

INTERACTIONAL ANALYSIS FOR TWO-PARTY RISK ASSESSMENT IN PUBLIC PRIVATE PARTNERSHIPS (PPP)

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ABSTRACT

Public Private Partnerships (PPP) have been increasingly used over the past years. However, problems have arisen with the increased use of this procurement strategy. These problems usually occur as a result of various risks that manifest over the long duration of the project. These include risks at the macro, market and project level specific to PPP projects. Examples include concessionaire default in loans for the Sydney Airport Rail Link project, bank refusal to loan the concessionaire for the Channel Tunnel Rail Link project in the United Kingdom and high interest loans on private debt for the Taiwan High Speed Rail project. Identifying risks in previous projects would lead to a risk registry that would help in understanding the sequence of events as well as the parties involved. Case studies have suggested that the outcome of the identified risks can be linked to the interaction of the parties in a PPP project. Parties to the risk in a PPP project include owner or government, developer, financier, sponsor, supplier, architect, subcontractors, contractors, non-governmental organizations (NGOs), media, authorities and regulatory, politicians, workers, end-users and experts. In this paper, game theory is used to analyse the interactions between parties to understand dynamic outcome of the associated risks in PPP project because of the actions taken by the parties to the risk. The scenarios of risks are defined based on actions and their transaction cost as well as outcomes and their payoff. Strategies would be developed and simulated to propose mitigation plans to address risks.

Keywords: Game Theory; Interactional Analysis; Public Private Partnerships; Risks.

1. INTRODUCTION

Public Private Partnerships have seen an increase in usage as a delivery method. The concession period of PPP projects is usually a long duration of 20-100 years and involves multiple parties, which increases the chance of risk occurrence. In a PPP project, these parties include government, private company, lender/financial institution and operators. In cases of risks, these parties interact together to resolve the issue. These risks have been studied in various literature for certain project types or phases. Risk assessment is important for PPP projects in order to control high risks, minimize their effects and prepare mitigation plans. Each risk that occurs instigates actions from the parties involved. Interactions between parties in a risk scenario determine the outcome of the situation and the benefit for each party. In this paper, we discuss the use and importance of interactional analysis and focus on the context of a PPP project. The paper presents a case study of the railway project in Tanzania in order to showcase how interactional analysis can be used to understand the possible strategies and determine the best course of action.

2. LITERATURE REVIEW

Use of PPPs has been increasing over the years. Sarmiento and Renneboog (2014) defined eight sectors where PPPs have been used: “traffic, healthcare, culture and sport, administration, defence, justice, education and others.” Different risks manifest in construction projects, which becomes especially complex in PPP projects that span long durations of 20-100 years. Khallaf *et al.* (2016) identified 75 risks and classified them into three categories: macro/country, market and project risks. These risks manifest throughout the different project phases and may lead to renegotiation of project parameters. Examples of

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such risks include: monetary inflation, bureaucratic delays, risk management practices of parties and insolvency of contractor/operator (Khallaf *et al.*, 2016). These risks not only plague the projects, they also plague the country itself. For example, Colombia awarded the first batch of highway PPPs in the 1990s and suffered due to: lack of a specified roadmap which led to inability to expropriate the required land, lack of bidders, projects were awarded based on preliminary studies that were performed which lacked a lot of detail, lack of financing of the concessionaire which the government did not check and incomplete contracts that lacked mechanisms for conflict resolution (Engel *et al.*, 2003). This led to a failure of many of the PPPs.

According to Domingues and Zlatkovic (2015), the main reason behind contract renegotiations is the complex risk sharing mechanism. Parties renegotiate in order to reduce their losses due to a risk occurrence or to increase their profits in an opportunistic manner. Renegotiations can occur due to various reasons such as incomplete contracts, inadequate regulations and inadequate public sector management (Cruz *et al.*, 2014). These renegotiations are affected by the risks that occur in the project as well how the parties interact to deal with these risks. Interactions between parties can aggravate or reduce the risks and outcomes related to them. Naderpajouh (2013) studied the interaction between parties in an international project. This interactional analysis approach is very valuable in quantifying the results of the actions of each party in a situation of negotiation.

