Risk Management for Public Private Partnership Models in Urban Water Supply Projects

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Abstract- *Scarcity of water in all countries has made it a social and an economic good. Lack of adequate funds and associated constraints have resulted in emergence of PPP models in water supply sector. Water supply systems include collection and distribution of water through complicated networks that serve and extend broad geographical regions. A PPP water supply project typically involves number of risks and is always subjected to a probability of failure. Risk management is handling risks involved in a project which is an ongoing process that continues throughout the life cycle of the concession period of PPP project. So risk management which includes risk identification, risk allocation, and risk mitigation is a key for its success.*

In this paper different types of project risks is identified and classified into different categories. Risk has been allocated such that it should be borne by the party who has better control over it. Different factors are identified that are relevant, and contribute towards risk in water supply PPP projects. Attempt to prepare general framework for risk management in water supply system which include identification of risk events and finally risk mitigation will be done.

This paper has gives guidelines to carry out study of risk analysis and mitigation of PPP projects in water supply and useful to prepare a feasibility report.

Keywords- Risk, Public Private Partnership, Risk management, Risk Analysis, Water Supply Systems Risk Identification, Risk Allocation, Risk Mitigation.

I. INTRODUCTION

In today's globalizing age, the infrastructure plays an important role. Now days, India faces so many problems like draughts, natural calamities, non periodical cycle of rain and also the lack of proper provision of water rural as well as in urban areas. So that it becomes a vital issue to provide adequate necessities of community and fulfill them.

In infrastructure, a water supply network has a lion's share. Water is the limited source and this source is continuously goes on decreasing on the other hand, the needs of the growing population for drinking water. Water for domestic, agricultural and industrial uses should be provided satisfactory. From the poorest household to the richest household needs the water for their higher standard of living.

For all these requirements, the accurate water supply management is to be adopted in better manner.

This has lead government across the world to look at the PPP models for the development of infrastructure & provide public service through PPP

In India the growth of infrastructure sector is relatively very slow as compared to the industrial and manufacturing growth. Also due to the lack of energy storage systems inadequate transportation network and insufficient water supply system slower down the economical growth of country. Public private partnership (PPP) offers a unique and innovative method of involving the private sector in delivering the public services. It adopted by different sectors. PPP model face several risks in water supply scheme or system are unavoidable so that risk analysis, risk evolutions risk control & further risk management becomes an important step for successful execution & working of water supply project.

Objective of this paper is to discuss the role of risk management for the design and operation of WSS.

Water Supply Sector in India:-

In India distribution of water for domestic as well as for industrial purposes are not even. Only 50% urban community well under the water distribution network. Only 40-50% water is available to use from total availability of water at the water purification project as remaining is lost in transmission, purification, evaporation and theft. In India only 24% of water connections are metered as the production cost is very higher as compared to the lower level recoveries, also the maintenance cost is very high and due to the limited fund availability, the services are restricted

II. PUBLIC PRIVATE PARTNERSHIPS

Public Private Partnerships:-

Various governments, PPP agencies, academics, policy research institutes and non-profit groups have defined Public-Private Partnerships in different ways. Some of these definitions show the varied aspects related to PPPs.

Public-Private Partnership (PPP) Project means a project based on a contract or concession agreement, between a Government or statutory entity on the one side and a private sector company on the other side, for delivering an infrastructure service on payment of user charges.

Innovative methods used by the public sector to contract with the private sector who bring their capability and ability to deliver projects on time and to budget, while the public retains the responsibility to provide these services to the public in a way that benefits the public and delivers economic development and improvement in the quality of life.

PPP means an arrangement between a government or statutory entity or government owned entity on one side and a private sector entity on the other, for the provision of public assets and/ or related services for public benefit, through investments being made by and /or management undertaken by the private sector entity for a special time period, where there is a substantial risk sharing with the private sector and the private sector receives performance linked payments that conform (or are benchmarked) to specified, pre-determined and measurable performance standards.

Public private Partnerships (PPP) means coming together of two dominant but divergent sectors of economy. Both of these sectors have different prescriptions and objectives for the overall development of the community.

A. Objectives of Public Private Partnership: -

1) The main purpose of PPP is to encourage private sector involvement in public infrastructure and related services.
2) To encourage innovation in the provision of infrastructure and related service delivery.
3) To encourage governance over the selection of projects and competition for the awards of contracts.

