

ANALYSIS OF RISK CATEGORIES AND FACTORS FOR PPP PROJECTS USING ANALYTIC HIERARCHY PROCESS

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Abstract: Success of Public Private Partnership projects is greatly influenced by proper management of the risks associated with the project. All projects which are undertaken using conventional procurement method or using a PPP approach have known risks and unknown risks. Risk identification plays an important role in development of PPP framework. The participation and investment of Private sector has been the main stay of the Government of India policy toward infrastructural growth. In this study main risk categories and factors of Public Private Partnership projects have been recognized. A total of 7 risk categories and 31 risk sub-factors for each category were identified for PPP projects safety listed under subheads. The questionnaire was prepared on the basis of literature review and was filled by 100 Stakeholders namely Consultant/Client, Project Manager/ Contractor, Engineer. Generally Analytic Hierarchy Process (AHP) is widely used as multi criteria decision making. Normally it is very hard to meet the consistence need of a comparison matrix in analytic hierarchy process. In this study AHP is used to categories the risks of PPP projects in different levels and the impact of those risks on the PPP projects are identified.

Keywords: Analytic Hierarchy Process (AHP), Risk Category, Public Private Partnership (PPP), Risk Factors, Multi criteria decision making (MCDM).

1. Introduction:

Everywhere throughout the world, constrained subsidizing for the improvement and task of framework ventures impels governments to draw in private investment and enter public– private organizations (PPPs). Distinctive sorts of PPPs have been rehearsed in framework advancement in both created and creating nations, with differing results. In spite of the fact that PPPs have numerous favorable circumstances, they include a few complexities in arranging, execution, and observing and control that differ as per explicit undertaking and nation conditions. Advocating the PPP choice likewise relies upon the capacity to distinguish, investigate and allot project hazards enough. Inability to do as such will have money related complications for the open division and additionally the disappointment of the undertaking to accomplish its targets. In this manner, at the project distinguishing proof stage, notwithstanding evaluating the wellsprings of income connected with the reasonableness of the task, the Authority and its counsels need to attempt an expansive appraisal of the dangers that emerge from the undertaking fundamentals so as to oversee them. This can appear as a risk matrix or a risk register.

1.1 Public Private Partnership (PPP):

The term ‘public–private partnership’ seems to have instigated in the U.S, originally concerning to public and private sector’s combined funding for educational programs, but used in broader sense in the 60s to refer to joint ventures of public and private sectors for urban renewals. The term PPP is now generally used for any long-term public and private sector contract to provide public infrastructures and facilities.

However, the emphasis of this study is ‘project-based’ or ‘contract based’ PPPs, a current development. PPPs generally have the following Characteristics:

1. A long-term contract between a public and a private sector;
2. For designing, constructing, financing, and operating public infrastructure or service by the private sector;
3. With payments made to the private sector for the use of the facility either by public sector or public itself;
4. With leaving the facility in public-sector ownership, or giving back the ownership to public-sector at the end of the PPP contract.

Over the past decade, private sector financing through public–private partnerships (PPPs) is becoming very widespread as a mean of procuring and upholding public infrastructure, in various sectors.

1.2 Systematic Approach to Risk Management

The systematic approach makes the risks clear, formally describing them and making them easier to manage. In other words, systematic risk management is a management tool, which requires practical experience and training in the use of the techniques. Systematic risk management helps to:

1. Identify, assess, and rank risks, making the risks explicit;
2. Focus on the major risks of the project;
3. Make informed decision on the provision for adversity, e.g. mitigation measures;
4. Minimize potential damage should the worst happen;
5. Control the uncertain aspects of construction projects;
6. Clarify and formalize the company's role and the roles of others in the risk management process;
7. Identify the opportunities to enhance project performance.

1.3 Risk

Risk can be defined as an unplanned activity which results in adverse outcomes, in a PPP it relates to ambiguous consequences which have a direct influence either on the providing of the services or the financial feasibility of the project. In any way the consequence is a loss in revenue or increased cost which has to be tolerated by somebody, and one of the core elements of PPP structuring is to determine where this loss in revenue or increased cost will lie.

So identifying and mitigating risks in any PPP project is very crucial. Hence risk management is adopted to deal with risks involved in any project.

