

# A Causal feedback relationship model for critical success factors of PPP projects based on system dynamics

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**Abstract** The Study on causal feedback relationship between critical success factors of PPP projects is of great significance to the successful implementation and performance improvement of PPP projects. This paper aims to describe a set of critical success factors (CSFs) and establish a critical success factors causal feedback model to provide a tool to confirm the relationship between CSFs. Thirteen CSFs were derived from extend literatures, then were used to develop a causal feedback model based on the system dynamics method. PPP projects generally involve three different stakeholders, public sector, private sector, and public, this paper analyzed causal feedback between factors based on different stakeholders. This study suggests that, This study suggests that the direct factors influencing the stakeholders is different, at the same time, emphasize the public participation has important effects on PPP project success, causal feedback relations between CSFs will contribute to the PPP project sustainability and success.

**Key words** Public private partnership; System dynamics; Critical success factors; Causal feedback relationship.

## 1 Introduction

Public-Private Partnerships (PPP) are considered by developed and developing countries to be an effective means of providing public infrastructure and modern public services. Previous practice has shown that this innovative procurement approach would reduce the government's financial burden and meet the growing demand for public facilities and services. PPP has many forms and scales, generally organized around design, financing, construction, Own, operations, and handover modes, and involves the private sector financing and the private sector project management capabilities. Although numerous countries have implemented PPPs for infrastructure development in recent years, not all projects are successful, most PPP failures are due to inappropriate risk allocation and lack of success factors in specific stakeholders. It is against this backdrop that many scholars across the globe have a huge interest in the successful implementation of PPP.

Rockart [1] defined CSFs as “the few key areas of activity where favorable results are necessary for managers to achieve their goal”. In recent decades, many studies have focused on CSFs in the context of PPPs. For example, using different research methods, such as case studies, questionnaires, or other research methods to identify critical factors that contribute to the success of a PPP project [2, 3]. Researchers identify and evaluate critical success factors based on different project life cycle stages [4], project types, project areas [5], and project stakeholders [6]. Moreover, Research on key success factors of PPP also involves concepts such as conceptual frameworks [2, 7], risk management [8], relationship management [9], and organization management, etc. The purpose of these studies is to focus on the identification and sequencing of success factors. Although many important insights are provided, they are based on a basic assumption that the success factors are independent and have no causal relationship. However, the public-private partnership project is a very complex system engineering, and its influencing factors are not independent of each other. Some factors and their interactions may even lead to project efficiency changes. Based on this background, this study intends to use system dynamics methods to determine and validate the causal relationship between key success factors in public-private partnership (PPP) project implementation.

## 2 Build a causal feedback relationship model

### 2.1 Methodology

A qualitative methods was adopted. First, a comprehensive literature review was adopted to identify critical success factors of PPP projects, a qualitative model was subsequently developed, which was demonstrated through a causal cycle diagram to describe the interrelationship between the identified success factors. Three symbols are adopted by the figure: Including arrows, + and -. The arrow is used to connect variables, and + and - are used to indicate relationship between arrow-head and arrow-tail variables. The + arrow indicates that

the arrow-tail variable has a positive effect on the arrow-head variable, while – means the opposite.

## 2.2 Identification of CSFs for PPPs

Table 1 indicates the findings of the previous research on CSFs for PPPs in ascending chronological order according literature review.

**Table 1: PPP success factors from literature review**

Cheung	2009	Commitment/responsibility of public/private sectors, Favorable legal framework Stable macroeconomic conditions, Strong private consortium, Appropriate risk allocation and sharing.
Chan et al.	2010	Stable macroeconomic environment, Shared responsibility between public and private sectors, Transparent and efficient procurement process, Stable political and social environment, Judicious government control.
Meng et al.	2011	Project profitability, Asset quality, Fair risk allocation, Competitive tendering, Internal coordination within government, Employment of professional advisers, Corporate governance Governmental supervision.
Hwang et al.	2013	Well-organized public agency, Appropriate risk allocation and sharing, Strong private consortium, Transparency in procurement process, Clear defined responsibilities and roles, Clarification of contract documents, Favorable legal framework, Shared authority between public and private sector
Ng et al.	2012	Technical support and innovation, Stable and favorable economic environment, Sound financial package, Favorable social environment, Supportive political and legal framework, Supportive project team and management actions.
Wibowo and Alfen	2014	Appropriate risk allocation and sharing, Nature of contractual agreement, Favorable legal frame work, Clear defined coordination mechanisms , Strong political support.
Ameyan and Chan	2015	Strong private consortium, Available financial market, Commitment/responsibility of public /private sectors, Favorable legal frame work, Strong political support.

From table 1, thirteen critical factors for the success of the PPP project are summarized, as shown in table 2.

**Table 2: Critical Success Factors for PPP Projects**

Political support
Favourable legal and regulatory framework
Government financial guarantee
Governmental supervision
Firms profit expectations
Public opinion
Strong private consortium
Reasonable service price
Appropriate risk allocation
Transparent PPP process

Table 2, cont.