B. Types of PPP models:-

The usually adopted models are as below,

1) Design-Build (DB)/Build-Transfer (BT):- Under this model the public sector contracts with a private partner to design and build a facility in accordance with the requirements it sets. Upon completion the public sector assumes responsibility for operating and maintaining the facility.

2) Design- Build- Maintain (DBM):- This model is similar to Design- Build except that the private proponent also maintains the facility. The public sector retains the responsibility for operations.

3) Design-Build-Operate(DBO) / Build-Transfer-Operate (BTO): Under this model, the private sector designs and builds a facility. Upon completion, the title for the new facility is transferred to the public sector, while the private sector operates the facility for a specified period.

4) Design-Build-Operate-Maintain (DBOM)/ Build-Operate - Transfer (BOT): This model combines the responsibilities of design build procurements with operations and maintenance of a facility for a specified period by a private sector partner. At the end of that period the operation of that facility is transferred back to the public sector.

5) Build-Own–Operate-Transfer(BOOT): The public sector grants a franchise to a private partner to finance, design, build and operate a facility for a specific period of time. Ownership of the facility is transferred back to the public sector at the end of that period.

6) Build-Own-Operate (BOO): The public sector grants the right to finance, design, build, operate and maintain a project to a private entity, which retains ownership of the project. The private entity is not required to transfer the facility back to the public sector.

7) Design-Build-Finance-Operate / Maintain (DBFO, DBFM): Under this model, the private sector designs, build, finances, operates and/or maintains a new facility under a long term lease. At the end of the lease term, the Facility is transferred to the public sector.

8) Build Operate and Transfer (BOT): In this type of PPP, the private partner is responsible to design, build, operate (during the contracted period) and transfer back the facility to the public sector. The private sector partner is expected to bring the finance for the project and take the responsibility to construct and maintain it. The public sector will either pay a rent for using the facility or allow it to collect revenue from the users.

The BOT and BOOT models appear to be most widely used in Indian context. It has been observed that These PPP models face several risks, uncertainties and challenges. (Debasis, kintan2012)

C. Trend of PPP in Water Supply Systems in India:- In our country the need for water supply and sanitation services is increasing day by day due to increase in population. The water supply services are managed by the state and local governments. The overall services provided in the country for this sector are very inadequate. There are large infrastructural gaps and the operations of the water supply have high levels of inefficiencies. The per capita availability of water in most urban centers of the country is lesser than what is needed. Only 50% of the urban population is directly connected to the distribution network. The existing infrastructure suffers from high degree of operational inefficiencies. Approximately 40-50% of the water pumped into the system is not available for consumption, since it is lost in transmission and theft. On an average only 24% of all connections in the country are metered. Due to poor collection practices by the utilities have resulted in low cost recovery rates at 20-30% of operation and maintenance (O&M) cost. The cost of production of these services is too high as compared to the low level recoveries resulting in limited fund availability with service providers for routine maintenance. This eventually causes poor infrastructure coverage poor access and low quality of services. Additionally the service providers have been incurring huge losses on their services.

In this current decade, the country has seen several PPP projects being implemented successfully. Trend of PPP in water supply system is observed in several urban development programs where projects are undertaken through PPP mode.

D. Risk in WSS:-

Risk is the combination of the probability of an uncertain event and its consequences. A positive consequence presents an opportunity; a negative consequence poses a threat. A definition of risk is, "The chance of certain occurrences adversely affecting project objectives, typically: Scope, quality, time and cost. A risk is an event, which is uncertain and has a negative impact on some endeavor.

Risk in WSS design and operation are unavoidable. Water supply projects are always subjected to a probability of failure in achieving their intended purpose. A water supply project may not deliver demanded water. This failure may be due to failure of the delivery system or may be due to lack of supply. The uncertainty in a WSS cannot be determined and is beyond our rigid control. Every undesired event is followed by undesired consequences. Risk can be defined and expressed as follows,

$$R=PXC \qquad \text{…….. (1)}$$

Where, **R**=Risk, **P**=Probability of occurrence of undesired event, **C**=consequences of the event.

For the consumers it is important to be supplied with water of good quality, but there should also be enough water. Therefore the project should focus on the quality and quantity of the water supply, as both these aspects are essential for the customer.

Risk management is the practice of using risk analysis to devise management strategies to reduce risk. Every PPP project will carry some risk. The challenge is to reduce uncertainty to an acceptable level and allocate responsibility to the party best able to handle it. Success in PPP often rests on the ability of key participants to share accurate and timely information so that perceived risks can be minimized and resources can be spent efficiently in managing real risks.

