016). The case study method was not practical for this study because very few water PPPs in China have reached the TP. Simulation-based ways (e.g. numerical example) were not suitable because of the difficulties in digitising the complex transfer process. Instead, industry-wide experts' opinions were deemed more practical and appropriate for validating the outcomes of this study, which per se has an exploratory nature and aims to benefit the practice of the industry (Zayed and Chang 2002). The process of the validation interviews basically follows the prior interviews of this study, and its questions mainly refer to the efficacy of the model in handling TCE issues in the TP, as well as to the description, scope, model consistency and model comprehensiveness (Mokhtar et al. 2016), which will be discussed in more detail later.

7.5.1.1 Qualitative interview for model validation

Generally speaking, model validation could be conducted via various methods, such as expert intuitions, real-world cases and computational simulations (Hillston 2003; Macal 2005). Comparing the model with real-world cases is deemed the most reliable way; however, it is often infeasible either because the comparison could be too costly to conduct or no appropriate real-world cases are available (Hillston 2003). As mentioned previously, the Chengdu Project is the only water PPP that has experienced the TP in China. Given that it has been taken as the case for model development, other water PPP projects can be used for model validation; however, no other appropriate water PPP projects were available during the research period. Some mathematical models could be validated by computational simulation, which could simulate the real-world system by computer technology. Unfortunately, the DFTMS is a process model that covers the entire TP and includes massive decision points relating to distinct objectives, which means that it is too complex to be simulated by a computer under the limited research resource of this study. As a result, to deal with the complexity of the process model, some researchers suggested adopting the expert validation method.

For instance, Beecham et al. (2005) used expert panel means to validate their requirement capability maturity model; Mathew et al. (2011) performed content validation of an experimental assessment process for the safety of assistive technology by a panel of six experts; and Mokhtar et al. (2016) selected a few experts to validate their function-based classification model for electronic records. The variety of the application areas proved the effectiveness and applicability of the expert means in dealing with the validation of the process model. Following the precedence established by the literature, the present study conducted model validation of the DFTMS by referring to the experts with respect to the water PPP sector of China.

While all eight interviewees participated in the identification of initial transfer risk categories and transfer success criteria, only four of them, namely, two industry experts and two academic researchers, offered their insights for the final model validation. The other four experts could not be involved in the model validation due to their busy schedule during the interview period, which is understandable because they are all senior-level management members of their entities. Despite the reduction of interviewees, no more other interviewees were added to the model validation stage due to the rigorous selection criteria of candidates. Validating the outcomes of a research study requires the participants to be information-rich so they can provide thorough and sophisticated insights (Liamputtong and Ezzy 2005). Therefore, the criteria for identifying the experts for model validation of this study were two-fold. Participants must possess extensive knowledge about the research area, and they also must have in-depth understanding of this particular study so that they can effectively assess whether or not the research process was solid, and all research objectives were achieved. The selected four expert interviewees not only participated in the initial factor identification stage but were also involved in the questionnaire survey stage, which means they had enough knowledge about this particular study. Therefore, they emerged as the best candidates for the final model validation. Other experts were not involved because they failed to meet both criteria. In fact, due to the solidity of the modelling method (i.e. triangulation method), many researchers who also proposed process-based managerial models in a similar way have not conducted model validation procedures (Bevilacqua et al. 2012; Climent et al. 2009; Cloutier and Verma 2007).

7.5.1.2 Criteria for model validation

To the best knowledge of the author, this study serves as the first effort to validate the process model in the PPP domain. Therefore, eight validation criteria for the DFTMS were proposed based on similar existing research in other areas, such as Beecham et al. (2005) and Mokhtar et al. (2016). The criteria list was adjusted, and the specific description of each criterion was accordingly rephrased to adhere to the research objectives of this study. Table 7.3 summarises these eight criteria and their descriptions.

Table 7.3 Criteria for validation of the DFTMS (adapted from Beecham et al. (2005) and Mokhtar et al. (2016))

Criterion	**Descriptions**
Compatibility	The proposed overall model should compatibly integrate three sub-models so that it contains all necessary elements and could clearly indicate the users what the next step is whenever encountering issues during the TP.
Scope	The model serves as the simplification of the entire transfer management process and hence is impossible to include all details about the TP. However, the scope of the details represented by the model should be appropriate.

Consistency	There should be appropriate consistency in the use of terms to describe the model components, in level of granularity at which the structure between model components or within each sub-model is constructed, and in organization of the processes outlined by the model versus the ones of the real-world TP.
Ease of understanding	The model should be clearly defined with accurate and understandable terms, so all the users can acquire unambiguous and effective information by the model to facilitate their decision makings in the TP.
Ease of use	Each part of the model has been sufficiently decomposed into a level that is simple enough for normal users to understand and requires little training to use the model.
Tailorability	The structure of the model must be flexible, modular and transparent enough to let the users tailor it to suit the particular project development context.
Upgradability	As time goes by, the model allows to be upgraded by modifying the relevant processes, parameters, and/or any other model elements according to the change of the environment of the project.
Effectiveness in addressing TCE issues	In overall, the adoption of the DFTMS can effectively address the three potential TCE issues (i.e. the adaptation issue, safeguarding issue and performance evaluation issue) of the TP and facilitate the smooth transfer of the water PPPs in China.

7.5.2 Validation process

The qualitative interviews for the model validation were conducted between June and July 2018. Face-to-face and telephone interviews were adopted to ensure the accessibility of the four expert interviewees during the validation period. Regardless of the interview approach, the main research outcomes, including the DFTMS and three sub-models, the validation criteria and brief interpretations, were sent to them in advance for their information. On interview day, further explanation was given to the interviewee firstly if needed, and then the interviewee started to evaluate the proposed models in accordance with the validation criteria. Given the profound understanding of the water PPPs and their general knowledge about the present study through the earlier participation, all interviewees did not encounter any major issues in understanding the validation objectives and the criteria and therefore can cut to the chase quickly during the interview process. To provide the interviews as much as possible flexibility to make judgment, the experts were simply asked if they considered the research outcomes of this study as acceptable in a certain criterion and why. Each interview lasted for 40 to 60 minutes or so, and the whole process was recorded. Audio records of interviews were then transcribed. The interview transcripts were then further processed through content analysis to extract both manifest and latent information regarding the validation of the research outcomes. Each interviewee was given a code to facilitate the revisit of the data as the analysis was conducted.

7.5.3 Validation results

7.5.3.1 Compatibility

All expert interviewees agreed that the DFTMS integrated the three sub-models in a compatible way. The elements from different sub-models, they pointed out, are connected in a coherent manner, forming a complete system that offers holistic guidance for the multiple possible scenarios of the transfer management. They believed that the establishment of the GTPM is the basis for the compatibility of the DFTMS, because the hierarchically decomposed GTPM could offer optional time points and management means for the operation of the TPES and TRMS. To support this point, one senior manager from a water company (referred to as Exp. 1) claimed as follows:

> Compatibility is not a problem as long as the GTPM has been well developed, because knowing the details of the transfer process makes it possible for model users to flexibly set the appropriate time points for performing evaluations or to immediately identify related factors when risks occur. To do so, your suggested way to combine the three sub-models could be helpful, and of course, our particular project condition should be considered as well.
>
> (Senior manager, Exp. 1)

7.5.3.2 Scope

In general, experts deemed the model scope of the DFTMS as acceptable given that it contains complete key components of the process for managing the TP. These key components have been fully described to provide sufficient details about how to conduct overall transfer management step by step. Hence, the model users can directly follow the instructions of the model to form the management scheme for the transfer of water PPPs. Moreover, the experts expressed full understanding of the scope limitation of the model, as stated by a PPP researcher (referred to as Exp. 2):

> I would say it (the model scope) is completely acceptable. It (the model) lays a good basis for further study on the TP of water PPPs or PPPs in other sectors. One cannot solve all problems in a single research study.
>
> (PPP researcher, Exp. 2)

An expert who admitted the acceptance of the model scope in general also expressed some concern about the extent to which the details presented by the model can be directly applied to the future transfer management of the water PPPs in China. The expert's concern was mainly due to the heavy reliance on the sole Chengdu Project case study. For this point, the interviewer interpreted that the Chengdu Project was the only one water PPP project that had experienced the TP and was also followed by a great number of succeeding water PPPs in China, which means a wide application market of the model. With this interpretation, the concern of the expert was greatly reduced.

7.5.3.3 Consistency

From the experts' assessment, consistent terms were used in the description of the model and the sub-models. Therefore, the model could be understood by all kinds of users with basic industrial common language. In terms of the level of granularity, some difference existed between three sub-models. For example, the GTPM seemed to have a higher level of granularity than the TRMS and TPES. However, experts admitted that this difference is understandable as the GTPM was newly proposed by this study and hence was unfamiliar to the practitioners who tend to have relatively more experience in dealing with general PPP risks and performance evaluation. This idea could be supported by Exp. 1, who indicated that

> As a leading water company in China, we have rich experience in managing the PPP risks and performance evaluation before the TP. This experience could be helpful to transfer management, but the primary thing is that we need to know what the transfer risks and performance criteria are.
>
> (Senior manager, Exp. 1)

For consistency between the process outlined by the model and the actual TP, experts shared the same agreement that the model could be a good abstraction about what the processes of the TP are and how the TP should be handled step by step.

