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Procedia Engineering 145 (2016) 1354 – 1361

**Procedia
Engineering**www.elsevier.com/locate/procedia

International Conference on Sustainable Design, Engineering and Construction

A Proposal for risk Allocation in social infrastructure projects applying PPP in Colombia

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Abstract

The public private partnership (PPP) is actually one of the most important procurement mechanisms of project development. The developed countries have implemented this method for delivering infrastructure projects in a variety of sectors: transportation, telecommunications, power, water, sanitation, health, education, and correction facilities among others. Despite the positive international experience, some of the developing countries only have implemented PPP as a delivery method for construction transportation, telecommunications and power infrastructure. These countries have not yet started to use the PPP mechanism for social infrastructure for three main reasons: a) the lack of clear legislation, b) uncertainty of risk allocation, and c) financial feasibility. This paper aims to identify the risk allocation for the development of a public school in Colombia by interviews with experts from the academia, public sector and private sector. The interview structure was designed in such way that the question sequences enable the experts demonstrate their opinions. The analysis of the quantitative data was done through a results adjustment as probabilistic distributions. The responses demonstrate that the private sector has to assume natural risks, financial risks, macroeconomic indicators risks, construction risks, and operational risks, while, the public sector has to assume the social risks, selection project risk and political risks. Finally, the legal and legislation risks, residual risk, relationship risk should be shared by both public sector and private sector. This study provides important information about the appropriate risk allocation and a risk assessment for the construction social infrastructure projects through PPP in Colombia.

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Peer-review under responsibility of the organizing committee of ICSDEC 2016

Keywords: Public private association, risk assessment, social infrastructure, experts interviews

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1. Introduction

There is not a widely accepted definition for public private partnerships (PPP). Overall, a PPP is an agreement between the public sector and the private sector in which particular services and tasks, that are responsibility of the government, are provided by the private sector [1]. The use of private capital to finance public infrastructure is not a new scheme, but recently it has been promoted in multiple ways thanks to the PPP. This mechanism is characterized by the contribution on financial, construction and operation issues of public projects by the private sector. The advantages of the PPP mainly relate to obtain the best value for money through the skills of the private sector to obtain resources, make investments, and provided high quality infrastructure. All of these advantages are achieved by transferring much of the risks from the public to the private sector.

Worldwide, PPP are used for the construction of different types of infrastructure with many successful cases. UK, Canada and Australia are the most remarkable countries in PPP implementation, due to these countries priorities to infrastructure development, and the appropriate policies and legal regulation that enables the involvement of the private sector. The PPP are implemented for the development of different types of infrastructure such as power, communications, water supply, and transport, which actually is the most prominent sector, built as PPP [2]. Another sector in which the PPP can be implemented is the social infrastructure, as hospitals, schools and prisons among others. In the social sector is more difficult to implement PPP, because the contractual issues are not clear when the private sector is going to provide services that should be provided by the government. PPP for Social infrastructure has been implemented only by the countries which have a good administrative, financial and legal capacity.

In the specific case of Latin American countries, the main characteristics of the PPP have been identified due to the role of the Multilateral Investment Fund (MIF) [3]. This organization has promoted the private investment through technical, educational and financial support in order to evaluate and cooperate with the economic growth of the region. For instance, Brazil and Mexico are the most remarkable countries in this aspect. On one hand, Brazil has eight units of PPP control, more than one thousand specialists, two laws and regulations. On the other hand, Mexico has seven units of control and approximately four hundred specialists; however, in contrast with Brazil, this country have seventeen laws and regulations, which may be the result of the difficulty to establish correct laws for PPP [4].

Uruguay, Paraguay and Colombia have implemented PPP less steeply than Brazil. Uruguay is the most representative of these three countries, with two units of PPP, two laws, regulations and approximately one hundred specialists. Paraguay remained second place among this three countries, with one unit of PPP, one law and approximately fifty specialists. Lastly, Colombia has one unit of PPP, two laws and regulations, and approximately twenty specialists [4].

The projects concluded under PPP schemes have specific characteristics, like duration, cost and number of stakeholders, which make imperative to do a careful analysis of the allocation of each latent risk of the project. The risks involved in the PPP projects come mainly from the complexity of the contract, specifically among the documentation, financing, technical details, taxation themes [5].

One of the mainly hitches in the implementation of PPP in social infrastructure in Colombia is that it requires to allocate the risks in a way that each risk will be assumed by the sector that is more able to manage it. However, it is not easy to identify the correct way to allocate the risk, mainly because the uncertainty associated to each risk. Therefore, an appropriate risk analysis must be made through qualitative and quantitative estimation [6].