The key to the success of PPP projects is a balanced and fair sharing of risks and benefits

Risk management process includes the following main components:-

1) Risk Identification
2) Risk Allocation
3) Risk Mitigation

1) Risk Identification:-

Participants in a water supply PPP will experience varying degrees of risks at different times during the project cycle. This has significant implications for developing an overall risk management strategy. The urban water supply sector is Vulnerable to risks due to several factors. Vulnerabilities exist in policy making, Regulation, organizational management, etc. The extent of risk and where these risks lie will differ under different conditions

Successful implementation of a PPP contract is dependent on how effectively the risk involved are identified and allocated. Hence all the risks associated with the project are to be listed down. They are as follows,

Table No-1 Generic Risk Categories

Risk Category	Description of Risk
Commissioning Risk	Approvals may not be received or expected changes in legislation.
Construction Risk	Construction may not be completed in time, within the budget & specification.
Demand(usage) Risk	Actual demand for a service is lower than planned.
Design Risk	Proposed design may not be according to requirement.
Environmental Risk	Adverse effect on environment.
Financial Risk	Private sector may overstress by inappropriate financial structuring.
Technology Risk	Technology used is superseded during term of project.
Force Majeure Risk	Unnatural or natural disaster.
Operating Risk	Unexpected change in daily operation.
Performance Risk	Operator may not perform up to desired level.
Change in law Risk	Current regulatory will change.
Latent defect Risk	Defect may exist in structure being built.
Upgrade Risk	Upgrading of assets over the term of project.

2) Risk Allocation:-

Balanced allocation of all risks identified plays a critical role in successful implementation of any PPP structure. Each risk should be allocated to whoever is best able to manage it at least cost taking in to account public interest. Thus rather than a maximum transfer of risk, optimal risk transfer should be undertaken,

Important factors to be considered during risk allocation include,

1. The nature of project
2. The strength and ability of each party to manage risk
3. Flexibility of the output specification
4. Previous levels of risk transfer
5. Prevailing market attitudes towards risk
6. Public interest factors
7. Other policy considerations
8. External environment and economic scenario.(comptroller 2009)

3) Risk Mitigation:-

Once the risks have been identified and allocated properly next step is to develop proper risk mitigation strategies. Risk mitigation strategies are developed with the intention of reducing each party's exposure to the risk.

A list of risk mitigation strategies for both the urban local body/state agency and the private developer has been given below,

Table No-2 Risk Mitigation Measures for ULB/State agency and the private developer,

ULB/State Agency	Private Developer
1.Preparation of comprehensive document	1.Insurance
2.Correct and appropriate bid process	2.Financial market Instruments
3.Reduce possibility of scope roll back	3.Diversification of project portfolio
4.Contingency plan	4.Arrange for a pass through
5.Insurance	-

It is recommended that in addition to identification, allocation and development of mitigation measures, the ULB/state agency also develop a dispute resolution mechanism. Once the project implementation begins with the private developer, it is necessary to ensure that a regulatory body be formed which would formally look into the disputes that might arise during the concession period.

The key to success of PPP projects is a balanced and fair sharing of risks and benefits between the partners, and transparency and accountability in all transactions relating to the management of contract.

Following table no. 3 shows most effective mitigating measures:

Collection risk	To convince the common people through the local leaders regarding the future benefits of the project. Set up a help desk for people who have doubts regarding the project and counsel them for economical use of water so the monthly bill can be less. Apply the slab system for billing as in electricity bills.
Political risk	Maintain good rapport with local political leaders and convince them regarding the benefits of the project to common people, and how it can be a win-win situation for both of them.
Construction (cost & time overrun)	To enter into contracts with the project participants. E.g. .constructors, input suppliers, and the operator. To keep stand-by loan or Stand-by capital. The lenders can also be asked to provide standby credit facilities for cost overruns. Clear output specifications should be there.
Operation & maintenance	Penalty regime and performance monitoring to be done. Adequate O & M contract with substitution rights. Special insurance and special security in form of final maintenance bonds.

E. Methodology for Risk Analysis of Water Supply Systems:-

Risk Analysis:-In risk analysis various hazardous events related to the water utility are identified and the corresponding risk are estimated. This is done by estimating the frequency of hazardous events and various consequences of these events.

Risk analysis is done or classified into two parts,

1)Qualitative Risk Analysis

2)Risk Quantification Methods

1. Qualitative risk analysis:- In order to study risk related to water quality, the complete water supply chain should be considered, some examples of risk measures for water quality are,

(i) Probability of a specific degree of contamination/pollution of the water source.