7.5.3.4 Ease of understanding

The experts believed that the model per se is understandable due to the unambiguous definition of the model elements and the explicit description of the connections between the elements. Moreover, the model can also help practitioners better understand the management of TP by its hierarchical diagrams that reveal the different levels of activities plus physical and informative flows in between. The other PPP researcher interviewee (referred to as Exp. 4) remarked on the ease of the understanding criterion as follows:

> IDEF0 offers much ease for the understanding of the model, as it is a mature and proven tool for process modelling. Showing the overall transfer management process by using a framework model is also helpful given its simplicity and clearness.
>
> (PPP researcher, Exp. 4)

In addition, considering that this study adopts the local government's perspective, Exp. 4 suggested a more flexible range of the interpretation of the model usage to adapt to the distinct levels of the local governments in China:

> Personally, I believe that it is not a problem for high-level local governments, such as the Chengdu municipal government, to understand the model, because they can seek help, if necessary, from professionals easily. But some local governments with less technology support may need

a more understandable model explanation.

(PPP researcher, Exp. 4)

7.5.3.5 Ease of use

Relatively more arguments rose from this criterion. Two PPP researchers gave a more positive appraisal of the usability of the research outcomes. They believed that this study has clearly indicated the answers to several key questions of the potential users about adopting the model. According to Exp. 2, the key questions related to the ease of adaptation included the following:

> I considered four questions to assess the usability of the model: (1) what are needed? (2) who should be involved? (3) when is the proper time for certain activity? and (4) how should the activities be carried out? The DFEMS, in my case, offers adequate answers for these questions.
>
> (PPP researcher, Exp. 2)

As far as the industry experts were concerned, they generally admitted that significant information about the model usage was provided by this study. However, they emphasised the role of the computerisation of the research outcomes in easing the use of the model, as stated by Exp. 1.

> To be honest, the best situation is that all your findings can be computerised, and that would really ease the use of the model very much. I bet the government would agree with me on this point.
>
> (Senior manager, Exp. 1)

7.5.3.6 Tailorability

Little dissent was expressed about the tailorability of the model among all four expert interviewees. The model was generalised from the official PPP guideline and the typical case of China's water PPPs, indicating that it is likely applicable to the transfer of most water PPPs in China. Exp. 3 confirmed the applicability of the model by referring to the exemplary role of the Chengdu Project.

> The model could be applicable to most, if not all, water PPPs in China that were developed after the Chengdu Project. The truth is that we had no experience in developing water PPPs at that time, so the Chengdu Project naturally became the benchmark of the sequent exercises.
>
> (Senior manager, Exp. 3)

The model also allows the users to customise the specific transfer management process by adding, removing or decomposing certain transfer steps or by adjusting the list of CTRCs or KTPIs, because the model structure was flexible, modular and transparent, and the means to develop each module was explicitly described by this study as well.

7.5.3.7 Upgradability

While tailorability refers to the changes caused by particular project condition, upgradability refer more to the changes that resulted from the institutional environment, such as the change of law, policy or economic condition From the experts, the model was equipped to have sufficient upgradability. The basis for the upgradability is similar to that of tailorability, that is, the flexible, modular and transparent model structure that allows users to fix the model weakness in time when the model does not meet the latest institutional environment. In fact, the experts suggested regular upgrades of the model to maintain its usability concerning the dynamic PPP institution system in China, as stated by Exp. 4:

> As we can see, currently, in China the institutional environment of PPP development remains very dynamic, under which the PPP participants, regardless of the public or private sectors, should be alert to the latest changes from the national level. When it comes to the TP, the DFTMS should be checked from time to time according to those changes, as some change may directly impact the main objective of the transfer.
>
> (PPP researcher, Exp. 4)

7.5.3.8 Effectiveness in addressing TCE issues

Finally, the experts were requested to evaluate the research outcomes for their effectiveness in addressing TCE issues, namely, adaptation issue (P1), safeguarding issue (P2) and performance evaluation issue (P3). As discussed previously, due to P1, the transfer process could be unknown to the practitioners, leading to costly, time-consuming transfer management; due to P2, the project value is likely to be undermined by transfer risks; and due to P3, the transfer management performance tends to be unclear to the government.

The experts deemed that the DFTMS in which three sub-models are compatibly integrated is capable of addressing these three TCE issues effectively. Particularly, they believed that using GTPM to address the P1 was ‘practical’ and ‘enlightening’, as claimed by Exp. 1:

> As you mentioned, the adaptation issue refers to the incompleteness of the PPP contract, which seems to be doomed to happen according to TCE theory. In this case, I think it is much more practical to solve the problem by focusing on the TP itself than trying to draw a complete contract in advance of decades of years. So, in my view, the GTPM made it, and besides, it is really enlightening to me, as I have not carefully thought about transfer management yet. Good job!
>
> (Senior manager, Exp. 1)

Originally, in the business area, P2 mainly concerns the opportunism risks, while this study expands the risk scope considering the complexity of the PPP mode. The need to redefine the safeguarding issue in the context of this study has been confirmed by the research findings in which a series of risk categories was identified as significant and opportunism risks ranked eighth (please refer to Chapter 5). After being told the above information, the experts expressed their support for the TRMS in effectively addressing the P2, as indicated by Exp. 4.

> The CTRCs is interesting to me. It fully shows the uniqueness of the TP in risk management. I have no doubt as to its reference value to the PPP practitioners who will be facing PPP transfer sooner or later. Managing the transfer risk by referring to the process model factors is also inspiring and original. I would like to see the application of the model in the future.
>
> (PPP researcher, Exp. 4)

Experts also positively evaluated the effectiveness and objectiveness of the TPES to solve the P3. They believed that the hierarchical structure of the transfer success is desirable for the users to appropriately allocate limited resources on different levels of objectives. They also agreed that the quantitative evaluation method and multiple evaluation nodes could help model users understand the performance more accurately and dynamically. Exp. 1 mentioned the benefits that the private sector could achieve from the model.

> Although your model was developed from the local government's perspective, I believe we (water companies in China) could also benefit. Firstly, it is necessary to know what our partnership expects from the transfer, and secondly, some of the KTPIs are actually quite informative to us as well, such as the reduced employee objections, which we definitely should pay attention to when doing transfer work.
>
> (Senior manager, Exp. 1)

7.6 Summary of the chapter

This chapter investigated the interrelatedness among the three sub-models developed in the prior three chapters to construct the integrated model, DFTMS (RO4). Three hypotheses regarding the significant correlations between GTPM and TRMS, GTPM and TPES, and TRMS and TPES were proposed. By analysing the data collected via the questionnaire survey, we found that the correlations among the CTSFs, CTRCs and KTPIs were statistically significant, indicating that the three hypotheses were supported. The data analysis results also revealed that different KTPIs were connected with CTRCs and CTSFs by different strengths. As a result, the specific correlations among the three types of factors can be used to systematically and dynamically manage the transfer process and control the transfer risks and finally achieve the hierarchical transfer objectives. To do so, three modules that compatibly integrate components from three sub-models were proposed, that is, module one: pre-evaluation of the project for transfer; module two: management of the transfer process; and module three: evaluation of the transfer management results. The three modules were assembled in accordance with the sequence of the transfer process, leading to the overall transfer management model, the DFTMS, by which the practitioners can be given comprehensive knowledge about the transfer management and therefore be prepared to keep the three possible TCE issues in the TP under control. At last, by considering eight criteria, expert interviewees validated the proposed DFTMS and offered suggestions for the future promotion of the model. The next chapter will summarise the key findings of the entire study and will also present the significance of the findings, the limitations of the study and the potential future research directions.

CHAPTER 8 CONCLUSIONS AND RECOMMENDANTIONS

8.1 Introduction

This chapter provides a global summary of the study to accentuate the main research findings, the significance and contributions, limitations and possible future research directions. The chapter is organised as follows: Section 8.2 summarises the major findings by five points; Section 8.3 points out the significance and contributions to both the academia and the industry; Section 8.4 discusses some limitations of the study; and Section 8.5 shows several potential research directions for future researchers.

8.2 Summary of the major findings

This study started from an extensive literature review of the PPP research from a life cycle perspective. The analysis of the literature showed that, compared with other phases of the PLC, the TP has received much less attention from the PPP researchers. By using TCE theory, this study identified three major issues related to the successful transfer of the water PPPs in China. To address the three issues, four research objectives plus a series of research questions were defined, and accordingly, an appropriate research methodology was selected and conducted to attain these research objectives. Therefore, the major findings of this study can be summarised into five aspects that respectively refer to the life cycle-based literature review and other four sections focusing on the fulfilment of the four research objectives. These main findings are presented as follows.

8.2.1 Review of PPP literature from a life cycle perspective

To understand the research status of the PPP field, this study provided a systematic literature review of the state-of-the-art PPP research published in seven selected journals, namely, JCEM, CME, IJPM, JME, PICE-CE, ECAM and JIS, from 1996 to 2016.

On the basis of a structured search method and a five-step classification process, a total of 282 papers were identified and classified from the life cycle perspective. Analysis showed that existing research has covered the entire concession life cycle, whereas the distribution of papers differed from phases. The project preparation phase was the subject of most papers, while the implementation phase was with the most researched topics. The highlighting of these two phases is understandable because of the detailed and complex requirements for PPP preparation and the difficulty in managing a long-term concession period. The project identification and procurement phases also attracted a significant amount of research on distinct topics. By contrast, very little literature has been identified on the TP possibly because few projects have reached this phase. Quite a few papers referred to indivisible topics given that they cannot be classified into any single phase appropriately, which may show that system thinking is critical for PPP development.

