International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.01, March 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

STUDY OF RISK FACTORS IN PUBLIC PRIVATE PARTNERSHIP (PPP) 24X7 PRESSURIZED WATER SUPPLY PROJECTS IN INDIA

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ABSTRACT

Many developing countries adopting Public-Private Partnership (PPP) for improvement in the infrastructure and service level in water supply sectors. In the midst of earliest decades of India, the standard state controlling framework has experienced inconveniences in dealing with the huge demand for new establishments and change in organization levels.Since the 1990s, there have been a couple of attempts in India to incorporate the private division in urban 24x7 water supply organizations. However, many problems originating from unsuccessful risk management have been encountered in PPP applications that have eventually led to project failure. So, analyzing such risk factors become necessary.

This paper aims to identify the different risk factors associated with PPP projects in India and to study the severity by giving them ranks based on their critical risk factors.A list of total 25 number of risk factors was established through investigation in water projects cases and an industry-wide questionnaire survey with industry practitioners that would have significant impacts on water supply partnership. First checking the reliability of this data, these factors then analyzed by two methods viz. arithmetic mean analysis and fuzzy preference method. In the arithmetic mean analysis, the critical risk factors are obtained from the probability and severity of the risk factors while in fuzzy preference method, statistical formulas are used to rank the severity. The results showed that the overall risk level of water PPPs in developing countries is high. The fuzzy analysis overall confirmed that financial/commercial risk category is the most critical principal factor.

Keywords:Critical Risk factors (CRF), Public-Private-Partnership (PPP), WDN, 24x7 water supply projects

I.INTRODUCTION

The word PPP means the agreement between government and the private sector regarding the provision of public services or infrastructure. The social priorities with the managerial skills of the private sector, relieving government from the burden of large capital expenditure, and transferring the risk to the private sector. The public assets are transferred to the private sector as privatization, so the Government decided to work together with the private sector to provide services.

Public Private Partnerships (PPPs) in the water supply sector began to emerge in the early 1990s in most developing countries of the world. Initiated in most countries by international private operators, these arrangements were typically large-scale PPP projects which required the private operators to finance, develop, operate, and manage the water supply system for a large population base. In the course of recent decades, improvement of 24x7 pressurized water supply projects has been given more significance in India. This takes after governments' underinvestment in World Bank and maturing open water structures, quick urbanization and populace development referred to in and expanding demand–supply irregularity in urban focus reports that in 2007; around 925 million individuals needed access to safe drinking water, and the greater part of these individuals live in developing countries like India.

In the 1990s, the World Bank initiated a technique to create open water structures in developing nations through public–private organizations (PPPs).However, many risk factors encountered in the projects running through this organizations due to the unsuccessful risk managements, finally led to the project failure. Among all the risk factors that are identified as the major factors, this paper analyses the severity of these factors and rank them in their severity using the methods that are mentioned in the paper.

Thus, the objective of this paper is to study the various types of risks that are possible in 24x7 pressurized water supply in India and to analyze it using the methods mentioned in this paper

viz. arithmetic mean analysis method and the fuzzy preference method. The results presented in this paper are expected to contribute to the development of PPPs in the Indian water supply sector and provide the valuable information and risk management implications for the government and interested investors to better understand the risk issue associated with Indian water projects in particular

II.LITERATURE REVIEW

YongjianKeet. al. (2011) aims to conduct a more up to date evaluation of the potential risks in China's PPP projects. A two round Delphi survey was conducted with experienced practitioners to identify the key risks that could be encountered in china`s PPP project. The probability of occurrence and severity of consequence for the selected risks were derived from the surveys and used to calculate their relative risk significance index score. Effah and Albert P.C Chaninvestigates the risk factors and assesses the risk level of PPP water supply projects in developing countries using the fuzzy synthetic evaluation approach. Paper concludes that these projects are risky to both Government and private participants.The main objective ofDr. Sanjay Dahasahasraet. al. (2012) paper was to develop proper zones in which reservoirs supply water without getting empty or overflow, alsothepaper explains the methodology that trans-formation of existing intermittent water supply into 24x7 system needs design of operational zones which supply water continually. Zhi-Ping Fan, Quan Zhanget. al.