(ii) Probability of a specific failure of the treatment system, resulting in contaminated water entering the distribution network and delivered to the customer.

(iii) Mean number of consumers getting adverse health effects caused by drinking water.

At some stages of project, sensitive type of risk arises. This situation can be overcome by studying experiences in earlier, comparable projects and investigating the situation as a whole. Steps are to be taken to reduce the uncertainty. This may require remedial actions at project, sector or national level,

a) Make specific agreements to ensure contractor performance and quality during construction works to reduce delays.

b) Conduct information or awareness building/educational programs to ensure the involvement of customers and to improve the hygienic use of water.

c) Implement a pilot phase to test technical assumptions and observe users reactions, in case there is considerable uncertainty in a large project.

d) Set certain criteria to be met by the subprojects before approval for example, in rural WSP s, village would have to fulfill certain criteria such as community involvement to be included in the program.

e) Make price and tariff adjustments to ensure sufficient revenues.

f) Conduct technical assistance program to develop appropriate project and operational management skills for staff. (Handbook for Economic Analysis of WSP,1999)

2. Risk Quantification Methods:-

The purpose of quantitative risk analysis is to estimate the probability that the project NPV will fall below zero. The quantitative techniques relevant and applicable for risk analysis include simple arithmetic analysis (estimate) decision analysis (Bayesian decision analysis), sensitivity analysis, probability trees, Monte-Carlo simulation, decision tree analysis, fuzzy set theory, game theory, Project Evaluation and Review Technique.etc.

III. DATA COLLECTION

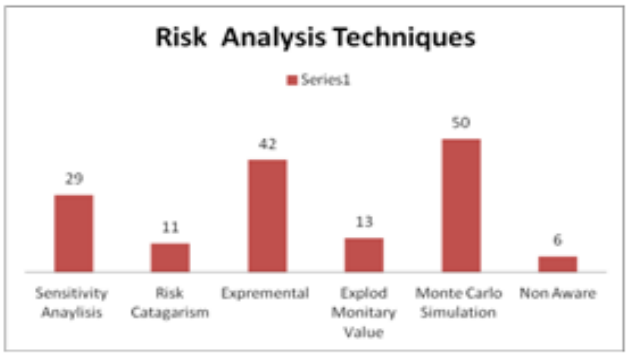
Criticality of Risks:

The survey results concerning the criticality of risks associated with urban water supply PPP projects are tabulated in Table. The risks are ranked from 1 to 9 on the basis of their scores. The risk with the highest score would be ranked 1 and so on.

Critical Risk	No. of respondents who answered						Ranking
	Not Applicable	Not At All Critical	Only Slightly Critical	Critical	Very Critical	Very much Critical	
Collection Risk	0	0	2	4	9	3	1
Political Risk	0	0	3	7	6	2	2
Construction (Cost and Time overrun)	0	0	3	7	6	2	2
Operation & Maintenance	0	1	2	9	4	2	3
Tariff Risk	1	1	1	6	6	3	4
Investment (Cash Flow Risk)	0	0	4	11	3	0	5
Contractual Risk	0	4	3	6	4	1	6
Financial Risk (Exchange rate, Interest)	4	0	5	6	2	1	7
Technical Risk	0	6	10	2	0	0	8

IV. DATA ANALYSIS

1) Risk Analysis Techniques:



Graph-shows the percentage of risk analysis technique frequently used. Following graph shows that Monte Carlo simulation technique is used most frequently with 47% and intuition, judgment and experience for 41 %.

2) Use of Risk identification Tools:

Graph shows the percentage usage of different risk identification tools. The documentation reviews with 53% and similar cases comparison also at 53% is used as a tool for risk management and checklist analysis is used after that with 47%.

V. METHODS OF RISK QUANTIFICATION

Methods which are used for risk quantification of Water Supply System are as follows,Sensitivity analysis, Monte-Carlo Simulation, Decision Tree analysis.

1. Sensitivity Analysis:-

Sensitivity analysis is defined as the study of how the variation in the output of a model can be apportioned, (qualitatively or quantitatively) to different sources of input variation. Sensitivity analysis is also called as "What if

analysis". Sensitivity analysis is a modeling technique used to identify the impact of a change in the value of a single risky independent parameter on the dependent variable.