On the basis of the life cycle taxonomy, an extensive literature analysis and a series of future studies have been presented. This study suggested that the TP, which is the end of a PPP contract life cycle and the start point of post-transfer operation, requires more comprehensive studies given that the problematic transfer process has been observed while little has been known about this phase. Other future studies, such as risk allocation on the identification phase, optimisation of mathematical models on the preparation phase, concessionaire selection on the procurement phase, risk management on the implementation phase and the application introduction on the indivisible topics, have also been recommended. The literature review built the connection between important project problems and PPP phases from which PPP practitioners may benefit because they know better what problems need to be particularly considered in a certain phase. Researchers may be inspired by the research outcomes to nourish the existing body of PPP knowledge by focusing on phases that have been underrated previously. The knowledge gap in the TP was accentuated, offering important inspiration to the formulation of a systematic research scheme on the TP of this study.

8.2.2 Modelling the transfer process

The first research objective RO1 was to develop the GTPM to address the adaptation issue of the TP of China's water PPPs. To attain the RO1, four research questions, that is, RQ1 to RQ4, needed to be answered. The first research question RQ1 regarded the status quo of the transfer process. The answer to this question was exhibited by the as-is model built by using IDEF0 language and an extensive literature review. Findings indicate that in China, the transfer process of water PPPs currently consists of four steps connected by 18 process factors that were classified into four groups.

The second research question RQ2 related to the deficiencies of the current transfer process. To acquire the answer to this research question, the as-is model was used to analyse the transfer process of the Chengdu Project. The results of the case study revealed the following six major deficiencies in the current transfer management regime in China:

- Disordered transfer preparation process;
- Problems in making the overhaul plan;
- Late determination of the transferee;
- Lack of emphasis on personnel settlement;
- Impracticality of evaluating the PPP life cycle performance; and
- Low quality of process factors in the as-is model.

Continuous observation of the transfer of the Chengdu Project was conducted to seek the answer for the RQ3 regarding the measures to address the six above deficiencies. As a result, six measures were suggested to handle the existing transfer deficiencies. According to the six measures, the as-is model was modified into the to-be model that was proposed as the best practices for the transfer management of water PPPs in China. In the to-be model, five steps and 23 process factors that form a number of material and data flows in the TP were identified. These factors were further categorised into four groups according to the similarity of their roles within the model.

Research question RQ4 investigated the criticality of the 23 process factors identified by GTPM. Statistical analysis showed that 22 out of the 23 process factors were critical to the success of the transfer process; therefore, they were identified as CTSFs. An analysis of the 22 CTSFs by factor group showed that the feedback factors were the most critical factor group, followed by product, process control and constraint factors. This result was different with the ranking of CSFs for normal PPP development phases (i.e. phases prior to the TP), implying that the success of the TP requires attention to factors with different criticality order. The difference of the criticality ranking of the CTSFs could be explained by the characteristics of the TP.

8.2.3 Managing the transfer risks

The second research objective RO2 referred to the development of the TRMS by which the safeguarding issue of the TP was controlled. To develop the TRMS, the RO2 was further decomposed into three research questions, namely, RQ5, RQ6 and RQ7.

The RQ5 was relevant to the identification of the key risk categories of the TP. Initially, 19 risk categories were identified as the potential critical transfer risks, including 14 adapted from literature and 5 suggested by experts considering the traits of the TP. An analysis of the data from the questionnaire survey shows that the experts from the academia and industry paid more attention to the risks in the TP than those from the public sector and consultancy. This situation could remind the local governments and consultancies in China to focus more on the transfer of the water PPPs for its successful implementation.

The RQ6 concerned the risks' significance by which CTRCs could be obtained. According to the evaluation from all expert respondents, seven risk categories were finally identified as CTRCs with statistically critical risk significance, including overhaul, contract, post-transfer operation, residual value, political, information, and succeeding operation risks. Of the seven risks, three had never been identified by past PPP studies, and as a whole, these seven risks deemed significant in the TP were distinct from the situation in other PLC phases, which again confirmed the uniqueness of the TP. Another finding was that the succeeding operator risks should be noted as it was significant to the TP but also received relatively less attention from the government and consultancy.

On the basis of the above findings, the managerial implications and the final TRMS were presented and hence, the RQ7 focusing on managing the transfer risks were answered. In particular, four managerial implications were proposed to the seven CTRCs regarding the improvement of the institutional environment, local government, private sector and the cooperation of the government and the private sector. Consequently, the process for conducting effective transfer risk management was visualised by the TRMS framework model in which the transfer risks were connected to the CTSFs of the GTPM. In other words, the model contained an assumption that a close relationship existed between the TRMS and GTPM.

8.2.4 Measuring the transfer performance

The third research objective RO3 was to develop the TPES, which was established to address the performance evaluation issue in the TP of the water PPPs in China. This objective was accomplished by answering three research questions, namely, RQ8, RQ9 and RQ10.

The RQ8 referred to the identification of the criteria used to evaluate the transfer performance. No existing research has examined the performance evaluation of the TP. Thus, a brief literature review was conducted firstly to determine the optimum way to study this topic. As a result, this study adopted the KPIs model as the evaluation framework and used the LFM to define transfer success as two hierarchical levels, i.e. TPS and TMS. A total of 14 criteria were initially identified based on the literature review and expert interviews and carefully classified into TPS and TMS groups. Under TPS, eight criteria were further grouped as transfer goal, which included three criteria, and transfer purpose, which comprised the remaining five. TMS contained three groups of criteria, that is, time and cost (with two criteria), efficiency (with two criteria) and stakeholder satisfaction (with two criteria).

The RQ9, how effective are the criteria, was answered by the results of the statistical analysis. Twelve out of the 14 criteria were statistically significant in terms of their significance to evaluate transfer success and hence were defined as KTPIs. The TPS was also confirmed to be more effective than the TMS in the hierarchical structure of the transfer success. The top five criteria were ongoing product provision (SC5), complete technology transfer (SC1), satisfactory asset performance (SC4), timely designation of eligible succeeding operator (SC8), adherence to transfer schedule (SC14) and no environmental damage (SC2) (the last two shared the same ranking at the fifth). This ranking result reflected the uniqueness of the TP.

The RQ10 dealt with how the KTPIs could be used to evaluate the transfer success. To make the evaluation more accurate and comparable, this proposed the TSI method to quantify the transfer success. The TSI method is based on FSE, which has been adopted by many past studies, and it is easy to use and can accurately distinguish the weightings of different transfer success criteria in determining transfer success. On the basis of the above findings, the TPES was finally proposed to show the dynamic process of evaluating the transfer performance. In particular, three evaluation nodes were set to satisfy distinct needs, and the evaluation results were expected to contribute to the formulation and real-time adjustment of the transfer strategies.

8.2.5 Developing a dynamic framework model for transfer

The last research objective RO4 was to integrate the three sub-models into the holistic transfer management model, the DFTMS. Two research questions, namely, RQ11 and RQ12, were answered to attain the RO4.

The RQ11 regarded the demonstration of the relationships between the three sub-models. In fact, the TRMS and TPES were built on the basic assumption that the transfer risk management and performance evaluation could be connected to the transfer process and its factors. This assumption was formally phrased as three hypotheses under RQ11, which were further tested by statistical analysis. Findings indicated that correlations between the three sub-models were statistically significant, offering theoretical support to the attempt to integrate them. Moreover, important managerial implications were drawn from the detailed correlations between the CTSFs, CTRCs and KTPIs. On account of the prior findings, the DFTMS consisting of three modules were proposed. The final model covered the entire TP and provided clear strategy options when different scenarios occur during the TP.

The final research question RQ12 concerned the model validation of the DFTMS. A qualitative interview with experts was adopted as the validation approach after the comparison of several common ways to perform model validation. With the literature used as reference, eight criteria were specially defined as the validation criteria for the DFTMS, such as compatibility, scope, consistency, ease of understanding, ease of use, tailorability, upgradability and effectiveness in addressing TCE issues. The experts were requested to validate the model by considering these eight criteria. The analysis of the interview results showed that, in general, the experts agreed on the acceptable performance of the model in all the eight criteria. The experts also offered some professional suggestions for the improvement of the model in the future.

The abovementioned main findings of this study are summarised in Table 8.1.

Table 8.1 Summary of the research findings of the present study

Research objectives	Research findings
Review of the PPP literature: life cycle perspective	
To understand the research status of the PPP field from a lifecycle perspective	• Existing research has covered all the concession life cycle, whereas the distribution of papers differed from phases; and • Particularly, the TP requires systematic study.
RO1: Modelling the transfer process	
RQ1: What is the status quo of the transfer process in water PPPs of China?	• Consisting of four steps connected by 18 process factors which were classified into four groups.
RQ2: What are the deficiencies of the current transfer process?	• Disordered transfer preparation process; • Problems in making overhaul plan; • Late determination of the transferee; • Lacking emphasis to personal settlement; • Impracticality of evaluating PPP lifecycle performance; and • Low quality of process factors in the as-is model
RQ3: How can these deficiencies be addressed?	• Redefining the A1 step; • Decomposing the new A1 step; • Renaming new A4 step; • Postponing original A4 step; • Developing A5 step; and • Improving the quality of the process factors
RQ4: How critical are the process model factors?	• 22 out of the 23 process factors were identified as KTPIs; and • The feedback factors were the most critical factor group, followed by product factors, process control factors, and

	constraint factors.
RO2: Managing the transfer risks	
RQ5: What are the key risk categories in the TP?	• 19 risk categories were initially identified as the potential critical transfer risks
RQ6: How significant are the key risk categories	• Seven CTRCs: overhaul risks, contract risks, post-transfer operation risks, residual value risks, political risks, information risks; and succeeding operator risks
RQ7: How can they be efficiently managed?	• Four managerial implications in relation to: institutional environment, government's responsibilities, private sector's responsibilities, and cooperation of the two sectors. • Findings were synthesized as the TRMS.
RO3: Measuring the transfer performance	
RQ8: What are the criteria for transfer success?	• A total of 14 criteria were initially identified on the basis of the literature review and expert interview and carefully classified into TPS and TMS groups.
RQ9: How effective are the criteria?	• 12 out of the 14 criteria were statistically significant in terms of their significance to evaluate transfer success, and hence were defined as KTPIs.
RQ10: How is the evaluation conducted?	• The TSI method based on fussy synthetic evaluation was proposed to quantify the transfer success. • Findings were synthesized as the TPES.
RO4: Developing dynamic framework model for transfer	
RQ11: What are the correlations among three sub-models?	• Correlations among the three sub-models were statistically significant. • Important managerial implications: (1) Adopting system thinking for transfer risk management; (2) Effective control of transfer risks through CTSFs; (3) Making transfer management more targeted; (4) Relationship between "CSFs" and "success criteria" of PPPs; (5) Understanding transfer risks by transfer objectives; • Findings were integrated as the DFTMS.