This paper aims to identify the risk allocation for social infrastructure projects in Colombia through three stages. First, an extensive literature review is made to identify the risks of PPP projects. Then, a comparison between the bibliographic risks and the risks of two real projects is made. Finally, the identification of risk allocation based on recognized PPP experts.

2. PPP risk management

The PPP is a contractual mechanism in which the public sector shares their risks with the private sector. There are many risks that both public and private sector are exposed in PPP, because the majority of the public projects present a long term development and a high investment (CAPEX). In addition, the duration, cost and quality, initially forecasted for the project, can change during its process. The amount and type of risk depend on the each project characteristics. Therefore, there are many ways to manage and mitigate the risks in the PPP.

2.1. Risk identification

In spite of the many types of possible risks in PPP, there are mainly eight types of risks that are presented on any infrastructure project [5]:

- Technical risks: these risks relate to the weaknesses of the project implementation caused by errors in engineering design.
- Construction risks: these risks relate to the problems during the construction phase that are associated with cost overruns or delays.
- Economic risks: these risks relate to the changes of the cash flows caused by price volatility, changes in the service demand, and changes in the economic conditions.
- Legal risks: these risks relate to legal and regulatory changes that could affect the course of the project.
- Environmental risk: these risks relate to the environmental factors that could affect the project sustainability.
- Operating risks: these risks relate to the problems during the operation phase caused by poor design, failures in the construction, and changes in the forecasted operation characteristics.
- Natural risks: these risks relate to events of force majeure as acts of nature, fires, floods, wars, or another kind of disaster.

2.2. Risk analysis

In order to carry out effective risk assessment, it is important to do a qualitative evaluation in order to determine the probability of occurrence and the level of impact of each risk. In 2011 [7] developed a computerized model to do a risk evaluation for public private partnerships, based on different input parameters like surveys and literary revisions. They surveyed more than 500 experts in construction sector in China, asking for the probability of occurrence, level of impact and some missed risks. The results were analyzed by 3 methods: a) Factor Analysis (FA), b) Fuzzy Sets (FS) and d) Fuzzy Synthetic Evaluation (FSE).

In 2010, [8] identified the risks present in road construction PPP projects in India. They identified the need of identifying the governing risks in PPP projects. The Interpretative Structural Modelling (ISM) was the author's tool to build the hierarchical structure of the risks in the developing stage of road projects in India. This study identified 17 risks and they determined that fourteen risks were independents and the financial closure risk, the cost overrun risks and the time overrun risk are highly dependent on other risks.

2.3. Risk allocation

Regarding the risk allocation, [9] the Final Offer Arbitration (FOA) proposed a methodology, in which a third party, known as arbitrate, have to make a decision between the parties' offers. In the specific case of the PPP, the parties (public sector, private sector, insurance companies, borrower, etc.) should to determine the amount of risk willing to take according to their expected return. This risk allocation was showed as a mathematic model through a utility functions with variables as the risks probability of occurrence, the parties risk aversion, among other.

3. Methodology

The risk allocation in education projects through PPP was determined in two steps. The first step was an identification of the risks in PPP project, and the second step was an interview with experts from the public sector, private sector and the academy. The risk identification was initially done through a literature review of studies in which the risk of PPP project was evaluated, quantified, or allocated. After the risk identification, a risk selection was done through a comparison between the risk identified and two projects of social infrastructure in Colombia. Finally, an interview was done to three PPP experts from the private sector, three PPP experts from public sector, and three PPP experts from the academy; these experts were carefully selected by their experience and knowledge.

3.1. Bibliographic review

The risk identification was done through a review of fourteen PPP studies. In 2004, [10] studied the risk allocation in PPP projects in the UK. In 2012, [11] compared the critical factors and risk allocation between a high speed rail project and general infrastructure projects. In 2009, [12] studied the risk allocation of PPP projects in China. In 2011, [13] made a empirical study of risk assesment and allocation in PPP project in China. In 2010, [15] identified techniques of response to risk in construction projects. In 2010, **¡Error! No se encuentra el origen de la referencia.** identified the determinants of an appropriate risk allocation in PPP projects in Australia. In 2010, [16] developed a model for risk assasment in PPP projects in China with a fuzzy synthetic evaluation. In 2011, [17] determined a risk assessment methodology based on Fuzzy AHP. In 2011, [18] made a comparision of risk factor between water, power,and transportation PPP projects. In 2006, [19] proposed a model of risk managment for the traffic revenue in road projects in India. In 2010, [20] identified the contractor's approach to risk identification in construction projects in New South Wales, Australia. In 2010, [21] made a framework for risk managment for construction projects in developing countries. Finally in 2012, [22] developed an analysis of the factor, risks and risk allocation from the perspective of contractor to PPP projects in Singapore.

