Risk Allocation in Public Private Partnership by Mathematical Model

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ABSTRACT: This article examines how risk is reflected in infrastructures on the basis of regulatory contracts. Partnership between private and public sectors requires risk to be allocated to contractual party that is better able to bear them. An empirical questionnaire was designed to examine the importance of risk factors and to allocate the risk factors to different parties in PPP project. A total of 220 questionnaires were sent and total of 46 was valid responses. The Mann-Whitney U test was employed between academic and industrial to find out the mean rank. By empirical we find that this three are the most important risk factor for PPP project in India (1) Completion Risk (2) Cost Overrun Risk (3) Design and Construction Risk. We conclude that risk is a major issue in contracts with the public and private sectors.

KEYWORDS: Public-private partnerships (PPP); Risk allocation; Contracts; Risk management.

I.INTRODUCTION

India is one of the most densely populated countries in the world. The estimated population in India is projected to increase to approximately 1.73 billion people in 2050 (United Nation 2017). The infrastructure investment is mainly depending on the private capital markets for financing; because of the inadequate government funding and it limit the development of the projects. Public private partnership (PPP) has been identified as innovative tools for funding major infrastructure projects.

The Public private partnership (PPP) is a commercial legal relationship defined by the Government of India in 2011 as an arrangement between government / Statutory entity / government owned entity on one side and private sector entity on the other. The government acquisition the land and Private sector will make a investment and maintain for specific period of time.

Risk Management in PPP projects:

Risk management is the process of identifying, analyzing and addressing significant risk on the recent basis. It is a process that can avoid the negative outcomes, and help in emerging opportunities. Risk management is a continuous process throughout the process cycle. Risk management is an important concept for every construction. A successful contractor must know how to identify the risk and manage in his project. A condition that does not occur repeatedly needs to have an orderly and consistent approach to measure the risk properly.

Risk management is an important part of the decision making process in construction (Kangari 1995), and now widely accepted as a vital role in the management of projects (Wood and Ellis 2003). A variety of risk management techniques has been studied and introduced in the literature (COSO 2004; Lyons 2003; Walker and Johannes 2003; Cano and Cruz 2002) which are included in the risk management process of risk identification, risk analysis, risk responses, risk monitoring. The ultimate efficiency of the construction during the process. Thus there has been increase in research aimed at investigating risk management practice in the construction. Although various demands of risk reside in different people mind, risks always exist in construction projects and often cause schedule delay. PPP project has no exception. The identification of risk and management is the core design of any PPP project.

Classification of Risk:

There are different classifications of risks, depending on the author. For example: Grimsey and lewis (2002, 2004) consider at least nine risks for infrastructure projects:
- Technical
- Constructions
- Operating
- Revenue

- Financial
- Force majeure
- Regulatory/Political
- Environmental and project default risks.

In their taxonomy, they categorize risks into global and elemental. The former includes the risks associated with the project agreement, including political, legal, commercial and environmental risks; and the latter includes risks with the project per encompassing the construction, operation, finance, and revenue generation risks.

In another study, Ng and Loosemore (2007) categorize risks into two major groups: project and general risks. Project risk comprises the events concerning the micro environment associated with the each project and general risks are external to the PPP projects itself. Li et al. (2005) propose a classification of risk into three categories: macro, micro and meso level risks. Macro level risks are externally generated and therefore not related to the project, whereas meso- level risks are endogenous to the project. Finally, the micro level comprise the risk borne in the procurement process, these are associated with stakeholder relationship and difference of public and private perspectives. Another study classifies the risks into production, commercial, and contextual risks.
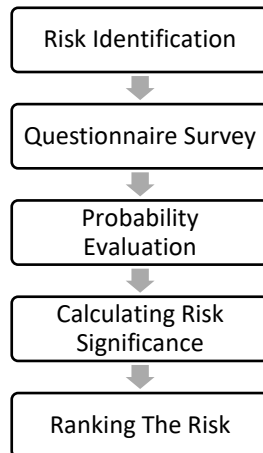
II.RESEARCH METHODOLOGY

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Fig 1: Methodology

In PPP projects there lot of risk, first of all we have to identify the major risks which affects the project and cause cost overrun and delay and which affects the project wholly. From study we have taken 25 major risks which were found to be major ones. After identification of risks questionnaire was prepared which also collects the background information of the respondents. The questionnaire was created in Google forms and it sent out to both industrial and academic people. The mean value was taken from the responses and the ranking of the risk factors were done. Risk significance is calculated by multiplying the risk probability and risk impact. Now Mann Whitney U- test were conducted in SPSS software to ensure whether the hypothesis can be selected or rejected. If the p values which is calculated from the SPSS software is greater than the significance level then it can be accepted otherwise it should be rejected. The upper and lower limits form the mean value should be set and then risk is allocated.