RQ12: How effective of the overall model?	• Eight criteria for the validation of the DFTMS: compatibility, scope, consistency, ease of understanding, ease of use, tailorability, upgradability, and effectiveness in addressing TCE issues. • In general, the experts agreed the acceptable performance of the model in all the eight criteria. They also offered some professional suggestions for future improvement.

8.3 Significance and contributions

Most existing studies on the PPP domain examined issues in relation to phases prior to the transfer of the project, such as project preparation and implementation phases. By contrast, the TP has attracted much less attention from both the academia and industry, possibly because very few PPPs have reached this point. However, as time goes by, an increasing number of PPPs are approaching the TP, leading to an urgent demand of systematic investigation on this very phase. Especially in China's water sector, the transfer of numerous water PPPs could result in significant challenges and disadvantages to the local governments involved, which has been observed from the transfer management process of a famous water PPP project in China, the Chengdu Project. This study therefore was conducted with a view to providing holistic and dynamic transfer management guides in the context of China's water PPPs. The research findings made significant contributions to both PPP theories and practices.

8.3.1 Theoretical contributions

The general contribution to the body of knowledge in the PPP domain was with regard to the filling of the knowledge gap in the TP. From the life cycle perspective, most phases of the PLC have been studied continuously for the past three decades, whereas the TP was still unknown to the research community. This study made a timely empirical contribution to the knowledge gap of the TP through a triangulated research method such as an in-depth case study on the Chengdu Project, which was undergoing transfer during the research period, and a questionnaire survey among experts in China's water PPP sector. To the knowledge of the author, this study was the first to systematically investigate the TP and develop a comprehensive transfer management framework model that simultaneously considers multiple objectives of the TP.

The study also contributed to knowledge by defining new concepts and theories in several existing important PPP themes, such as PPP success and PPP risk management. For example, this study investigated the success of the TP and defined CTSFs, KTPIs and relevant theories on the basis of some existing concepts in PPP success area such as CSFs and KPIs. Therefore, findings about the new concepts can be deemed an important contribution to the topic of PPP success. Similarly, the PPP risk management area was promoted as well by findings about the CTRCs and related theories.

To the best of the author's knowledge, this study is the first research in PPP literature that extensively analyses the relationships among the success factors, risk factors and success criteria. With the support of empirical data, this study proved that these three types of factors cannot be viewed in isolation. Instead, significant correlations exist among them, implying that the correlations could be efficiently utilised to facilitate the transfer management of water PPPs in China. As a result, the final holistic model that systematically considers TP, transfer risks and transfer performance evaluation was constructed. Previous studies qualitatively claimed a close relationship between the success factors and success criteria, while this study confirmed this relationship by offering empirical evidence.

The study also proposed a new way to apply TCE theory in the PPP domain. Traditionally, individual points of TCE theory (e.g. opportunism assumption) are used to analyse several topics of this domain, such as PPP risk management. This study revealed that combining the basic points of the theory enables the TCE approach to interpret a much wider scope of issues relating to various activities in PPPs. This study, for instance, deemed the TP of the PPP as a special transaction that tended to create excessive cost. Therefore, TCE theory was adopted to define the three main research issues. Similarly, the manner proposed by this study could be followed by future researchers in the PPP domain to investigate other issues that could be viewed as some type of transactions.

8.3.2 Practical contributions

The first practical contribution of this study lies in the analysis of the status quo of the transfer management regime in China's water PPP domain. Under the current institutional environment for PPPs in China, the general requirements for the transfer process have been summarised, the existing deficiencies have been identified and the possible solutions have been submitted. The findings are particularly informative for the PPP authorities in China, who can take these deficiencies into account when creating policies for the development of China's PPPs. The practitioners of transfer management of water PPPs can directly benefit from the above findings by knowing in advance the possible deficiencies in the transfer of water PPPs and hence maintain reasonable expectations about the upcoming transfer of their own projects.

This study also recognises the best practices for the transfer process by developing the GTPM. The transfer process shown by the GTPM has a wide application prospect in practice due to numerous existing water PPPs. Practitioners can compare their project condition to the proposed transfer process, coming up with an appropriate transfer plan that clearly identifies and fully addresses all deficiencies. Similarly, the findings of the study provide practical contribution to the industry by identifying transfer risks and transfer success criteria, thereby providing a basis for the development of the other two sub-models, the TRMS and TEPS. The findings of the above three aspects are significant for the transfer practice, as this study found that the TP faces unique process, risks and objectives that have not been revealed by past PPP studies.

In addition, the findings contribute to the industry practice by offering an integrated transfer management programme. To facilitate the use of the research findings, this study presents the final product by integrating those findings into a holistic framework model that guides users to conduct transfer management step by step. As the study takes the standpoint of the local governments, most of which are still fresh players in China's PPP market, the holistic model can hopefully ease their understanding of the challenging process of transfer management and consequently increase the applicability of the research findings.

8.4 Limitations of the study

This study made the first step to systematically examine the TP of the water PPPs in China. As a study with an exploratory trait, limitations unavoidably exist in aspects such as research contents, data collection methods and research assumptions. Some of the limitations are presented briefly below.

The first limitation is related to the research contents. Given the use of TCE theory in identifying research objectives, this study mainly shed light on three TCE issues in the TP. The abundant research findings provide an integrated program to address the three issues during the TP. Nonetheless, because the three issues are considered simultaneously, this study provides limited space for the author to investigate each issue in a more in-depth manner. Fortunately, the current findings laid a solid groundwork for further investigation of each of the three issues.

Secondly, limitations are caused by particular research methodologies. The development of the process model relied heavily on the case study of Chengdu Project, which is the only transferred water PPP. In spite of the justification of its representativeness for a large number of water PPPs in China, the Chengdu Project does have unique traits (e.g. nature of the project company, ability of the participants and geographical location), which might lead to different conditions for the transfer. Furthermore, a limitation may arise from the relatively small-scale respondents of the questionnaire survey, although the difficulties in acquiring more respondents have been fully presented (e.g. limited number of experts specialising in the transfer of water PPPs in China). This condition occurs because the small amount of the data can limit the use of more accurate statistical techniques (e.g. some parameter statistical techniques), which may have a required minimum number of valid respondents. Additionally, limitations could also be stemmed from the weakness of the analytical techniques. For instance, bivariate correlation analysis is adopted in the thesis to prove the significant relationship among three sub-models. One weakness of this technique is that the conclusion is correct at a certain confidence level (e.g. 95% in this study), which means errors may exist and even be accumulated when many correlations are taken into consideration. Following the precedent established by similar studies, these possible errors are not considered in this study.

The third limitation refers to the assumption of linear relationships between KTPIGs (see Section 6.4.4). This study developed a mathematical formula for calculating the overall success degree. To simplify the understanding and use of the evaluation method, the parameters of the formula are organised by linear relationships, which imply that the parameters are independent of each other. This practice was adopted by similar past studies; however, it may lead to bias between the calculated value of the transfer success and the actual situation. Therefore, the result generated by the proposed method cannot be seen as the exclusive precise measure of the transfer success, but a facilitating reference for the practitioners to make decisions.

Finally, the research scope of this study is limited to the water sector of China because all data were collected from this particular area. The application scope of the research findings could therefore be limited as well because PPPs in different sectors normally have varied features.

8.5 Future research directions

On the basis of the findings of this study, a series of future research directions could be expected. Focusing on these research directions could further the study on PPP transfer. In the meantime, the research limitations summarised above could be remedied to some extent.

Firstly, future researchers could continue to decompose the hierarchical structure of the TP model to the level of details that is as explanatory as needed. In this study, the GTPM contains three hierarchical levels, in which the third level merely refers to the first step *prepare for transfer* because of the limited space of the study and the particular context of China's water PPPs. In the future, the decomposition of the first step could carry on to the fourth level or even further, and the other steps of the second level could be decomposed to elaborate their operations.

Secondly, future researchers are recommended to focus on the study of transfer risks. This study made the first effort to recognise the main risk categories in the TP and had all the risk categories evaluated by experts, based on which seven CTRCs were identified. However, under each risk category, various specific risk factors may cause the same consequences and were not discussed in depth in this study due to the limited research time and sources. The author believes that identifying more detailed risk factors in the TP could help develop more effective transfer risk management strategies.

Thirdly, the research outcomes could be computerised to ease the use for common practitioners. In other words, a transfer management software that includes all modules of the DFTMS is suggested to be developed in the future based on the research findings. As suggested by the experts in the model validation stage, computerising the complex research outcomes, such as the fuzzy performance evaluation method, so that the framework model could be more user-friendly ensures accessibility. By using the computerised model, practitioners with different expertise in this area could efficiently conduct transfer management.