Right project identification
Competitive tendering process
Technological innovation

### 2.3 Model development

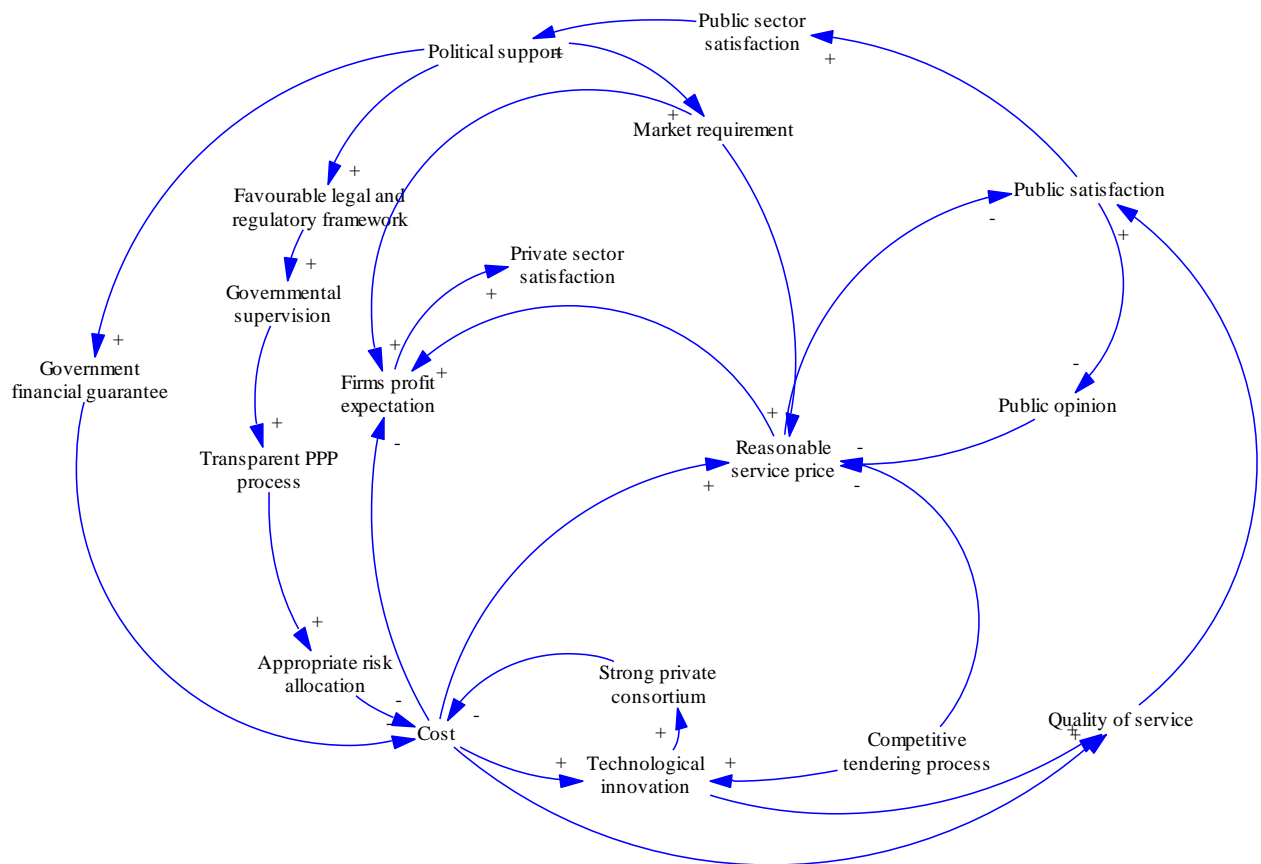
In the late 1960s, scholars used cost, time, and quality to measure the success of a project at the project level, and In the 1980s, they noted the project's connection with Stakeholders and began to focus on measuring success and success criteria from a different stakeholder perspective. For example, Müller and Zolin undertook research to determine whether there was any collective understanding of success within groups [10].

The success of a project may mean different things to different stakeholders, taking into account the different goals of PPP project stakeholders, from each Stakeholders' consideration of the success criteria of PPP projects will promote collaboration among stakeholders to achieve the success of the entire project. It is worth mentioning that the public and private sectors are key stakeholders in public-private partnerships. In addition, Boyer et al. proposed that public participation can improve project performance and contribute to value and money and improve service quality [11], Therefore, it makes sense to use the public as an important stakeholder group in the implementation of the PPP project, and in this article, three stakeholders are involved – the public sector, the private sector, and the public.

The multi-party satisfaction of project participants is one of the important purposes pursued by modern project management. The World Bank loan project requires the survey of the satisfaction of the participants in the post-project evaluation as an important criterion for the successful implementation of the evaluation project. The success of public-private partnerships means the need to find a delicate balance between private sector's satisfaction, government's satisfaction and public's satisfaction [12, 13].