1.4 Objective of the Study

This research mainly aims to investigate important Risk categories and factors in PPP projects. Understanding the risk factors is helpful for the construction professionals in order to efficiently deliver the project as per the plan. Hence, the main goal of the study is to provide essential information about Risk categories and factors to construction professionals to enable the project's to be successful. This study can also be used by other researchers as an input for further studies related to risk categories and factors in construction projects. Following are the main objectives of the research work

1. To identify the risk and explore different categories of risk
2. To identify different risk factors which are involving the categories identified earlier
3. Based on the survey, analysis of risk factors using AHP is carried out
4. To identify the most critical risk affecting the PPP projects by comparing the results of analysis by AHP

1.5 Need for study

In PPP projects, we need to study risk categories and factors due to following purpose

1. Risk management plans help a business determine what their risks are in order to reduce their likelihood and provide a means for better decision-making in order to avoid future risk.
2. A risk management plan helps companies identify risk and risk factors.
3. A risk management plan protects a company's resources
4. A risk management plan can help a company discover reusable information

2. Analytic Hierarchy Process (AHP)

The analytic hierarchy process (AHP) is a structured technique for organizing and analyzing complex decisions. Based on mathematics and psychology, it was developed by Thomas L. Saaty in the 1970s and has been extensively studied. Rather than prescribing a "correct" decision, it helps decision making find one that best suits their goals and their understanding of the problem. It provides a comprehensive framework for structuring a decision problem, for representing its elements, for relating those elements to overall goals. Users of the AHP decompose their decision problem into a hierarchy of easy, each of which can be analyzed independently. The elements of the hierarchy can relate to any aspect of the decision problem, carefully measured or roughly estimated, well understood-anything at all that applies to the decision at hand.

2.1 Applications of AHP

It is widely used for decision making. Decision situations to which the AHP can be applied include

Choice - The selection of one alternative from a given set of alternatives, usually where there are multiple decision criteria involved

Ranking - Putting a set of alternatives in order from most to least desirable.

Prioritization - Determining the relative merit of members of a set of alternatives, as opposed to selecting a single one or merely ranking them.

Benchmarking -Comparing the processes in one's own organization with those of other best-of-breed organizations.

Quality management -Dealing with the multidimensional aspects of quality and quality improvement.

Conflict resolution-Settling disputes between parties with apparently incompatible goals or positions.

2.2 Advantages of Analytic Hierarchy Process

Some advantages of AHP are as follows,

- 1 It illustrates how possible changes in priority at the upper levels have an effect on the priority of criteria at lower levels.
- 2 The method is able to rank criteria according to the needs of the buyer which also leads to more precise decisions concerning supplier selection.
- 3 It provides the buyer with an overview of criteria, their function at the lower levels and goals at the higher levels.

2.3 AHP PROCESS

The procedure for using the AHP can be summarized as:

1. Model the problem as a hierarchy containing the decision goal, the alternatives for reaching it, criteria for evaluating the alternatives.
2. Establish priorities among elements of the hierarchy making series of judgments based on comparisons of elements by the values of fundamental scale of absolute number given in Table 1
3. These judgments to yield a set of overall priorities for the hierarchy.
4. Check the consistency of the judgments.
5. Come to final decision based on the results of this process.

Table 1: Fundamental Scale of Absolute Numbers

Intensity of Importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
2	Weak or slight	
3	Moderate importance	Experience and judgement slightly favour one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgement strongly favour one activity over another
6	Strong plus	
7	Very strong or Demonstrated importance	An activity is favoured very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation
A reciprocal of above 1-9		A reasonable assumption

(Source: Saaty, T.L., “Decision making with the analytic hierarchy process”, *Int. J.Services Sciences*, 2008, Vol. 1, No. 1, Pg.83–98, Pittsburgh, PA 15260, USA.)