Moreover, future researchers could follow the research methodology of this study to confirm and promote the current findings through additional actual cases and/or knowledgeable experts in China's water sector. As stated previously, one of the great difficulties for this study was to acquire reliable data because the TP is still a future concern for most PPPs in China. However, as time goes by, more water PPPs, except for the Chengdu Project, will no doubt go through the TP, leading to new data sources for future studies on the TP.

Lastly, the research scope could be expanded from the water sector to other sectors of China. For the development and operation of the projects, differences exist between the water sector and other sectors, such as transportation, electricity and tourism. Do the differences result in a distinct arrangement for the project transfer at the expiry date of the PPP contract? What issues may occur in the transfer of the PPPs in these sectors? How should the TP of the PPPs in these sectors be managed? Questions like the ones mentioned above are still waiting for answers. Hopefully, after in-depth investigation into the TP of PPPs in several distinct sectors, a model that can universally guide the transfer management of PPPs across sectors would be built.

8.6 Summary of the chapter

This chapter reviewed the entire study by highlighting its main findings, significance and contributions, limitations and potential future directions. The main research findings of the study were summarised, covering those related to the structured literature review and the four research objectives. These research findings were then demonstrated to be significant and able to contribute knowledge to ongoing PPP research and the increasing PPP exercises in China. Subsequently, the research limitations that stemmed from multiple reasons, such as the limited space of the thesis, imperfect research methodologies and the adoption of assumptions, were presented. This chapter concluded by pointing out potential research agenda that could help remedy the abovementioned limitations, reinforce usability or amplify the application prospect of the research outcomes.

APPENDICES

Appendix A

Questionnaire for survey

Survey on evaluation of the transfer process factors, success criteria and risk categories for PPP water projects in China

Dear Sir/Madam,

We would like to express our warmest regards for your participation in this questionnaire for research into the captioned items. This survey forms a part of an ongoing Ph.D. research under a Joint PhD Programme leading to Dual Awards of The Hong Kong Polytechnic University and Sichuan University.

In this study, the “transfer phase” is defined as a period of time before the expiry date of concession agreement, during which all the preparation work for transfer has to be completed to ensure the final project transfer. Please be noticeable that the study focuses on the transfer led by contract expiry only. The findings collected via this survey can facilitate our systematic study on the transfer phase of PPP projects in China’s water sector.

Please, kindly note that all your responses are anonymous and will be utilized for academic purpose only. We will be very grateful if you could spare part of your valuable time to complete the questionnaire. Please feel free to contact the research team by email at fengyu.bao@ if you have any questions.

We greatly appreciate your contribution to this important effort.

Best regards,

Fengyu Bao, Ph.D. student
Department of Building and Real Estate, The Hong Kong Polytechnic University

Institute of Disaster Management and Reconstruction, Sichuan University

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Albert P.C. Chan, Ph.D., Ir Professor, Head of Department of Building and Real Estate, The Hong Kong Polytechnic University
Chuan Chen, Ph.D., Professor, Business School, Sichuan University

Section A: Information of Participants

1. Your current professional affiliation (multiple answers allowed):

☐ Academic/research institute ☐ Public sector ☐ Private investor

☐ Consultancy ☐ Contractor ☐ Other, please specify______________

2. Your current position in organization:

☐ Senior level ☐ Middle level ☐ Front line ☐Other, please specify_____________

3. Your working experience in PPP field:

☐ 0-3 years ☐ 4-7 years ☐ 8-10 years ☐ 11-15 years ☐ 16-20 years ☐ 21 and above

4. Please indicate the sector of PPP projects you have been involved in (multiple answers allowed):

☐ Energy ☐ Transport ☐ Water and sewerage ☐ Municipal engineering
☐ Other(s), please specify______________________

5. Please indicate the number of PPP projects you have been involved in (if any)
____

6. How important is the transfer phase management to the life cycle success of PPP projects?

☐ Extremely important ☐ Very important ☐ Important ☐ Possible important
☐ Not important

Section B: Evaluation of the transfer process factors for PPP water projects in China

This section aims to survey your evaluation to the transfer process factors of water PPPs in China. The transfer phase includes several steps and a number of factors that are needed to make the steps run. These factors are defined as transfer process factors in this study. According to the various roles, these factors are classified into four categories, that is, inputs, outputs, mechanisms, and controls. Based on research outcomes already achieved, there are five steps and 23 factors identified in a transfer process, and by the evaluation of this section, their integrity and criticality will be further validated.

1. Currently, the transfer phase of the PPP projects in water sector of China contains five processes: (1) **prepare for transfer**, (2) **overhaul assets**, (3) **assess and test assets**, (4) **perform transfer procedures**, and (5) **perform post-transfer procedures**. Do you think the division is complete?

☐ Complete ☐ Not complete, needs to add______ ☐ Redundant, needs to delete_____

2. Evaluation of process factors in the transfer phase of China's water PPPs

Please, indicate an estimated criticality of each factor for the success of transfer based on the following scale: 1-5 (extremely low-extremely high). You may also select the option "N/A" if the factor is not applicable in your opinion. If you want to add a certain kind of factor, please fill in the blank and make evaluation as well.

No.	Success factors	Criticality Low --------------- High	N/A
1	Good status quo of the project facilities (prior to overhaul)	☐1 ☐2 ☐3 ☐4 ☐5	☐
2	Adequate available resources (used for conducting transfer management)	☐1 ☐2 ☐3 ☐4 ☐5	☐

3	Completeness of technical document	☐1 ☐2 ☐3 ☐4 ☐5	☐
4	Capability of transfer committee	☐1 ☐2 ☐3 ☐4 ☐5	☐
5	Capability of private investor	☐1 ☐2 ☐3 ☐4 ☐5	☐
6	Capability of project company	☐1 ☐2 ☐3 ☐4 ☐5	☐
7	Capability of responsible government department	☐1 ☐2 ☐3 ☐4 ☐5	☐
8	Capability of transferee	☐1 ☐2 ☐3 ☐4 ☐5	☐
9	Integrity of the operation knowledge produced in the transfer process	☐1 ☐2 ☐3 ☐4 ☐5	☐
10	Transfer experience of stakeholders	☐1 ☐2 ☐3 ☐4 ☐5	☐
11	Well-defined contract system	☐1 ☐2 ☐3 ☐4 ☐5	☐
12	Adequate and competent staff performing transfer	☐1 ☐2 ☐3 ☐4 ☐5	☐
13	External conditions of the project site (natural, political, legal etc.)	☐1 ☐2 ☐3 ☐4 ☐5	☐
14	Reliability of the overhaul report	☐1 ☐2 ☐3 ☐4 ☐5	☐
15	Reliability of the performance test report	☐1 ☐2 ☐3 ☐4 ☐5	☐
16	Transferability of a PPP	☐1 ☐2 ☐3 ☐4 ☐5	☐
17	Rationality of the holistic transfer arrangement	☐1 ☐2 ☐3 ☐4 ☐5	☐
18	Clarity of the transfer technical criteria	☐1 ☐2 ☐3 ☐4 ☐5	☐
19	Rationality and timeliness of determining succeeding operator	☐1 ☐2 ☐3 ☐4 ☐5	☐
20	Asset status after overhaul	☐1 ☐2 ☐3 ☐4 ☐5	☐
21	Asset status after test	☐1 ☐2 ☐3 ☐4 ☐5	☐
22	Asset status after transfer	☐1 ☐2 ☐3 ☐4 ☐5	☐
23	Efficient usage of project assets in post-transfer operation	☐1 ☐2 ☐3 ☐4 ☐5	☐
Please indicate other process factors (if any)			
		☐1 ☐2 ☐3 ☐4 ☐5	
		☐1 ☐2 ☐3 ☐4 ☐5	
		☐1 ☐2 ☐3 ☐4 ☐5	

Section C: Evaluation of risk factors in transfer phase of Chinese PPP water projects

This section aims to evaluate the probability and severity levels of risk factors that may occur in the transfer process.

Please, indicate an estimated level of probability of occurrence and severity of consequence for each risk factor based on the following scale: 1-5 (extremely low-extremely high). You may also select the option "N/A" if the factor is not applicable in your opinion.