Interactional analysis applies the concepts of game theory to study the interactions between different entities and how their choices affect their payoff as well as the payoff of others. Game theory is a method to study the interactions between people, which can be simulated in order to study the outcomes involved. The analysis of these interactions helps in understanding decision-making to create strategies (Neumann and Morgenstern, 1944; Glumac *et al.*, 2015). These interactions are seen as a game where the players are the actors in a situation. These players take actions sequentially that affects their payoff received. Researchers have used game theory to study the interactions between parties in different situations (Asgari *et al.*, 2013; Eleftheriadou and Mylopoulos, 2008; Madani, 2010; Samsura *et al.*, 2009; Zlotkin and Rosenschein, 1989). Table 1 shows a list of the studies that used game theory. It can be seen that game theory is a reliable method that has been used for to study interactions of actors in different fields.

Table 1: Researches that Applied Game Theory to Study the Interactions of Parties

Source	Description
Asgari <i>et al.</i> (2013)	Proposed a game theory framework to model resource sharing and management among subcontractors
Madani (2010)	Applied game theory to address conflicts in managing water resources.
Samsura <i>et al.</i> (2009)	Used game theory to model the behavior of actors in situations of decision-making related to land development.
Eleftheriadou and Mylopoulos (2008)	Implemented game theory to a case study of negotiations between Greece and Bulgaria on Nestos/Mesta Transboundary River.
Zlotkin and Rosenschein (1989)	Applied game theory to multi-agent negotiation

Table 2 lists the studies that used game theory to address scenarios in Public Private Partnership projects. Some of them enforced the use of game theory in PPPs (Scharle, 2002; Kargol and Sokol, 2007); some studied the financial aspects in PPP projects (Ho, 2006; Kennedy, 2013), while others addressed risks that occur (Naderpajouh, 2013; Zou and Kumaraswamy, 2009).

Table 2: Game Theory in PPP Projects

Source	Description
Scharle (2002)	Discussed PPPs and emphasized the importance of the gaming perspective to understand PPPs
Ho (2006)	Studied when and how government will rescue a distressed project and what impacts government's rescue behavior has on project procurement and management using Game Theory
Kargol and Sokol (2007)	Presented a descriptive method in order to link the theoretical aspects of PPP to game theory
Zou and Kumaraswamy (2009)	Presented a basic summarized theoretic approach for understanding risk allocation in PPP projects in terms of Take/Transfer a risk
Chen <i>et al.</i> (2012)	Presented a Game Theory model to analyze the Taiwan High Speed Railroad project to examine how developers implement different strategies during project stages to alter the contract's conditions in order to continually creating competitive advantage after they have been awarded the contract
Kennedy (2013)	Applied Ho's (2006) model to "Metronet - London Underground PPP" project
Naderpajouh (2013)	Applied game theory and simulation to model emergent risks from the interaction of project developer and social opposition.
Glumac <i>et al.</i> (2015)	Applied a game theory experiment to brownfield PPP projects in three cases of negotiations: "building claim, future land use and reparcelling of the land"

3. METHODOLOGY

Naderpajouh *et al.* (2014) proposed the use of game theoretic concepts to study emergent dynamics between actors and applied it to a case of social opposition of an infrastructure development project. In this paper, game theory is used to model the interactions between two parties to a PPP project. The parties are considered actors that play a sequential game, taking turns choosing actions. Each action has a payoff for each actor. This payoff is based on transaction costs for their choice of either a formal or informal action that they incur. Examples of informal actions include protests, while formal actions include litigation. Transaction costs are unique to each actor so they have their own cost for informal and formal transactions. In this case study, we focus on a scenario between two parties: the union and government. Studying the relationship between these two parties helps in understanding the negotiation process, possible courses of action and the resulting payoff. The relationship between these two parties is important because it affected the project, led to instability and later public resentment of the project.

4. CASE STUDY

In this paper, we build a hypothetical model based on the dynamics associated with the case of the Tanzania Railway Concession project. A need for rehabilitation, development and operation of the railway drove the need for this project (IFC, 2016). Based on several studies performed by a private consultant and also by the World Bank from 1997 to 2000, a framework of PPP was suggested for execution of the project (Phipps, 2009). In 2007, RITES of India won the concession from the Government of Tanzania. A new entity named Tanzania Railways Limited (TRL) was formed between RITES - with 51% shareholding - and the Government of Tanzania with 49% for the operation of the railway transport for 25 years (Tito, 2016). A Governmental agency, RAHCO (Reli Asset Holding Company) was formed and tasked with monitoring contract compliance and managing the rail assets.