3 Research Methodology

In the study, following steps are taken in the given methodology

3.1 Development of Frame Work of Criteria’s

From the study of past research work and with the help of expert opinion, risk categories and criteria’s were identified which affects PPP projects in construction work in the cities of Ahmedabad and Bhavnagar of Gujarat state in India. Risk categories are divided into 7 major groups as: Political Risk, Regulation Social & Legal Risk, Construction Risk, Financial Risk, Commercial Risk, Partnership Risk, and Operation Risk. These 7 criteria’s are further broken into 31 sub criteria. So, the criteria makes comprehensive coverage of all factors affecting PPP projects. The next work of the research is to assign the relative importance in the form of numeric values. Analytical Hierarchy Process (AHP) technique is selected for this Research work. A Survey questionnaire is prepared based on AHP technique.

3.2 Questionnaire Distribution and Collection

The questionnaire was distributed to various stakeholders by informing them regarding the purpose of the research and asking them about their willingness to participate in the research. Once the initial willingness was shown by the respondents, a questionnaire was given to them.

Total 130 questionnaires were distributed to different respondents in Ahmedabad and Bhavnagar. Total 100 respondents provided their response for this research work. Table 2 represents the distribution of responses throughout the area of the study

Table 2: Distribution of Respondent

Stakeholder	City		Total
	Ahmedabad	Bhavnagar	
Contractor/ Project Manager	22	12	34
Client/Consultant	15	12	27
Engineer	23	16	39
Total	60	40	100

The Figures 1 and Figure 2 reflects the percentage of response received as per stakeholder wise in the cities of Ahmedabad and Bhavnagar respectively.