(2002) investigates the multiple attribute decision making (MADM) problem with preference information on alternatives. A new approach is proposed to solve the MADM problem, where the decision maker gives his/her preference on alternatives in a fuzzy relation.In Honggang Wang1 and Xin Chen paper, mathematical models were developed and optimisation process is used for optimal WDN (Water Distribution Network) maintenance planning under random failures. A conditional probabilistic measure known as conditional expected supply impact (CESI) was derived which took into account both WDN infrastructure conditions and dynamic customer demands.

III.RISK FACTORS IN PPP WATER PROJECTS

24x7 water supply projects procured through PPP`s are exposed to a plethora of risks than other infrastructure projects. The riskiness of water PPP`s result from a combination of risk factors that are naturally associated with the sector and those arising from private sector participation.Stress that PPP projects require careful identification and analysis of risk factors that could adversely affect their success. This paper reviews some of the studies related to water PPP risk factors. Comparing risk factors across transportation and water/wastewater PPP`s in India, observe that the critical risk factors frequently encountered in water/wastewater projects differ from those of the other infrastructure projects. The top-five risk factors are political interference, contamination and leakage problem, corruption, conflicts between partners, completion risk. This reinforces the argument that previous findings on general PPP risks may not reflect those of 24x7 water supply projects. Among 25 risk factors, they report the significant risk variables as pricing (tariff) uncertainty, breach of contract by government, scarcity of raw water, and construction cost & time overruns.

In many developing countries,tariffs have long been kept below costs. This implies that the private sector should note this major risk in its decision to invest in this country.Identify 25 risk factors in water utilities contracts and classify them into three principal's risks as: production, commercial and context. Present the eight most common principal factors associated with water PPPs as legal framework, fiscal space, political environment, macroeconomic conditions, institutional capacity, willingness to pay for services, tariff sustainability, and size and location of project. Findings from above studies reveal some common risk factors occurring across time and places: poor pricing policies, non-payment, financing, and completion risk. These risk factors are therefore considered critical in water PPPs in developing countries. A limitation from the reviewed studies is that, given their nominated risk factors, they fail to evaluate the overall risk levels of PPP projects in their respective countries. The current study will contribute to filling this gap.

IV.RESEARCH METHOD

4.1 Identification of risk factors

Identification of relevant risk factors that affect a project is one key factor in achieving project success. A two-step systematic, qualitative approach was adopted to establish the important risk factors in PPP 24x7 water supply projects to identify possible risk factors. The case study analysis drew on documented lessons and experiences from projects that were stalled or terminated, completed or in operation. This approach provides an effective means to identify and understand factors that contribute to failure of the studied projects. These experts were invited to vet the factors based on their experience and willingness. This approach facilitates the addition of, if any, unidentified relevant risk factors, and led to a 25-factor list for water PPPs in developing countries. To generalize the factors, and because it is not possible to include all risk factors for different forms of project modalities the identified factors were carefully selected through above approaches to include the most important risk issues and as consensus-based factors that typically affect water PPPs in developing countries.

4.2 Questionnaire survey and participants

PPP risk management research has been predominantly conducted through questionnaire survey because a questionnaire is an effective tool forgauging experts' perceptions and the information from a questionnaire can reveal correlations in their perceptions Hence, a ranking-type questionnaire survey for data collection was adopted for this study. The established 25-risk factor list was formulated into a questionnaire for a survey.

4.3 Survey Process

A total of 25 risk factors (Table 1) affecting Indian PPP projects were identified through an intensive literature review; thus, a comprehensive list was established. These risk factors were adopted in this study and categorized into 4 critical risk groups (CRFs): Financial and Commercial, Legal and socio-political, Technical risks and other risk.