The thirteen critical success factors identified in this paper are based on the criteria of stakeholder satisfaction, the goals of the three stakeholders are not completely independent, it's important to seek a condition that can meet the needs of the government, the private sector, and the public. So it is necessary to clarify their interaction by studying the causal relationship between critical factors.

System Dynamics is a computer simulation method created by Professor Forrester of the Massachusetts Institute of Technology in the 1950s. This method can well study the dynamic behavior of the information feedback system. It is a comprehensive application of qualitative and quantitative methods, and can still be studied in the absence of data. In the system dynamics method, a model that reflects causality is the Causal Loop Diagram, in which the causal relationship can be positive, negative, unrelated or complex. Construct a causal feedback relationship model for critical success factors of PPP projects, as shown in Figure 1.



**Figure 1: Causal feedback relationship model for critical success factors of PPP projects**

### 3 Discussion

The private sector is a key factor in forming and sustaining Public and private partnership, and private sector’s capacity and experience are important outcomes. For the private sector, a strong private consortium is an important factor for the successful implementation of PPP. Generally, large and reputable companies will win PPP contracts. In addition, the innovative capabilities and technologies of private enterprises will reduce the overall cost of the project, realize the value of money and improve the satisfaction of the government and the public.

Public is an important stakeholder of the PPP projects, although they did not participate in the PPP contract, the public is the user of public service, they focus on service quality and service price ,their expectations or the perception of the service is very important to improve the PPP project operation and performance , according to Jamali, customer satisfaction helps achieve value for money and improve the quality of service . Boyer et al. believe that public participation can improve project performance [14].In addition, Ahmed et al. 's research results also provide some similar evidence for the importance of public recognition or public opinion in PPP project implementation [15].Good public participation in PPP projects will improve the organizational relationship between the public and partners, and public opinions or needs will be reflected in the service delivery plans of the public and private sectors, thus reducing public opposition and improving the sustainability of the society .Boyer et al. believe that appropriate public participation will have a positive impact on PPP, and public opinion is a key factor for the success of PPP projects’ implementation.

The government plays an important role in creating a good project environment in PPP projects. These effects exist in two ways; First, the government supervises the quality of service and protects the public interest .The second is to Remove private sector concerns about risks, private sectors’ willingness to invest in public infrastructure projects depends largely on the project environment .A good environment can also help

the public understand the documents used in PPP projects and express their opinions reasonably.

Here are several analysis of important feedback loop:

### **3.1 Public sector satisfaction**

With government support, the government makes financial guarantees to reduce the cost of communication and coordination between the private sector and the public sector. At the same time, appropriate risk allocation can also reduce the cost of risk, enabling the private sector to provide a reasonable service price for the higher quality of service infrastructure and Public services to improve public satisfaction, and maintain a better government image, ultimately improve government satisfaction. Public satisfaction is closely related to government satisfaction, and the goals of the two sectors in the PPP project are partially consistent, eventually higher public satisfaction and government satisfaction will contribute to increased private sector satisfaction in PPP project cooperation.

### **3.2 Private sector satisfaction**

From the perspective of private sector satisfaction, profits will directly affect private sector satisfaction. In the causal cycle diagram, market demand, service prices, and costs affect profits, and political support has a positive impact on market demand, for example, when the education district is divided, political factors have an impact on the students' source of school. When the market demand increases, a larger user scale is formed, marginal costs is reduced and have positive feedback on profits.

### **3.3 Public satisfaction**

From the perspective of public satisfaction, service prices and service quality directly affect public satisfaction. On the one hand, the increase in cost of project implementation will stimulate technological innovation and lead to the improvement of enterprise capabilities, The feedback of enterprise capability will form a control over cost of project implementation, and the increase in cost of project implementation, the short-term solution for private sector may be to increase the price of services, and the increase in service prices will lead to a decline in public satisfaction. On the other hand, the improvement of service quality depends on the cost of project implementation and technological innovation, the improved service quality will increase public satisfaction and affect the success of PPP projects.

## **4 Conclusion**

In this paper, the system dynamics principle was used to construct the critical success factor causal feedback model of PPP project, and the relationship and interaction between various critical success factors of PPP projects were analyzed systematically and comprehensively. Changes in each key factor in the system will cause other factors to change, and there are direct and indirect links between various factors. Through the causal cycle diagram, the direct and indirect factors affecting the success of PPP can be clearly identified.

Based on the success criteria of the participant satisfaction evaluation, and considered the impact of the public as a stakeholder on the success of the project, the success of the PPP project was evaluated from the perspective of the government, the private sector, and the public. This suggested how the stakeholders collectively perceive some CSF as less important in the successful management of PPP projects.

The limitation of this research is that only three groups of stakeholders were taken into consideration. It is recommended to conduct future studies on a wider range of stakeholders engaged in PPPs, such as financial institutions or academic institutions under a PPP project.

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