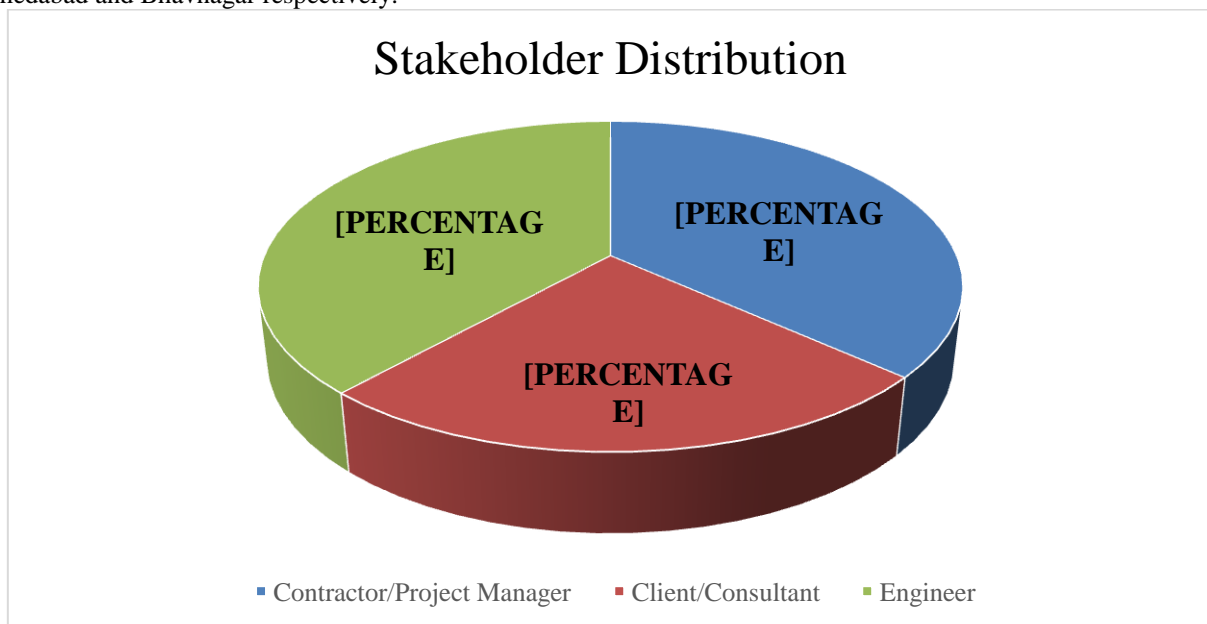


Figure 1: Percentage of Response Received Stakeholder Wise in Ahmedabad

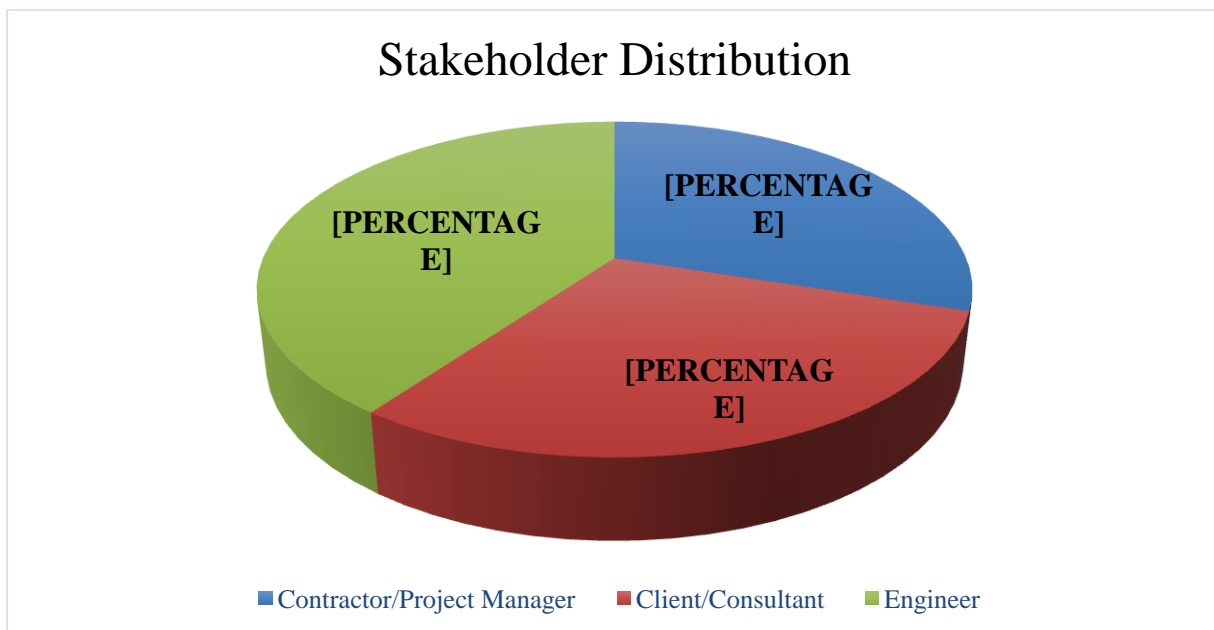


Figure 2: Percentage of Response Received Stakeholder Wise in Bhavnagar

3.3 Data Analysis

It is important to identify the degree to how much the respondents agree or disagree on the severity of these causes based on their own experience and knowledge. The data Analysis is done with the help of AHP concept over the qualitative data that is converted to a quantitative form. The data collected from experts were analyzed using Microsoft Excel sheet. Final data obtained after analysis will help to prepare a risk factors and ranking of various risk factors affecting the PPP projects.

3.3.1 Local Weight and Global Weight

Local Weight: It represents the relative weights of the nodes within a group of siblings with respect to their parent node.

Global Weight: It is obtained by the multiplying the local weights of the siblings by their parent's global weight. The sum of all criteria's Global weight must be equal to 1.

For example: If criteria and sub criteria's local weights are known.

For sub criteria: Change in law

Global Weight = local weight of Political risk * local weight of Change in law

$$= 1 * 0.406 = 0.406$$

For sub criteria: Delay In Project Approval and Permits

Global Weight = local weight of Political risk * local weight of s Delay in Project Approval and Permits

$$= 1 * 0.280 = 0.280$$

For sub criteria: Unstable Government

Global Weight = local weight of Political risk * local weight of Unstable Government

$$= 1 * 0.136 = 0.136$$

For sub criteria: Government Intervention

Global Weight = local weight of Political risk * local weight of Government Intervention

$$= 1 * 0.177 = 0.177$$

Table 3 shows Local weight and Global Weight of the above example

Table 3 Local Weight and Global Weight Criteria (Political Risk)

Criteria	Local Weight	Sub Criteria's	Local Weight	Global Weight
POLITICAL RISK	1	CHANGE IN LAW	0.406	0.406
		DELAY IN PROJECT APPROVAL AND PERMITS	0.280	0.280
		UNSTABLE GOVERNMENT	0.136	0.136
		GOVERNMENT INTERVENTION	0.177	0.177
Total				1

Global Weights of the criteria for each respondent was calculated by Eigenvector method of AHP. Aggregation of all global weights was done by Arithmetic Mean Method (AMM).