This survey consisted of two rounds of questionnaires administered within a time frame of 5 months. In Round 1, the questionnaire was e-mailed to all experts with the following instructions: "(1) Please estimate probability of occurrence based on a 5-point scale (where 1 = Rare probability of occurrence and 5 = almost certain to occur); (2) Please estimate the severity of the risk described on a scale of 1 to 5 (where 1 = negligible influence on the project and 5 = extreme, where the project would be aborted); (3) Please include an estimate of the probability of occurrence and severity of any new additional risk factors which you thought of as critical risk factors in Indian PPP/BOT projects

4.4 Data analysis and results

Data from the questionnaire survey was analyzed using the statistical package for social scientists (SPSS) 21.0. Statistical tests performed on the data include reliability analysis, mean analysis and normalization.

4.4.1Reliability analysis

Prior to performing the statistical analyses, reliability analysis was carried out to statistically check the consistency of the 25 factors and reliability of the survey instrument. This test is helpful in confirming the wider applicability, reliability, and consistency of the 25 risk variables. Internal consistency of the dataset was tested using Cronbach's alpha model. It has coefficient between 0 and 1, and recommends a value greater than approximately 0.70 to indicate reliable factors in the survey instrument. The overall Cronbach's a value for risk probability and risk severity is 0.786 suggesting a high internal reliability and consistency of the dataset.

4.4.2Mean score analysis

The arithmetic mean analysis was used to establish the relative significance of the risk factors in terms of their probability and severity. It is adopted because it represents the central tendency and is widely used in construction management studies to determine the significance of a list of factors. The probability and severity values as perceived by all the respondents are tabulated in Table 1. Having computed the probability and severity mean scores, the impact of a risk factor can be derived 'by taking the square root of the product of

IJARSE
ISSN: 2319-8354

probability and severity. This is a well-established risk measurement approach in decision theory domain and has been adopted in many past construction risks. Rankings of the risk factors are therefore based on their respective impact values. From Table 1, it is observed that mean probability values for the 25 risk factors ranged between 2.23(low) and 3.57 (very high), mean severity scores ranged from 2.77 (low) to 4.23 (high) and the mean risk impact values ranged between 2.32 (low) and 3.89 (high).Overall, 'Political interference' is rated as the most significant risk variable (probability =3.57, severity = 4.23, impact = 3.89). Contamination and leakage (Probability=3.1, severity=3.53, Impact=3.31) ranks second, 'Corruption' (probability = 3.30, severity = 3.30,impact = 5.30) ranks third.

Table 1.Ranking of CRFs of PPP Projects in India

Risk factors	Probability	Severity	Risk significance index	Risk impact	Ranking	Normalized values
Political interference	3.57	4.23	15.10	3.89	1	1.00
Water pricing and tariff review uncertainty	3.10	3.53	10.95	3.31	2	0.63
Corruption	3.30	3.30	10.89	3.30	3	0.62
Conflict between partners	3.33	3.23	10.78	3.28	4	0.61
Raw water scarcity	3.07	3.50	10.73	3.28	5	0.61
Financing and refinancing risk	3.37	3.13	10.55	3.25	6	0.59
Pipeline failures during distribution	3.00	3.33	10.00	3.16	7	0.54
Water theft	3.07	3.23	9.92	3.15	8	0.53
Construction time and cost overrun	2.77	3.37	9.31	3.05	9	0.47
Political discontent and early termination	3.00	3.07	9.20	3.03	10	0.45
Poor contract terms and condition	2.90	3.03	8.80	2.97	11	0.41
Non-payment of bills	2.70	3.23	8.73	2.95	12	0.40
Design and construction deficiencies	2.73	3.17	8.66	2.94	13	0.40
High operational cost	2.70	3.10	8.37	2.89	14	0.37
Insufficient operators performance at operation	2.77	2.93	8.12	2.85	15	0.34
Lack of PPP (officials) experience	2.67	3.03	8.09	2.84	16	0.33

Public resistance to PPP	2.87	2.77	7.93	2.82	17	0.32
Contamination and leakage issues	2.53	3.10	7.85	2.80	18	0.31
Land acquisition risk	2.60	2.97	7.71	2.78	19	0.29
Supporting utilities risk	2.77	2.73	7.56	2.75	20	0.27
Inflation rate volatility	2.67	2.67	7.11	2.67	21	0.22
Material and labor non-availability	2.53	2.67	6.76	2.60	22	0.18
Natural calamity risk	2.23	2.77	6.18	2.49	23	0.11
Fall in demand	2.23	2.63	5.88	2.43	24	0.07
Foreign Exchange Rate	2.30	2.33	5.37	2.32	25	0.00