III. RISK IDENTIFICATION

Risk is the effect of uncertainty on the objectives. From the standpoint of project management, risk relates to an uncertain even that, if it occurs may have an impact at least one of the project outcome. Risk can be quantified as the probability of a particular event occurring multiple times by its corresponding impact level. Because of the centrality of risk identification and assessment, so it's crucial to those who prepare the contract identity and allocate the risk before the

public-tender stage. A risk matrix with contractual clauses addressing each risk should be given to the bidders. The following risks are identified for the further process:

Table 1: Description of Risks

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Government corruption	The behavior of the corruption of government officials will increase the cost of keeping the relationships between the government and the project company
Government intervention	Government officials intervene in the project operations directly, which will affect the autonomy of private investors' decision making.
Political risk	Change in government policy or political opposition
Social risk / Public opposition	This risk arises from the different concerns, public objection to imposition of tariffs, discontent with the environmental impacts of civil works etc.
Legislation change	Change of law and regulations and other government macroscopic economic policies will cause the increase in project costs and decrease in revenue, etc
Interest rate fluctuation	Arising from the uncertainties of interest rate volatility.
Foreign exchange fluctuation	Variability of foreign currencies exchange.
Inflation	Increase or decrease in price level of commodities(goods)
Delay in project approvals and permit	Arises due to the complicated procedures
Land acquisition	Arises when acquiring land from people
Financing risk	The risk that sufficient finance will not be available for the project at reasonable cost resulting in delays in the financial closure for a project
Completion risk	Project delay and cost overrun, etc., which cause insufficient cash flow and inability to pay off debts on time.
Cost overrun risk	Arises due to the unexpected cost incurred in excess of a budgeted amount due to an underestimation of the actual cost during budgeting.
Change in market demand	Possibility that market conditions assumed in determining the viability of the project are not realized
Operation and Maintenance risk	The risks associated with the need for increased maintenance of the assets over the term of the project to meet performance requirements.
Force majeure	Risks due to unpredictable natural and man-made events such as earth quake, flood, civil war etc.
Change in tax regulation	The risk that before or after completion the tax impost on the private party, its assets or on the project will change.
Environment risk	These are risks relating to occurrence of environmental incidents during the course of implementation of the project
Design and Construction risk	The proposed design will be unable to meet the performance and service requirements in the output specification. The construction of the assets required for the project will not be completed on time, on budget or to specification.

Material and Labor non availability	Loss because of delay in raw materials, resources, machines and equipment, or energy supply.
Third party delay	Apart from government or private investors, other project participants do not implement the responsibilities agreed in the contract or project delay.
Poor public decision making process	Non standardized procedures, bureaucracy, lacking of PPP project experience and ability, insufficient preparation and information asymmetry, leading to poor decision making.
Technology Risk	Arises when the technology is not a proven one.
Uniform weather /geotechnical condition	Because of the project site's bad natural conditions, for example, climate condition, special geographical environment, and poor site conditions, etc.
Inadequate competition for tender	The risk includes unfair, nontransparent tendering process, incomplete tender information, insufficient number of tenders, vicious market competition, and bidding lowest price to win the tenders.