There was a long duration of 10 years between the decision to undergo a PPP and the actual signing of the contract. During that period, there was no investment in infrastructure so the workers were uncertain about their jobs. The concession was re-bid three times, which affected the workers and investors and showed the government's lack of commitment to this delivery method (Phipps, 2009). Problems started with the request of the "Tanzanian Railways Association Workers Union" (TRAWU) to increase salary,

with threats of going on strike if their needs were not met (Shlyk, 2009). TRL agreed to negotiate with the Government to solve this issue, however, their meeting was not fruitful and no decision was made. Due to the lack of action from these two parties, TRAWU followed their promise and went on strike. TRL and the Government of Tanzania were forced to make a decision to appease the union. Eventually, the Government decided to contribute to the salary increase.

It is important to understand how the decisions made by the Government of Tanzania and by TRAWU affected the union workers, concessionaire and project outcome. In this paper, we focus on the interactions between the union (TRAWU) and public (Government of Tanzania or GoT) because of the significant impact their individual choices made on the project. Studying these interactions ex post in this project sheds light on the choices that each party had, what they chose and the effect of these choices. Using an established case aims at validating the proposed framework in order to enforce the importance of its use. Figure 1 shows the possible actions of the parties in each phase in time. The game starts with TRAWU having a choice of either “no action”, thereby leaving the conditions as is, i.e., status quo, or taking informal action, which is requesting a salary increase and threatening to strike. If TRAWU decides to take “informal action”, GoT then makes a choice of either “no action” and accept their request or taking “informal action” and requesting to meet with TRL to discuss this. In case GoT takes “informal action”, the next move is up to TRAWU (due to their dissatisfaction of a lack of decision by GoT and TRL) and they either take “no action” or take a “formal action” by going on strike. In response to TRAWU’s strike, GoT either goes to settle the subsidy request or takes formal action by terminating the concession contract.

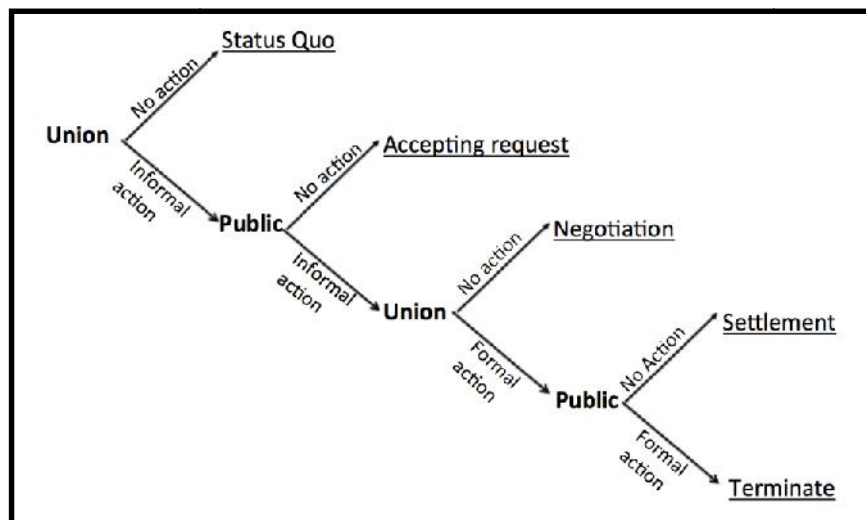


Figure 1: Game between Union and Government

Simulation is performed in order to observe the results from varying the parameters in different scenarios (Naderpajouh *et al.*, 2014). Using the Anylogic software, simulations are performed based on the hypothetical scenarios in order to explore the probability of ending at each node and the expected payoff for each party. Four cases are tested: base case, case of high transaction costs for TRAWU, case of high transaction costs for GoT and case where there is slightly less bargaining power of TRAWU. Figure 2 shows the results of the simulation performed and associated probability distributions where the black bars represent the union and the white bars represent the public.