Sensitivity analysis helps to determine how projected performance is affected by changes in the assumption. Sensitivity analysis is the study of how the uncertainty in the output of a mathematical model or system can be apportioned to different sources of uncertainty in its inputs. This method deals with uncertainty analysis, which has a greater focus on uncertainty quantification and propagation of uncertainty. Ideally, uncertainty and sensitivity analysis should run altogether. The sensitivity of an input variable or parameter is an indication of the effect that a variation of that input will have on the output. An input variable of higher sensitivity will result in a greater variation of the output and vice versa. The sensitivity of a variable illustrates the care that modelers must take to obtain and employ an appropriate value for the variable, but can also signify its importance in relation to its dependency by the model structure.

Uncertainty: Uncertainty is distinct from risk and the costs of uncertainty are normally shared between the private and public sector. The PPP project agreement will normally transfer some of the risk of uncertainty to the private sector. The method of dealing with this uncertainty can be discussed in detail.

Break Even Analysis :- In the assessment of bids the break-even discount rate should be calculated to consider the overall sensitivity of the VFM proposition to changes in the discount rate. A narrow VFM assessment sensitive to small movements in the discount rate should lead the evaluator to take additional steps, both qualitative and quantitative to provide a robust VFM assessment.

2. Monte-Carlo simulation:-

Monte Carlo simulation, or probability simulation, is a technique used to understand the impact of risk and uncertainty in project management, forecasting models. Monte-Carlo simulation is used for managing project risks and uncertainties. Monte Carlo simulation is a useful technique for modeling and analyzing real-world systems and situations.
This method is widely used for decades to simulate various mathematical & scientific situations. In water supply systems Monte-Carlo simulation can quantify the effects of risk and uncertainty in project schedules and budgets, giving the project manager a statistical indicator of project performance. Proper risk management education, training and advancements in computing technology combined with Monte Carlo simulation software allow project managers to implement the method easily.

The Monte Carlo simulation encompasses "Any technique of statistical sampling employed to approximate solutions to quantitative problems". A model or a real life system or situation is developed, and this model contains certain variables. These variables have different possible values, represented by a probability distribution function of the values for each variable. The Monte Carlo method simulates the full system many times (hundreds or even thousands of times), each time randomly choosing a value for each variable from its probability distribution. The outcome is a probability distribution of the overall value of the system calculate through the iterations of the model.

Monte Carlo Simulation is used in project management and explains how it aids the project manager in answering questions such as, "What is the probability of meeting the project due date? It also helps in assessment of uncertainty in forecasting models. Simulation is based on a systems approach and provides the decision maker with a wider view in the final choice between two competing alternatives. It does not remove the need for the decision-maker to apply a judgment and so there is inevitably a degree of subjectivity involved.

In cost management, project manager can use Monte-Carlo Simulation to better understand project budget and estimate in all budget at completion. Instead of assigning a probability distribution to the project task durations, project managers assign the distribution to the project cost. These estimates are generally prepared by a project cost expert, and the final product is a probability distribution of the final total project costs. Project managers often use this distribution to set aside a project budget reserve, to be used when contingency plans are necessary to respond to risk events.

Monte-Carlo simulation has been used in construction projects to better understand certain risks of the project.

Decision Tree Analysis:-

A decision tree is a method you can use to help make good choices, especially decisions that involve high cost and risks. Decision trees use a graphic approach to compare competing alternatives and assign values to those alternatives by combining uncertainties, costs and payoffs into specific numerical values.

General framework for risk management for WSS:-

Risk management is unavoidable in the course of any project delivery. As project risks are inevitable, the management of risk must be optimized rather than risk being ignored. It is impossible to eliminate all project risks in construction. But risk can be minimized, shared and transferred from one party to another or accepted and managed. Even in situations where most risks have been transferred, residual risks may still remain. Since project risks are inevitable the management of risks must be optimized rather than risks being ignored. To manage project risk effectively, they must be identified analyzed and controlled. (Akintola Akintoy 1999).

VI. CONCLUSION

Under different conditions different PPP structures are suitable; Focus is laid on different risks in Public private participation structures which would be faced by the urban water supply. Suggestions should be taken from internal PPP experts and urban water supply experts.

The techniques like sensitivity analysis, Monte Carlo simulation and decision tree analysis are widely used for the risk mitigation in large water supply projects.

The senior and middle level managers have personal knowledge of risk management even though very rarely they have undergone the training in risk management. Study also proved that there is well acquaintance and knowledge about various types of risks which an urban water supply PPP project undergoes.

The use of computers in risk management is low.

The risk management usage in the execution phase was found to be higher than planning and termination phase.

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