No.	Risk factors	Probability	Severity	N/A
		Low --------------- High	Low --------------- High	
1	Status quo of the assets	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐
2	Identification of succeeding operator	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐
3	Staff transfer	☐1 ☐2 ☐3 ☐4 ☐5	☐1 ☐2 ☐3 ☐4 ☐5	☐

4	Technology transfer	☐1	☐2	☐3	☐4	☐5		☐1	☐2	☐3	☐4	☐5		☐			
5	Overhaul scope (divergence about overhaul scope appears)	☐1	☐2	☐3	☐4	☐5		☐1	☐2	☐3	☐4	☐5		☐			
6	Facility performance after transfer	☐1	☐2	☐3	☐4	☐5		☐1	☐2	☐3	☐4	☐5		☐			
7	Contract risks (clauses relating to transfer do not suit the current situation)	☐1	☐2	☐3	☐4	☐5		☐1	☐2	☐3	☐4	☐5		☐			
8	Political risks (e.g. inappropriate interference from the government etc.)	☐1	☐2	☐3	☐4	☐5		☐1	☐2	☐3	☐4	☐5		☐			
9	Legal risks	☐1	☐2	☐3	☐4	☐5		☐1	☐2	☐3	☐4	☐5		☐			
10	Unethical practices（e.g. giving or receiving bribery）	☐1	☐2	☐3	☐4	☐5		☐1	☐2	☐3	☐4	☐5		☐			
11	Information asymmetry (between the government and project companies)	☐1	☐2	☐3	☐4	☐5		☐1	☐2	☐3	☐4	☐5		☐			
12	Opportunism risks（e.g. incomplete overhaul, government neglecting of duty）	☐1	☐2	☐3	☐4	☐5		☐1	☐2	☐3	☐4	☐5		☐			
13	Credibility risks	☐1	☐2	☐3	☐4	☐5		☐1	☐2	☐3	☐4	☐5		☐			
14	Environmental risks（environmental destruction during transfer）	☐1	☐2	☐3	☐4	☐5		☐1	☐2	☐3	☐4	☐5		☐			
15	Financial risks	☐1	☐2	☐3	☐4	☐5		☐1	☐2	☐3	☐4	☐5		☐			
16	Demand risks	☐1	☐2	☐3	☐4	☐5		☐1	☐2	☐3	☐4	☐5		☐			
17	Product price risks	☐1	☐2	☐3	☐4	☐5		☐1	☐2	☐3	☐4	☐5		☐			
18	Supporting infrastructure risks	☐1	☐2	☐3	☐4	☐5		☐1	☐2	☐3	☐4	☐5		☐			
19	Operation risks（e.g. reduced water quality, postponed water production）	☐1	☐2	☐3	☐4	☐5		☐1	☐2	☐3	☐4	☐5		☐			
Please indicate other success factors (if any)																	
		☐1	☐2	☐3	☐4	☐5		☐1	☐2	☐3	☐4	☐5					
		☐1	☐2	☐3	☐4	☐5		☐1	☐2	☐3	☐4	☐5					
		☐1	☐2	☐3	☐4	☐5		☐1	☐2	☐3	☐4	☐5					

<u>Section D: Evaluation of success criteria for transfer management performance of Chinese PPP water projects</u>

This section aims to evaluate the effectiveness level of 14 success criteria for measuring the performance of transfer management of China's water PPPs. These success criteria were extracted from extensive literature review.

Please, indicate an estimated level of significance for each success criterion based on the following scale: 1-5 (extremely low-extremely high). You may also select the option "N/A" if the factor is not applicable in your opinion.

No.	**Success criteria**	**Effectiveness** **Low --------------- High**	**N/A**
1	Effective technology transfer	☐1 ☐2 ☐3 ☐4 ☐5	☐
2	Leading to no environmental harm	☐1 ☐2 ☐3 ☐4 ☐5	☐
3	Extensive cooperation (defects liability period after transfer)	☐1 ☐2 ☐3 ☐4 ☐5	☐
4	Good condition of the transferred assets	☐1 ☐2 ☐3 ☐4 ☐5	☐
5	Uninterrupted supply of products/services	☐1 ☐2 ☐3 ☐4 ☐5	☐
6	Stable profitability	☐1 ☐2 ☐3 ☐4 ☐5	☐
7	Continued promotion of local economic development	☐1 ☐2 ☐3 ☐4 ☐5	☐
8	Timely identification of qualified succeeding operator	☐1 ☐2 ☐3 ☐4 ☐5	☐
9	Reduced contract changes and divergences	☐1 ☐2 ☐3 ☐4 ☐5	☐
10	Reduced project staff objection	☐1 ☐2 ☐3 ☐4 ☐5	☐
11	Reduced public objection	☐1 ☐2 ☐3 ☐4 ☐5	☐
12	Effective transfer risk management	☐1 ☐2 ☐3 ☐4 ☐5	☐
13	Meeting time	☐1 ☐2 ☐3 ☐4 ☐5	☐
14	Meeting budget	☐1 ☐2 ☐3 ☐4 ☐5	☐
Please indicate other success factors (if any)			
		☐1 ☐2 ☐3 ☐4 ☐5	
		☐1 ☐2 ☐3 ☐4 ☐5	
		☐1 ☐2 ☐3 ☐4 ☐5	

11. Do you have any other comments or remarks for the process model?

12. Please, if you would like to receive a summary of the research findings, kindly provide your email address: ___________________________

The end

Please, thank you for participating

Appendix B

Kruskal-Wallis Test for the CTRCs

Ranks

	Affiliation	N	Mean Rank
R1	1	11	26.86
	2	9	25.56
	3	18	28.50
	4	11	16.95
	Total	49	
R2	1	11	29.68
	2	9	22.89
	3	18	26.61
	4	11	19.41
	Total	49	
R3	1	11	31.00
	2	9	21.22
	3	18	27.42
	4	11	18.14
	Total	49	
R4	1	11	30.09
	2	9	23.50
	3	18	25.86
	4	11	19.73
	Total	49	
R5	1	11	25.32
	2	9	20.56
	3	18	29.53
	4	11	20.91
	Total	49	

R6	1	11	27.36
	2	9	19.56
	3	18	28.28
	4	11	21.73
	Total	49	
R7	1	11	29.59
	2	9	16.83
	3	18	30.22
	4	11	18.55
	Total	49	

1—Academia; 2—Public sector; 3—Private sector; 4—Consultancy.

Appendix C

Mann-Whitney Test for the Succeeding Operator Risks

Ranks

	Affiliation	N	Mean Rank	Sum of Ranks
R7	1	11	13.09	144.00
	2	9	7.33	66.00
	Total	20		

Test Statistics[a]

	R7
Mann-Whitney U	21.000
Wilcoxon W	66.000
Z	-2.213
Asymp. Sig. (2-tailed)	.027
Exact Sig. [2*(1-tailed Sig.)]	.031[b]

Ranks

	Affiliation	N	Mean Rank	Sum of Ranks
R7	1	11	14.18	156.00
	3	18	15.50	279.00
	Total	29		

Test Statistics[a]

	R7
Mann-Whitney U	90.000
Wilcoxon W	156.000
Z	-.411
Asymp. Sig. (2-tailed)	.681

Exact Sig. [2*(1-tailed Sig.)]	.707[b]

Ranks

	Affiliation	N	Mean Rank	Sum of Ranks
R7	1	11	14.32	157.50
	4	11	8.68	95.50
	Total	22		

Test Statistics[a]

	R7
Mann-Whitney U	29.500
Wilcoxon W	95.500
Z	-2.067
Asymp. Sig. (2-tailed)	.039
Exact Sig. [2*(1-tailed Sig.)]	.040[b]

Ranks

	Affiliation	N	Mean Rank	Sum of Ranks
R7	2	9	9.44	85.00
	3	18	16.28	293.00
	Total	27		

Test Statistics[a]

	R7
Mann-Whitney U	40.000
Wilcoxon W	85.000
Z	-2.126

Asymp. Sig. (2-tailed)	.033
Exact Sig. [2*(1-tailed Sig.)]	.035[b]

Ranks

	Affiliation	N	Mean Rank	Sum of Ranks
R7	2	9	10.06	90.50
	4	11	10.86	119.50
	Total	20		

Test Statistics[a]

	R7
Mann-Whitney U	45.500
Wilcoxon W	90.500
Z	-.306
Asymp. Sig. (2-tailed)	.759
Exact Sig. [2*(1-tailed Sig.)]	.766[b]

Ranks

	Affiliation	N	Mean Rank	Sum of Ranks
R7	3	18	17.44	314.00
	4	11	11.00	121.00
	Total	29		

Test Statistics[a]

	R7
Mann-Whitney U	55.000
Wilcoxon W	121.000

Z	-1.994
Asymp. Sig. (2-tailed)	.046
Exact Sig. [2*(1-tailed Sig.)]	.049[b]

1—Academia; 2—Public sector; 3—Private sector; 4—Consultancy

a. Grouping Variable: Affiliation

b. Not corrected for ties.

Appendix D

Spearman's Rank Correlation Analysis for CTRCs and CTSFs

Correlations (1)

		SF1	SF2	SF3	SF4	SF6	SF7	SF8	SF9	SF10	SF11
R1	Correlation Coefficient	.645**	.561**	.493**	.551**	.442**	.559**	.567**	.480**	.584**	.563**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52
R2	Correlation Coefficient	.563**	.506**	.448**	.387**	.321*	.439**	.521**	.507**	.419**	.410**
	Sig. (2-tailed)	0.000	0.000	0.001	0.005	0.020	0.001	0.000	0.000	0.002	0.003
	N	52	52	52	52	52	52	52	52	52	52
R3	Correlation Coefficient	.637**	.598**	.542**	.495**	.414**	.562**	.533**	.523**	.592**	.569**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52
R4	Correlation Coefficient	.516**	.420**	.290*	0.221	.391**	.426**	.349*	.282*	.311*	.542**
	Sig. (2-tailed)	0.000	0.002	0.037	0.115	0.004	0.002	0.011	0.043	0.025	0.000
	N	52	52	52	52	52	52	52	52	52	52
R5	Correlation Coefficient	.398**	.422**	.540**	.361**	0.189	.321*	.436**	.484**	.481**	.496**
	Sig. (2-tailed)	0.003	0.002	0.000	0.009	0.179	0.021	0.001	0.000	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52
R6	Correlation Coefficient	.507**	.416**	.440**	0.249	.300*	.337*	.379**	.494**	.468**	.486**
	Sig. (2-tailed)	0.000	0.002	0.001	0.075	0.031	0.015	0.006	0.000	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52
R7	Correlation Coefficient	.510**	.370**	.353*	0.254	0.231	.360**	.457**	.362**	.372**	.487**
	Sig. (2-tailed)	0.000	0.007	0.010	0.069	0.099	0.009	0.001	0.008	0.007	0.000
	N	52	52	52	52	52	52	52	52	52	52