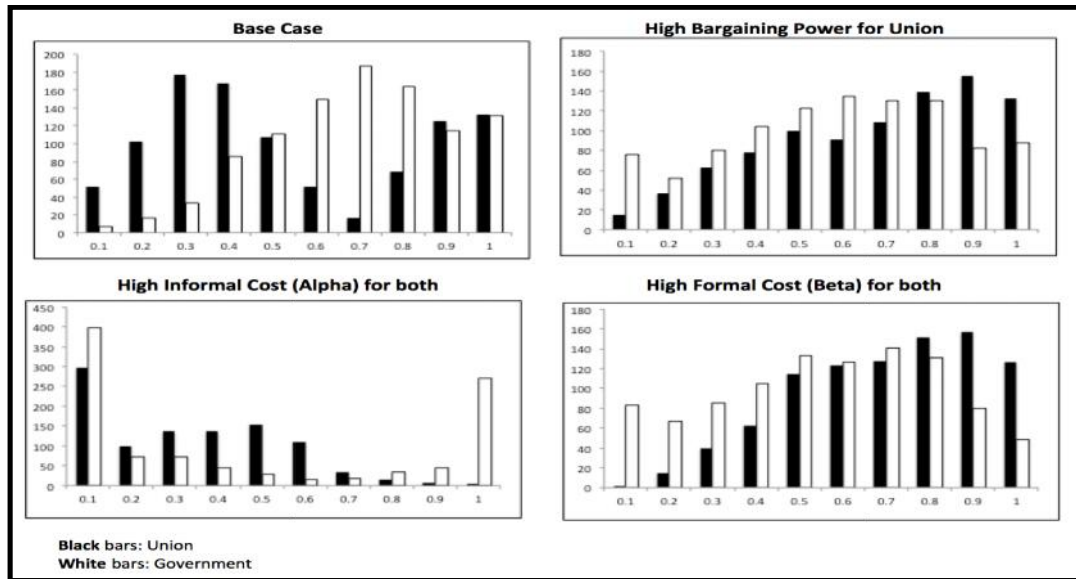


Figure 2: Simulation Results (Distribution of Outcomes for Union and Government)

5. DISCUSSION

Figure 2 shows the results of 1,000 simulations for the hypothetical examples as discussed below:

- 1) Base case without changing any parameters.
- 2) High bargaining power for union shown by increasing the percentage of negotiation: this results in an increase in the percentage of negotiation from the base case. It can also be seen that the payoffs shift towards the right, which means an increase in payoffs.
- 3) High informal cost for both parties: this causes an increase in the number of times that “status quo” was chosen since an increase in informal cost makes the parties less likely to reach that phase.
- 4) High formal cost for both parties: this increases the chance of ending up in “accepting request” and “negotiation” highly since the parties do not want to choose formal action for its extremely high cost.

These simulations show the result of varying the parameters such as bargaining power for the actors (2nd scenario), informal transaction cost (3rd scenario) and formal transaction cost (4th scenario). From the 1,000 simulations conducted, the possibility of ending at each node was calculated. Table 3 shows the results of the count of how many times we would end up in each node for the four hypothetical scenarios. It can be seen that when the informal cost is high, the probability of avoiding it and settling for status quo is higher than in other cases. When the formal cost is high, the probability of avoiding it is high so the game shifts towards negotiation. This table shows four chosen scenarios where the parameters are changed to see the effect on the probability of choosing this node and to see the payoff received.

Table 3: Probability of Ending at Each Node

	Base Case	High Bargaining Power for Union	High Informal Cost	High Formal Cost
Status Quo	0	2	192	1
Accept request	244	196	242	186
Negotiate	721	756	566	813
Terminate	34	46	0	0

6. CONCLUSION

This paper discussed the use of interactional analysis to simulate actions of parties in a risk and presented a case study for the Tanzania Railway project. The interactional analysis framework was targeted for cases of two parties in a PPP project and the results of the simulation showed the probability of ending up in each node for 4 cases: base case, high bargaining power for union, high informal cost for both parties and high formal cost for both parties. These results can be used by the parties to understand their best strategies in any given scenario. The framework was used to analyse the interactions in the Tanzania project ex poste to endorse its use for PPP projects and suggest its use a priori in the future in order to understand each party's possible choices and assess the impact of these choices on the inherent risks before taking a course of action.

This framework can be adapted and used for any project and any delivery method. More simulation scenarios can be adapted in order to show a wide spectrum of possible actions and develop a portfolio of the actions and resulting outcomes, which would help in future decisions. The authors are currently working on applying this model to more case studies and also expanding the model beyond its two-party interactions. This would be a more complex set-up but would shed light on the multiple parties involved in a negotiation scenario and how their interactions and choices affect their gains/losses in a PPP project.

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