IV. QUESTIONNAIRE SURVEY

A total of 220 questionnaires were sent out, and total of 45 valid responses were obtained for data analysis. In that 23 from academic and 22 from industrial people. The questionnaire was used to examine the importance of the risk factors and to analyze, how to allocate each risk factor to different parties when PPP project are delivered. The questionnaire was divided into three parts. The first part provides the definition of all 25 risk factor for PPP projects in India. The second part solicits the demographic information of the respondents. The main purpose of this part is to collect the background information of the respondents to conduct subsequent

Comparative analysis. The third part is designed to evaluate the principal risks of the projects in India. A five-point Likert scale is used as a measurement scale. Regarding the five point scale indicates the probability of occurrence and severity, the five point Likert scale represents 1 = very low, 2 = low, 3 = average, 4 = high, 5 = very high. Regarding the risk allocation, the five point scale represents 1 = wholly allocated to the public sector (Government), 2 = mainly allocated to the public sector (Government), 3 = equally shared by the public sector and private sector, 4 = mainly allocated to the private sector, 5 = wholly allocated to the private sector. In fact, nearly 60% of the respondents having the experience of 4 years and above.
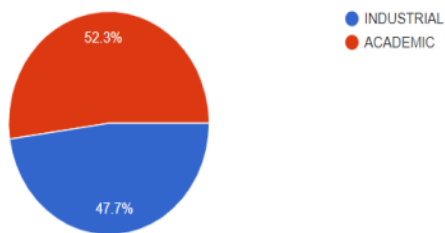
Fig 2: Respondents Background chart
Source: Google form
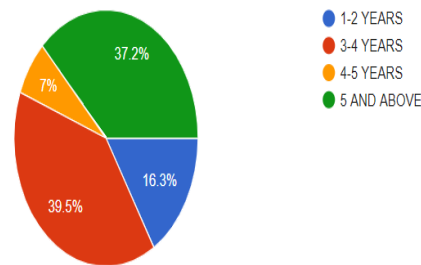
Fig 3: Respondents experience chart

Source: Google form

V. PROBABILITY EVALUATION

In the survey results, the mean rating was calculated for each risk factor of PPP projects in India on the basis of the associated Risk Probability and Risk impact. The rating of the risk significance is calculated by the product of Risk Probability and Risk impact:

Risk significance = Risk probability * Risk impact

Table 2 shows the top 10 risks factor for the PPP project in India on the basis of the value of mean rating of risk significance. The most risk significance is completion risk with the value of mean rating of

Risk significance equal to 14.175. The second risk factor is cost overrun with the value of mean rating of risk significance equal to 13.487. The third risk factor is Design and construction   with the value equal to mean rating of risk significance equal to 13.172. The mean rank and z-value of industrial and academic have been founded with the help of SPSS software. SPSS software

Table 2: Overall Risk Ranking of PPP projects in India

Serial no:	Risk Factors	Risk probability		Risk significance	Ranking
		Risk allocation	Risk impact		
1	Government Corruption	2.75	3.93	10.807	12
2	Government intervention	2.93	3.54	10.372	15
3	Political risk	2.63	3.61	9.494	21
4	Social risk and Public opposition	2.88	3.50	10.080	16
5	Legislation change	2.75	3.18	8.745	23
6	Interest rate fluctuation	3.34	3.5	11.690	9
7	Foreign exchange fluctuation	3.29	3.40	11.186	10
8	Inflation	3.52	3.59	12.636	5
9	Delay in project approval and permit	2.38	3.72	8.853	22
10	Land acquisition	2.09	3.70	7.733	24
11	Financing risk	3.40	3.72	12.648	4
12	Completion risk	3.63	3.90	14.175	1
13	Cost overrun	3.54	3.81	13.487	2
14	Change in market demand	3.27	3.36	10.987	11
15	Operation and Maintenance risk	3.52	3.40	11.968	6
16	Force majeure	2.93	3.40	9.962	18
17	Change in tax regulation	3	3.25	9.750	19
18	Environmental risk	3.02	3.52	10.630	13
19	Design and Construction risk	3.56	3.70	13.172	3
20	Material and labor Non availability	3.65	3.25	11.862	8
21.	Third Party delay	3.45	3.06	10.557	14
22	Poor Public decision making process	2.93	3.43	10.049	17
23	Technology risk	3.59	3.31	11.882	7
24	Geotechnical condition	3	3.20	9.600	20
25	Inadequate competition for tender	2.36	3.27	7.717	25

Calculating Risk Significance

The preferred risk allocation of PPP projects in India between the public and private sectors is analyzed based on the calculated mean ratings as shown in table . The following formula which is based on the distribution of the normal

distribution curve, is used to calculate the ranges within which PPP risks in India should be allocated to the contracting parties.