- Impact = (Probability × Severity)0.5
- Normalization value: (average actual value − average minimum value)=(average maximum value − average minimum value)
- Normalized value greater than 0.5 termed as CRF`s

V. RANKING USING FUZZY PREFERENCE METHOD

Assessing the overall risk level of a project involves different CRFs with varying degree of criticality on one level and risk factors on next lower-level. In this case, each CRF is assessed in terms of its criticality, from which the overall risk level of water PPPs can be quantified. The multi-level FPM is used to analyze this multi-factor and multi-level decision problem inherent in evaluating the risk of projects. Thus, the membership grades level by level from the lowest risk factors are calculated, and the final determination of projects risk level is derived from the membership grade of the top principal factors. Fuzzy preferences relations are deal with determine the relative weights of individual relations of risk so they acquire weight of every single risk and rank them. The fuzzy preference relations (FPR) have been used in several fields. For example, operation of data management (Wang and Chang 2007), partnership choice (Wang and Chen 2007), ability area selection (Boran 2011), dealer selection (Chen and Chao 2012) , risk calculation for construction projects (Kuoand Lu 2013), contractor selection in construction (Ibadov 2015), economic investigation in construction (Ilieva and Dimitrov 2015), and risk assessment for construction projects (Patel, Kikani, and Jha, 2016).

5.1 Ranking by fuzzy preference relation

Step 1: Forming multiplicative preference relation (MPR) matrix

FPR technique was applied on the responses of questionnaire survey. For this, multiplicative preference relation matrix, $P = [p_{ij}]$ where $p_{ij} \in \left[\frac{1}{9}, 9\right]$, is prepared for each risk factor and their attributes. For n number of criteria (factors/attributes), only (n-1) preferences such as $p_{12}, p_{23}, \ldots\ldots\ldots p_{(n-1)(n)}$ were required. The responses of the experts are aggregated using geometric mean as given in equation 1.

$$p_{ij} = (p_{ij}^{\,1} * p_{ij}^{\,2} * p_{ij}^{\,3} * ....* p_{ij}^{\,m})^{\frac{1}{m}} \, where, i, j \in (1,2,3,.........n) ....1$$

In the above equation, m is the number of respondents and $p_{ij}^{\,m}$ is the evaluation of criteria i with respect to criteria j by m^{th} respondent.

The multiplicative preference relation (MPR) matrix for success factors and their attributes are shown in Tables 2. The MPR matrix for attributes in success factor (SF-1) is only shown. The MPR matrices for attributes in rest of the factors were calculated in a similar manner.

Table 2 :- MPR matrix for success factors

	A	B	C	D
A	1	0.835618	0.930968	0.921287
B	1.196718	1	1.114107	1.102521
C	1.074151	0.89758	1	0.989601
D	1.085439	0.907013	1.010509	1

Step 2: Converting multiplicative preference relation (MPR) matrix into fuzzy preference relation (FPR) matrix

Multiplicative preference relation matrix is converted to fuzzy preference relation matrix $R = [r_{ij}]$ where $r_{ij} \in [0,1]$ using equation 2 (Chiclana, Herrera, and Herrera-Viedma, 2001; Herrera-Viedma, et al.2004; Patel et al., 2016)).

$$r_{ij} = \frac{1}{2}(1 + \log_9 r_{ij}) ....(2)$$

Here, $\log_9 r_{ij}$ is used because p_{ij} lies in the interval [1/9, 9]. If p_{ij} lies in the interval [1/n,n], $\log_n r_{ij}$ will be used.