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Correlations（2）

		SF12	SF13	SF14	SF15	SF16	SF17	SF18	SF19	SF20	SF21	SF22	SF23
R1	Correlation Coefficient	.647**	.531**	.422**	.510**	.496**	.690**	.489**	.576**	.609**	.465**	.377**	.463**
	Sig. (2-tailed)	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.006	0.001
	N	52	52	52	52	52	52	52	52	52	52	52	52
R2	Correlation Coefficient	.475**	.375**	.420**	.411**	.468**	.538**	.373**	.464**	.441**	.282*	.292*	.466**
	Sig. (2-tailed)	0.000	0.006	0.002	0.002	0.000	0.000	0.006	0.001	0.001	0.043	0.036	0.000
	N	52	52	52	52	52	52	52	52	52	52	52	52
R3	Correlation Coefficient	.553**	.470**	.466**	.558**	.583**	.571**	.587**	.547**	.594**	.423**	.453**	.531**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.001	0.000
	N	52	52	52	52	52	52	52	52	52	52	52	52
R4	Correlation Coefficient	.491**	.497**	.433**	.443**	.422**	.608**	.607**	.433**	.448**	.484**	.327*	0.264
	Sig. (2-tailed)	0.000	0.000	0.001	0.001	0.002	0.000	0.000	0.001	0.001	0.000	0.018	0.059
	N	52	52	52	52	52	52	52	52	52	52	52	52
R5	Correlation Coefficient	.458**	.406**	.403**	.382**	0.258	.392**	.371**	.532**	.485**	.329*	.416**	.539**
	Sig. (2-tailed)	0.001	0.003	0.003	0.005	0.065	0.004	0.007	0.000	0.000	0.017	0.002	0.000
	N	52	52	52	52	52	52	52	52	52	52	52	52
R6	Correlation Coefficient	.453**	.376**	.408**	.355**	.345*	.481**	.388**	.380**	.491**	.320*	.383**	.495**
	Sig. (2-tailed)	0.001	0.006	0.003	0.010	0.012	0.000	0.005	0.005	0.000	0.021	0.005	0.000
	N	52	52	52	52	52	52	52	52	52	52	52	52
R7	Correlation Coefficient	.390**	.419**	.335*	.470**	.505**	.462**	.614**	.492**	.428**	.334*	.370**	.428**
	Sig. (2-tailed)	0.004	0.002	0.015	0.000	0.000	0.001	0.000	0.000	0.002	0.015	0.007	0.002
	N	52	52	52	52	52	52	52	52	52	52	52	52

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix E

Spearman's Rank Correlation Analysis for Non-CTRCs and CTSFs

Correlations (1)

		SF1	SF2	SF3	SF4	SF6	SF7	SF8	SF9	SF10	SF11
R8	Correlation Coefficient	.528**	.455**	.467**	.316*	.369**	.454**	.379**	.513**	.525**	.489**
	Sig. (2-tailed)	0.000	0.001	0.000	0.022	0.007	0.001	0.006	0.000	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52
R9	Correlation Coefficient	.481**	.395**	.487**	0.262	0.112	.405**	.459**	.478**	.435**	.311*
	Sig. (2-tailed)	0.000	0.004	0.000	0.060	0.429	0.003	0.001	0.000	0.001	0.025
	N	52	52	52	52	52	52	52	52	52	52
R10	Correlation Coefficient	.358**	.457**	.451**	.282*	0.151	.300*	.468**	.490**	.368**	.348*
	Sig. (2-tailed)	0.009	0.001	0.001	0.043	0.287	0.031	0.000	0.000	0.007	0.011
	N	52	52	52	52	52	52	52	52	52	52
R11	Correlation Coefficient	.429**	.496**	.450**	.329*	0.146	.325*	.627**	.386**	.439**	.402**
	Sig. (2-tailed)	0.001	0.000	0.001	0.017	0.302	0.019	0.000	0.005	0.001	0.003
	N	52	52	52	52	52	52	52	52	52	52
R12	Correlation Coefficient	.479**	.318*	.424**	0.187	0.260	.337*	.437**	.585**	.437**	.302*
	Sig. (2-tailed)	0.000	0.022	0.002	0.184	0.063	0.015	0.001	0.000	0.001	0.030
	N	52	52	52	52	52	52	52	52	52	52
R13	Correlation Coefficient	.369**	.443**	.503**	.315*	.343*	.561**	.381**	.537**	.596**	.409**
	Sig. (2-tailed)	0.007	0.001	0.000	0.023	0.013	0.000	0.005	0.000	0.000	0.003
	N	52	52	52	52	52	52	52	52	52	52
R14	Correlation Coefficient	.290*	.357**	.374**	0.170	0.211	.382**	0.249	.498**	.351*	.280*
	Sig. (2-tailed)	0.037	0.009	0.006	0.228	0.133	0.005	0.075	0.000	0.011	0.044
	N	52	52	52	52	52	52	52	52	52	52
R15	Correlation Coefficient	.415**	.342*	.380**	0.156	0.177	.355**	.370**	.495**	.384**	.336*
	Sig. (2-tailed)	0.002	0.013	0.005	0.269	0.210	0.010	0.007	0.000	0.005	0.015
	N	52	52	52	52	52	52	52	52	52	52
	Correlation Coefficient	.474**	.378**	.508**	0.208	0.230	.422**	.463**	.477**	.432**	.419**

R16	Sig. (2-tailed)	0.000	0.006	0.000	0.140	0.100	0.002	0.001	0.000	0.001	0.002
	N	52	52	52	52	52	52	52	52	52	52
R17	Correlation Coefficient	.450**	.295*	.427**	0.265	0.237	.427**	.450**	.488**	.431**	.285*
	Sig. (2-tailed)	0.001	0.034	0.002	0.057	0.091	0.002	0.001	0.000	0.001	0.040
	N	52	52	52	52	52	52	52	52	52	52
R18	Correlation Coefficient	.285*	.317*	.487**	.274*	0.172	.334*	0.273	.554**	.485**	0.238
	Sig. (2-tailed)	0.040	0.022	0.000	0.049	0.223	0.016	0.050	0.000	0.000	0.090
	N	52	52	52	52	52	52	52	52	52	52
R19	Correlation Coefficient	.366**	.324*	.453**	0.269	0.221	.440**	.370**	.542**	.500**	0.244
	Sig. (2-tailed)	0.008	0.019	0.001	0.054	0.115	0.001	0.007	0.000	0.000	0.082
	N	52	52	52	52	52	52	52	52	52	52

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Correlations（2）

		SF12	SF13	SF14	SF15	SF16	SF17	SF18	SF19	SF20	SF21	SF22	SF23
R8	Correlation Coefficient	.593**	.521**	.552**	.462**	.434**	.564**	.503**	.445**	.523**	.401**	.415**	.436**
	Sig. (2-tailed)	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.001	0.000	0.003	0.002	0.001
	N	52	52	52	52	52	52	52	52	52	52	52	52
R9	Correlation Coefficient	.408**	.366**	.476**	.389**	.422**	.340*	.412**	.394**	.385**	0.199	.416**	.573**
	Sig. (2-tailed)	0.003	0.008	0.000	0.004	0.002	0.014	0.002	0.004	0.005	0.157	0.002	0.000
	N	52	52	52	52	52	52	52	52	52	52	52	52
R10	Correlation Coefficient	.391**	.275*	.432**	.377**	.382**	.408**	.354*	.343*	.381**	0.223	.294*	.518**
	Sig. (2-tailed)	0.004	0.048	0.001	0.006	0.005	0.003	0.010	0.013	0.005	0.113	0.034	0.000
	N	52	52	52	52	52	52	52	52	52	52	52	52
R11	Correlation Coefficient	.373**	0.267	.443**	.451**	.484**	.523**	.441**	.530**	.465**	.353*	.374**	.638**
	Sig. (2-tailed)	0.007	0.056	0.001	0.001	0.000	0.000	0.001	0.000	0.001	0.010	0.006	0.000

	N	52	52	52	52	52	52	52	52	52	52	52	52
R12	Correlation Coefficient	.396**	.443**	.360**	.352*	.341*	.293*	.440**	.390**	.412**	.289*	.333*	.583**
	Sig. (2-tailed)	0.004	0.001	0.009	0.010	0.013	0.035	0.001	0.004	0.002	0.038	0.016	0.000
	N	52	52	52	52	52	52	52	52	52	52	52	52
R13	Correlation Coefficient	.535**	.516**	.431**	.461**	.382**	.327*	.409**	.440**	.431**	.340*	.287*	.433**
	Sig. (2-tailed)	0.000	0.000	0.001	0.001	0.005	0.018	0.003	0.001	0.001	0.014	0.039	0.001
	N	52	52	52	52	52	52	52	52	52	52	52	52
R14	Correlation Coefficient	.402**	.425**	.332*	.330*	.443**	.303*	.371**	.276*	.279*	0.122	0.217	0.268
	Sig. (2-tailed)	0.003	0.002	0.016	0.017	0.001	0.029	0.007	0.047	0.045	0.391	0.121	0.055
	N	52	52	52	52	52	52	52	52	52	52	52	52
R15	Correlation Coefficient	.439**	.466**	.360**	.425**	.397**	.277*	.521**	.346*	.379**	0.188	.358**	.441**
	Sig. (2-tailed)	0.001	0.001	0.009	0.002	0.004	0.047	0.000	0.012	0.006	0.182	0.009	0.001
	N	52	52	52	52	52	52	52	52	52	52	52	52
R16	Correlation Coefficient	.413**	.424**	.516**	.346*	.375**	.425**	.374**	.425**	.447**	0.261	.396**	.459**
	Sig. (2-tailed)	0.002	0.002	0.000	0.012	0.006	0.002	0.006	0.002	0.001	0.061	0.004	0.001
	N	52	52	52	52	52	52	52	52	52	52	52	52
R17	Correlation Coefficient	.392**	.440**	.322*	.371**	.401**	.339*	.421**	.392**	.387**	0.121	.276*	.496**
	Sig. (2-tailed)	0.004	0.001	0.020	0.007	0.003	0.014	0.002	0.004	0.005	0.391	0.048	0.000
	N	52	52	52	52	52	52	52	52	52	52	52	52
R18	Correlation Coefficient	.398**	.437**	.322*	0.268	.329*	0.194	.364**	.311*	.330*	0.025	.294*	.409**
	Sig. (2-tailed)	0.003	0.001	0.020	0.055	0.017	0.168	0.008	0.025	0.017	0.859	0.034	0.003
	N	52	52	52	52	52	52	52	52	52	52	52	52
R19	Correlation Coefficient	.400**	.522**	.293*	0.246	.338*	0.255	.330*	.354*	.367**	0.100	0.263	.348*
	Sig. (2-tailed)	0.003	0.000	0.035	0.079	0.014	0.068	0.017	0.010	0.007	0.482	0.059	0.012
	N	52	52	52	52	52	52	52	52	52	52	52	52