3.2. Risk selection

After the risk identification, the risk selection was done through two comparisons. One comparison was made between the 61 risks from the literature review and the risk matrix of a construction project of the new building for the Attorney General of Colombia in Cali, the first social infrastructure project that has been proposed as PPP in Colombia. The second comparison was made between the sixty-one risks taken from the literary review and the risk matrix of a Quiroga Alianza school construction project in Bogota-Colombia as public auction that is the traditional way of performing the public projects in Colombia. A Pareto analysis was made for the identification of the definitive risks for being evaluated through the experts' interview.

3.3. Interview

The interview was conducted in three steps. The first step was an introduction about the research work on risks allocation in PPP projects and an explanation about the risk selected to evaluate them, according to the prior selection. The second step was a questionnaire about the appropriate sector to manage each risk. The risk allocation was determined numerically according to the answers of the experts, who have more than twenty years of experience in construction projects: (1) if the risk should be manage by the private sector, (0) if the risk should be manage by the public sector, and (0.5) if the risk should be shared between the private and public sector.

4. Findings and results analysis

The findings from this study are divided on three stages. The first stage is the risk identified through the literature review. The second stage is the risk selected through the comparison between the bibliographic risk and the risk of construction projects in Colombia. Finally, the risk allocation is presented as the result from the experts' interview.

4.1. Risk identified

A list of sixty two risks was obtained from the fourteen papers about risk in PPP. The risks identified were grouped into 11 different categories, this is shown in the Table 1.

Table 1 Category risk

Political	Ten risks associated with problems from government policies, political opposition, lack of support of government and mainly problems caused by an unstable government.
Legal	Nine risks associated with changes in legislation, taxes, contract characteristics and industrial regulatory.
Operation	Seven risks associated with operation stage defaults that can cause cost overrun, less revenues, maintenance more frequent than expected and low operating productivity.
Relationship	Six risks associated with a lack of work organization and coordination caused by inadequate distribution of authority, differences of the know-how between partners.
Design	Six risks associated with delays and scope variation caused by a design deficiency and unproven engineering techniques
Construction	Six risks associated with construction stage defaults that can cause costs overruns and time delays.
Macroeconomic	five risks associated with the volatility of the macroeconomic indicators as inflation rate, interest rate and foreign exchange
Natural	Four risks associated with force majeure events and land conditions that can cause problems in the project execution
Social	Three risks associated with the community acceptance caused by the public opposition, and lack of the private provision of public services
Project selection	Three risks associated with defaults in project selection that can cause difficulty on the project feasibility.
Financial	Three risks associated with problems in terms of the financial viability.

4.2. Risk selected

The Pareto chart was made through a weight assignment to the three strategies of risk identification. Therefore, a risk that was identified in the three strategies had a weight of 42, as shown in Fig. 1 .Based on this, 24 risks was selected because they have a higher weight than 15, which means that the risks was identified at least in two of the three strategies.