Consistency of the fuzzy preference relation matrix is based on additive transitivity; hence rest of the elements of the matrix is obtained by using equations 3, 4 and 5 (Chen and Chao, 2012).

$$r_{ij} + r_{ji} = 1, \forall i, j \in (1,2,........, n) ....(3)$$

$$r_{ij} + r_{jk} + r_{ki} = 3/2, \forall i \lhd j \lhd k ....(4)$$

$$r_{i(i+1)} + r_{(i+1)(i+2)} + ... + r_{(i+k-1)(i+k)} + r_{(i+k)i} = \frac{(k+1)}{2} \forall i \lhd j ....(5)$$

The fuzzy preference relation (FPR) matrix for success factors and their attributes are shown in Tables 3. The FPR matrix for attributes in success factor (SF-1) is only shown. The FPR matrices for attributes in rest of the factors were calculated in a similar manner.

IJARSE
ISSN: 2319-8354

Some of the entries in the fuzzy preference relation matrix may not fall within [0, 1] but fall in the interval [-k, 1+k], k > 0. The fuzzy preference relation matrix is transformed by a function called transform function which preserve the reciprocity and additive consistency. This matrix R' = f(R) is called consistent fuzzy preference relation (CFPR) matrix

Table 3:- FPR matrix for success factors

	A	B	C	D
A	0.5	0.444209	0.477778	0.47453
B	0.555791	0.5	0.533569	0.530321
C	0.522222	0.466431	0.5	0.496752
D	0.52547	0.469679	0.503248	0.5

Table 4:- Relative weight and ranking of success factors

Risk factor	Relative Weight	Rank
A	0.237065	4
B	0.26496	1
C	0.248176	2
D	0.2498	3

Where,

A: Financial/commercial risks

B:Legal and socio-political risks

C:Technical risks

D: Environmental risks

Step 4: Determining normalized weight of success attributes

To calculate the normalized weight of the attributes, a comparison matrix of success factors and their attributes was developed as shown in Table 5. The normalized weight of attributes (W) is calculated using equation 8 (Patel et al., 2016).

$$W = W_i * W_j \qquad (8)$$

Where, W_i = Weight of success factors, and

W_j = Weight of success attributes

The attributes were ranked according to their normalized weight. The attributes with higher weight were ranked higher.

Table 5:- Normalized weight of attributes

Risk factor	RelativeWeight	Risk factor
A2	0.05275	Non-payment of bills
D2	0.045819	Raw water scarcity
D3	0.045812	Contamination and leakage issues
B5	0.045765	Conflict between partners
B2	0.045223	Political interference
A7	0.045219	Financing and refinancing risk
A1	0.043394	Water theft
B1	0.04302	Corruption
C1	0.042702	Pipeline failure during distribution line
B4	0.042313	Political discontent and early termination
C3	0.041735	Construction time and cost overrun
C5	0.039155	Design & construction deficiency
B7	0.038912	Public resistance to PPP
B6	0.038217	Land acquisition risk
C4	0.038215	Poor contract terms and condition
D4	0.037324	Material and labour non availability
A6	0.03725	Water pricing and review uncertainty
C2	0.037077	Lack of PPP(officials) experience
A4	0.036908	High operation cost
B3	0.036588	Supporting utilities risk
C6	0.036507	Insufficient operators performance at

		operation
A5	0.035205	Inflation rate volatility
D1	0.033484	Natural calamity risk
A8	0.03097	Fall in demand
A3	0.030399	Foreign exchange rate

VI. CONCLUSIONS

In the present paper, a questionnaire survey table is prepared. The reliability of the data is checked by Cronbach`s alpha and then the analysis of the data is done by two methods, first by mean score analysis and second by fuzzy preference method. The critical risk factors are identified and then given ranking according to their severity. The following main conclusions are observed from the above study:

1. As the Cronbach`s alpha value obtained is 0.786, it has been concluded that the data is reliable.
2. The normalized value obtained using mean arithmetic method if exceeds the value 0.5, the risk factor is classified under critical risk factors.
3. In this study paper the following critical risk factors (normalized value > 0.5) have been identified viz. political interference, water pricing and tariff review uncertainty, corruption, conflict between partners, raw water scarcity, financial and refinance risks, pipeline failure during distribution, water theft.
4. Using fuzzy preference method, it has been concluded that the highest weight risk factor is for B category i.e. legal and socio-political and lowest for commercial risk factors
5. Also from the above method, it has been observed that the non-payment of bills considered as the critical risk factor as it shows the highest weight of response.

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