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix F

Spearman's Rank Correlation Analysis for KTPIs and CTSFs

Correlations (1)

		SF1	SF2	SF3	SF4	SF6	SF7	SF8	SF9	SF10	SF11
SC1	Correlation Coefficient	.589**	.617**	.536**	.436**	.434**	.594**	.582**	.395**	.629**	.554**
	Sig. (2-tailed)	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.004	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52
SC2	Correlation Coefficient	.519**	.512**	.497**	.373**	.282*	.322*	.420**	.562**	.553**	.524**
	Sig. (2-tailed)	0.000	0.000	0.000	0.007	0.043	0.020	0.002	0.000	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52
SC3	Correlation Coefficient	.532**	.473**	.435**	.290*	.306*	.326*	.496**	.445**	.419**	.530**
	Sig. (2-tailed)	0.000	0.000	0.001	0.037	0.027	0.018	0.000	0.001	0.002	0.000
	N	52	52	52	52	52	52	52	52	52	52
SC4	Correlation Coefficient	.531**	.584**	.412**	.401**	.566**	.436**	.402**	.363**	.521**	.568**
	Sig. (2-tailed)	0.000	0.000	0.002	0.003	0.000	0.001	0.003	0.008	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52
SC5	Correlation Coefficient	.553**	.618**	.543**	.468**	.318*	.441**	.454**	.523**	.564**	.637**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.021	0.001	0.001	0.000	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52
SC8	Correlation Coefficient	.540**	.423**	.532**	.382**	0.231	.353*	.380**	.474**	.470**	.531**
	Sig. (2-tailed)	0.000	0.002	0.000	0.005	0.100	0.010	0.005	0.000	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52
SC9	Correlation Coefficient	.655**	.482**	.492**	.355**	0.234	.318*	.489**	.543**	.395**	.546**
	Sig. (2-tailed)	0.000	0.000	0.000	0.010	0.095	0.022	0.000	0.000	0.004	0.000
	N	52	52	52	52	52	52	52	52	52	52
SC10	Correlation Coefficient	.561**	.603**	.616**	.477**	0.223	.348*	.578**	.633**	.569**	.617**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.113	0.012	0.000	0.000	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52
	Correlation Coefficient	.550**	.540**	.575**	.367**	0.150	.371**	.446**	.637**	.522**	.599**

SC11	Sig. (2-tailed)	0.000	0.000	0.000	0.007	0.288	0.007	0.001	0.000	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52
SC12	Correlation Coefficient	.680**	.624**	.526**	.578**	.292*	.452**	.511**	.589**	.590**	.586**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.035	0.001	0.000	0.000	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52
SC13	Correlation Coefficient	.679**	.561**	.631**	.498**	.468**	.549**	.597**	.645**	.714**	.698**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52
SC14	Correlation Coefficient	.649**	.615**	.573**	.536**	.305*	.510**	.543**	.438**	.591**	.548**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.028	0.000	0.000	0.001	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Correlations (2)

		SF12	SF13	SF14	SF15	SF16	SF17	SF18	SF19	SF20	SF21	SF22	SF23
SC1	Correlation Coefficient	.659**	.592**	.593**	.475**	.497**	.594**	.646**	.580**	.597**	.503**	.510**	.507**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52	52	52
SC2	Correlation Coefficient	.579**	.531**	.593**	.362**	.488**	.495**	.492**	.599**	.624**	.433**	.438**	.442**
	Sig. (2-tailed)	0.000	0.000	0.000	0.008	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001
	N	52	52	52	52	52	52	52	52	52	52	52	52
SC3	Correlation Coefficient	.522**	.373**	.511**	.441**	.505**	.547**	.539**	.581**	.523**	.409**	.415**	.503**
	Sig. (2-tailed)	0.000	0.006	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.003	0.002	0.000
	N	52	52	52	52	52	52	52	52	52	52	52	52
SC4	Correlation Coefficient	.605**	.522**	.628**	.366**	.450**	.566**	.634**	.594**	.598**	.575**	.414**	.399**
	Sig. (2-tailed)	0.000	0.000	0.000	0.008	0.001	0.000	0.000	0.000	0.000	0.000	0.002	0.003
	N	52	52	52	52	52	52	52	52	52	52	52	52
SC5	Correlation Coefficient	.649**	.510**	.587**	.451**	.439**	.644**	.499**	.600**	.612**	.525**	.529**	.401**
	Sig. (2-tailed)	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.003
	N	52	52	52	52	52	52	52	52	52	52	52	52
SC8	Correlation Coefficient	.421**	.524**	.497**	.433**	.543**	.567**	.592**	.458**	.489**	.399**	.367**	.394**
	Sig. (2-tailed)	0.002	0.000	0.000	0.001	0.000	0.000	0.000	0.001	0.000	0.003	0.008	0.004
	N	52	52	52	52	52	52	52	52	52	52	52	52
SC9	Correlation Coefficient	.457**	.546**	.420**	.408**	.570**	.485**	.595**	.465**	.423**	.310*	.545**	.464**
	Sig. (2-tailed)	0.001	0.000	0.002	0.003	0.000	0.000	0.000	0.001	0.002	0.025	0.000	0.001
	N	52	52	52	52	52	52	52	52	52	52	52	52
SC10	Correlation Coefficient	.630**	.488**	.498**	.527**	.528**	.575**	.564**	.554**	.557**	.399**	.669**	.588**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52	52	52
	Correlation Coefficient	.574**	.471**	.475**	.440**	.456**	.464**	.482**	.475**	.542**	.411**	.533**	.514**

SC11	Sig. (2-tailed)	0.000	0.000	0.000	0.001	0.001	0.001	0.000	0.000	0.000	0.002	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52	52	52
SC12	Correlation Coefficient	.677**	.553**	.552**	.426**	.617**	.558**	.596**	.531**	.506**	.424**	.514**	.478**
	Sig. (2-tailed)	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52	52	52
SC13	Correlation Coefficient	.690**	.587**	.568**	.610**	.506**	.653**	.650**	.694**	.764**	.606**	.588**	.662**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52	52	52
SC14	Correlation Coefficient	.569**	.473**	.475**	.433**	.475**	.597**	.588**	.448**	.535**	.430**	.467**	.499**
	Sig. (2-tailed)	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.001	0.000	0.001	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52	52	52

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix G

Spearman's Rank Correlation Analysis for KTPIs and CTRCs

Correlations

		SC1	SC2	SC3	SC4	SC5	SC8	SC9	SC10	SC11	SC12	SC13	SC14
R4	Correlation Coefficient	.599**	.449**	.518**	.655**	.579**	.549**	.504**	.450**	.475**	.498**	.628**	.561**
	Sig. (2-tailed)	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52	52	52
R7	Correlation Coefficient	.494**	.426**	.561**	.458**	.543**	.612**	.460**	.471**	.470**	.483**	.640**	.546**
	Sig. (2-tailed)	0.000	0.002	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52	52	52
R1	Correlation Coefficient	.592**	.510**	.488**	.504**	.619**	.459**	.433**	.575**	.502**	.640**	.726**	.576**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52	52	52
R3	Correlation Coefficient	.541**	.524**	.456**	.551**	.593**	.582**	.522**	.512**	.528**	.558**	.710**	.685**
	Sig. (2-tailed)	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52	52	52
R2	Correlation Coefficient	.468**	.572**	.548**	.406**	.509**	.387**	.484**	.494**	.438**	.570**	.577**	.598**
	Sig. (2-tailed)	0.000	0.000	0.000	0.003	0.000	0.005	0.000	0.000	0.001	0.000	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52	52	52
R5	Correlation Coefficient	.404**	.450**	.417**	.323*	.457**	.481**	.436**	.592**	.501**	.479**	.610**	.522**
	Sig. (2-tailed)	0.003	0.001	0.002	0.019	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52	52	52
R6	Correlation Coefficient	.456**	.469**	.453**	.387**	.386**	.403**	.496**	.546**	.554**	.516**	.633**	.638**
	Sig. (2-tailed)	0.001	0.000	0.001	0.005	0.005	0.003	0.000	0.000	0.000	0.000	0.000	0.000
	N	52	52	52	52	52	52	52	52	52	52	52	52

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed)

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