$X_{10\%} = U \pm Z*\alpha$

where $X_{10\%}$ = the values of upper and lower limits within which the risk should be allocated to a specific party; U = the mean value of the population; Z = corresponding z value as computed from the normal curve table; α = population standard deviation. After calculations, the following ranges can be defined:

$X_{10\%} = U \pm Z*\alpha = 3 \pm 0.125*1$

Because the value of 3 is the score for equally shared risk allocation taking 0.125 as the corresponding Z value and standard deviation of 1 for this calculation, the upper limit and lower limits range are 2.875 and 3.125 scores, respectively.

Hence, if the mean value is lower than 2.875 scores, the risk should be mainly boomed by the public sector. If the mean value is between the 2.875 and 3.125 scores, the risk should be equally shared between public and private sectors. If the mean value is less than 3.125, the risk should be mainly boomed by private sectors. The proposed method for determining risk allocation preference is considered more reliable and accurate than those applied by the previous researches.

Table 4: Risk Allocation

Sl.No	Risk Factors	N	Risk Probability Mean	Risk Allocation
1	Government Corruption	44	2.75	Public
2	Government intervention	44	2.93	Equally shared
3	Political risk	44	2.63	Public
4	Social risk and Public opposition	44	2.88	Equally shared
5	Legislation change	44	2.75	Public
6	Interest rate fluctuation	44	3.34	Private
7	Foreign exchange fluctuation	44	3.29	Equally shared
8	Inflation	44	3.52	Private
9	Delay in project approval and permit	44	2.38	Public
10	Land acquisition	44	2.09	Public
11	Financing risk	44	3.40	Private
12	Completion risk	44	3.63	Private
13	Cost overrun	44	3.54	Private
14	Change in market demand	44	3.27	Private
15	Operation and Maintenance risk	44	3.52	Private
16	Force majeure	44	2.93	Equally shared
17	Change in tax regulation	44	3	Equally shared
18	Environmental risk	44	3.02	Equally shared
19	Design and Construction risk	44	3.56	Private
20	Material and labor Non availability	44	3.65	Private
21.	Third Party delay	44	3.45	Private
22	Poor Public decision making process	44	2.93	Equally shared
23	Technology risk	44	3.59	Private
24	Geotechnical condition	44	3	Equally shared
25	Inadequate competition for tender	44	2.36	Public

The views between the academics and industrial people are largely consistent for all these following 6 risk factors and indicate that they should be allocated mainly to the public sector. They are: (1) Government corruption (2) Political risk (3) Legislation change (4) Delay in project approval and permits (5) Land acquisition (6) Inadequate competition for tender. A total of 18 risk factors are preferred to be allocated to the private sector these include (1) Interest rate fluctuation (2) Inflation (3) Financing risk (4) Completion risk (5) Cost overrun (6) Change in market demand (7) Operation and Maintenance risk (8) Design and Construction risk (9) Material and labor Non availability (10) Third Party delay (11) Technology risk. The following 8 risks are preferred to equally share between Public and Private sectors, they are: (1) Government Intervention (2) Social risk and public opposition (3) Foreign exchange fluctuation (4) Force majeure (5) Change in tax regulation (6) Environmental risk (7) Poor public decision making process (8) Geotechnical condition.

VI.CONCLUSION

It is challenging task to successfully implement the PPP projects in India. One of the major reasons is a lack of an effective risk assessment model and an equitable risk-sharing mechanism for the situation in India. This paper discussed the problem of risk in infrastructure regulatory contracts. We first identified the major risk associated with the sectors. We not only pointed out the more usual risk, but also depicted some of those more relevant in infrastructure, including consumption (demand) risk. Next we classified the risk and allocated them to the party (public or private) better able to mitigate them. The probability of occurrence and the impact of different risks were then briefly described. The empirical results also showed that by using Mann-Whitney U test. Regarding risk allocation, the research findings showed that both the public and private sectors are in general agreement with the majority of the risk identified as to preferred risk allocation. We conclude that the risk is generally taken into account in a flawed way, this represents one of the major reasons for contract failures. Thus by the above we justify that PPP procurement will be very much useful in the current situation of our country and also in future to provide infrastructures facilities to the public.

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