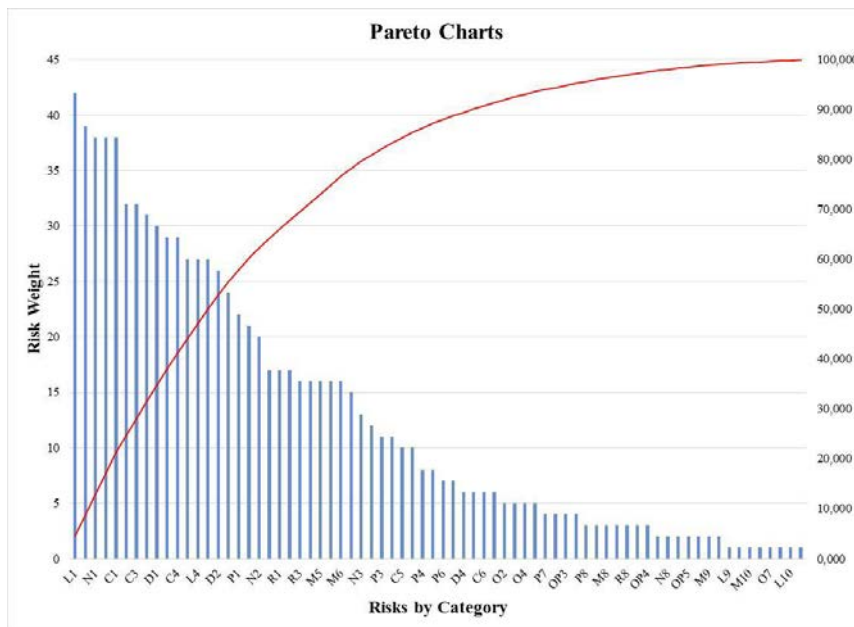


Fig. 1 Pareto Charts

The twenty-four risks selected, with their weight according to the identification strategy, are shown in Table 2. It is important to recognize that the political, macroeconomic, relationship and project selection risks are not present in

the Quiroga Alianza School project, because this project was made with a traditional contract method. On the other hand, some risk as industrial regulation changes, delays in time, subcontractor failures and site security are presented in the Colombian project but they have a lot weight in the bibliographic review due to the characteristics of the Colombian context.

4.3. Risk Allocation

Based on the interview replies, the results of the each risk allocation was similar within the category risk. Therefore the risk allocation was analyzed by categories as shown in Table 3. The project selection risk is the only risk in which all the experts have the same opinion. The opinion about the macroeconomic risk, financial risk, construction risk, natural risk, design risk and the operation risk achieved a clear allocation.

The interview responses defined that the political risk, legal risks and the relationship risk must be share between the parties. The social risk and the project selection risk must be assumed by the public sector. The private sector have to manage the macroeconomic, natural, financial, design, construction, and operation risks.

Table 2 Risks selected

	Risk	Bibliographic review	Attorney General of Colombia	Quiroga Alianza School	Total Weight
Political	Corruption	9	x		23
Macroeconomics	Inflation volatility	12	x		26
	Interest rate volatility	14	x		28
	Economic events	2	x		16
	Exchange rate volatility	8	x		22
	Legislation changes	13	x		27
Legal	Regulation taxes changes	9	x		23
	Industrial regulation changes	1	x	x	29
	Lack of legal regulation	4	x	x	32
	Contract changes	3	x		17
	Contract default	2	x		16
	Lack of contract standard	1		x	15
	Public opposition	4	x		18
Social	Demand change	11	x	x	39
Natural	Majeure force	10	x	x	38
	Geotechnical conditions	6	x		20
Project selection	No competitive tender	4		x	18
Financial	Financial viability	3	x		
Design	Residual risk	10		x	24
	Delays in permits approvals	14	x	x	42
	Scope variation	2	x	x	30
Construction	Cost overrun	8	x	x	36
	Delays in time	5	x	x	33
	Material availability	9		x	23
	Subcontractors failures	1	x	x	29
	Site security	5	x	x	33
Operation	Cost overrun	11	x		25
Relationship	Lack of coordination between stakeholders	4	x		18

Table 3 Risk allocation

	Private (1)	Public (0)	Share (0.5)
Political			x
Macroeconomics	x		
Legal			x
Social		x	
Natural	x		
Project selection		x	
Financial	x		
Design	x		
Construction	x		
Operation	x		
Relationship			x

5. Conclusions

Even though the developed countries have achieved a successful PPP implementation, the developing countries are still at the beginning of the learning process. In the developing countries, the PPP has largely been implemented for productive infrastructure projects because these projects have more reliable returns and are more aligned to the private sector interest. In the case of the social infrastructure, the PPP implementation is more difficult, taking into account that the project characteristics are less attractive for the private sector due to uncertainties associated with the flow of income and the appropriate risk allocation.

The risk allocation is an evident hindrance for the PPP implementation in social infrastructure in Colombia. There is no a clear methodology for the risk allocation in social infrastructure because the public authorities don't have sufficient knowledge about the most appropriate risk allocation among the parties to increase the attractiveness of these projects for the private investors. Therefore, the aim of this study was identify the risk allocation through an interview for Colombian construction experts.

The legal risk and the relationship risks are key factors for a successful PPP implementation. These risks depend on the government regulations and stability, but these risks have to be assumed by the private sector. Therefore, the government responsibility is to provide the most stable conditions for the project development.

The literature review showed that there are many types of risk that can be present in a PPP project. It was remarkable the comparison done between the literature review about risks and the Colombian projects risk, because it show the differences between the international context and the Colombian context.

Future research must be focused on the differences between the risks in productive infrastructure projects and the risk in social infrastructure projects. This topic could help public authorities to identify the main differences among these two types of infrastructure projects and overcome the hesitation by the private sector to get involved in social infrastructure.

References

- [1] World Bank. (3 de octubre de 2015). *ppp world bank*. Obtenido de <http://ppp.worldbank.org/public-private-partnership/overview/ppp-objectives>
- [2] cutting through complexity. (2014). *KPMG*. Obtenido de INFRASTRUCTURE 100 WORLD MARKETS REPORT: <https://www.kpmg.com/Global/en/IssuesAndInsights/ArticlesPublications/infra100-world-markets/Documents/infrastructure-100-world-markets-report-v3.pdf>
- [3] IDB. (2015). *Interamerican development bank*. Obtenido de Resources for businesses: <http://www.iadb.org/en/resources-for-businesses/multilateral-investment-fund,5763.html>
- [4] Fondo Multilateral de Inversiones-BID. (ABRIL de 2015). *FOMIN*. Obtenido de LECCIONES APRENDIDAS Y MEJORES PRACTICA DE APP
- [5] Darrin Grimsey, M. K. (9 de July de 2000). Evaluating the Risks of Public Private Partnerships for infrastructure projects. *International Journal of Project Management*, 12. Recuperado el 04 de 11 de 2015
- [6] Quinones, J. C. (2013). Public Private Partnerships law in Colombia: Principles and risk allocation schemes.

- [7] Xu, Y., Lu, Y., Chan, A. P., & Skibniewski, M. J. (13 de December de 2011). A Computerized Risk Evaluation Model for Public-Private Partnership (PPP) Projects and Its Application. *International Journal of Strategic Property Management*, 22. Recuperado el 09 de 11 de 2015
- [8] Iyer, K. C., & Sagheer, M. (2010). Hierarchical Structuring of PPP Risks Using Interpretative Structural Modeling. *JOURNAL OF CONSTRUCTION ENGINEERING AND MANAGEMENT © ASCE*, 9. Recuperado el 08 de 11 de 2015
- [9] Medda, F. (30 de june de 2006). A game theory approach for the allocation of risks in transport Public Private Partnerships. *INTERNATIONAL JOURNAL OF project management*, 6. Recuperado el 04 de 11 de 2015
- [10] Bing, L., Akintoye, A., Edwards, P., & Hardcastle, C. (2004). The allocation of risk un PPP/PFI construction projects in the UK. *Project Mangament*.
- [11] Chou, J. S., Tserng, H. P., Lin, C., & Yeh, C. P. (2012). Critical factor and risk allocation for ppp policy; Comparison between HSR and general infrastructure projects. *Transport Policy*.
- [12] Ke, Y., Wang, S., Chan, A. P., & Lam, T. P. (2009). Preferred risk allocation in China's public private partnership projects. *Project management*.
- [13] Chan , A. P., Yeung, J. F., Yu, C. C., Wang, S. Q., & Ke, Y. (2011). Emperical study of risk assesment and allocation of public private partnership projects in China.
- [14] Baker, S., Ponniah, D., & Smith, S. (2010). Risk response techniques employed currently for major projects. *Construction management and economics*.
- [15] Jin, X. H. (2010). Determinants of efficient risk allocation in privately financed public infrastructure projects in Australia. *Construction engeneering management*.
- [16] Xu, Y., Yeung, J. F., Chan, A. P., Chan, D. W., Wang, S. Q., & Ke, Y. (2010). Developing a risk assessment model for PPP projects in China — A fuzzy synthetic evaluation approach. *Automation in Construction*.
- [17] Li, J., & Zou, P. X. (2011). Fuzzy AHP-Based Risk Assessment Methodology for PPP projects. *Construction Engeneering Management* .
- [18] Cheung, E., & Chan, A. P. (2011). Risk Factors of Public-Private Partnership Projects in China: Comparison between the Water, Power, and Transportation Sectors. *Urban Plan* .
- [19] Singh, L. B., & Kalidindi, S. N. (2006). Traffic revenue risk management through Annuity Model of PPP road projects in India. *Project management*.
- [20] Bajaj, D., Oluwoye, J., & Lenard, D. (2010). An analysis of contractors' approaches to risk identification in New South Wales, Australia. *Construction management and economics*.
- [21] Wang, S. Q., Dulaimi, M. F., & Aguria, M. Y. (2010). Risk management framework for construction projects in developing countries. *Construction managment and economics*.
- [22] Haifang, C., Quan, Z., & Huaizhi, G. (2009). Risk Identification of Private Capital Participating in Government Project Based on Risk Matrix. *IEEE's Publications*, 5. Recuperado el 04 de 11 de 2015