Final global weights of each Risk categories and factors of overall both cities that is Ahmedabad and Bhavnagar is calculated and the analysis is done in following Table 4.

Table 4: Overall Local Weight and Global Weight of both the cities

SN	Criteria	Global Weight	Sub Criteria	Local Weight	Global Weight	Rank
1	Political Risk	0.223	Change in law	0.406	0.091	2
			Delay in Project Approval and permits	0.280	0.062	5
			Unstable government	0.136	0.030	13
			Government intervention	0.177	0.039	10

2	Regulation Social And Legal Risk	0.169	Change in tax regulation	0.191	0.032	12
			Corruption and Lack of respect for Law	0.406	0.069	4
			Legislation changes / inconsistencies	0.306	0.052	6
			Environmental clearance	0.097	0.016	21
3	Construction Risk	0.221	Land acquisition	0.211	0.047	8
			Availability of Labour / Material	0.080	0.018	19
			Availability of Finance	0.232	0.051	7
			Construction Cost Overruns	0.186	0.041	9
			Construction time delay	0.052	0.011	26
			Completion risk	0.051	0.011	27
			Quality risk	0.068	0.015	23
			Contractual variation	0.085	0.019	18
			Natural Calamity	0.035	0.008	28
4	Financial Risk	0.218	Unavailability and High Cost of Financing	0.488	0.106	1
			Lack of Suitable economic conditions	0.383	0.084	3
			Foreign exchange Rate fluctuations	0.130	0.028	14
5	Commercial Risk	0.069	Traffic / level of demand risk	0.190	0.013	24
			Lack of demand / slow economic development of the country	0.468	0.032	11
			Delay by govt. Notification	0.342	0.024	16
6	Partnership Risk	0.067	Different working methods between partners	0.303	0.020	17
			Inadequate Experience in PPP Project	0.242	0.016	22
			Lack of commitment from public / Private partner	0.362	0.024	15
			Organization and coordination risk	0.093	0.006	30
7	Operation Risk	0.040	Operation cost overrun	0.289	0.012	25
			Maintenance cost higher than expected	0.423	0.017	20
			Low operating productivity	0.178	0.007	29
			Quality of operation	0.110	0.004	31

Top 10 Risk Factors which affects in PPP projects in both the cities calculated by AHP process are as follows:

1. Unavailability and High Cost of Financing
2. Change in Law
3. Lack of Suitable Economic Conditions
4. Corruption and Lack of Respect for Law
5. Delay in Project Approval and Permits
6. Legislation Changes / Inconsistencies
7. Availability of Finance
8. Land Acquisition
9. Construction Cost Overruns
10. Government Intervention

3.3.2 Comparison of Ranks of Criteria's between City wise Groups

All respondent were divided into two groups of cities: Ahmedabad and Bhavnagar. Below calculation shows the rank comparison of Risk categories as well as Risk factors of Ahmedabad, Bhavnagar and Combine both cities. Their Ranks were compared in the Table 5

Table 5: Rank Comparison of Ahmedabad, Bhavnagar and Overall both cities by Global Weight

Sr.No	Risk Categories	Risk Factors	Overall Rank	Ahmedabad	Bhavnagar
1	Political Risk	Change In Law	2	2	1
		Delay in Project Approval and Permits	5	5	4
		Unstable Government	13	13	12
		Government Intervention	10	10	10
2	Regulation Social and Legal Risk	Change in Tax Regulation	12	11	13
		Corruption and Lack of Respect for Law	4	4	3
		Legislation Changes / Inconsistencies	6	6	7
		Environmental Clearance	21	21	23
3	Construction Risk	Land Acquisition	8	8	8
		Availability of Labour / Material	19	19	19
		Availability of Finance	7	7	6
		Construction Cost Overruns	9	9	9
		Construction Time Delay	26	26	25
		Completion Risk	27	27	26
		Quality Risk	23	23	22
		Contractual Variation	18	18	18
4	Financial Risk	Unavailability and High Cost Of Financing	1	1	2
		Lack of Suitable Economic Conditions	3	3	5
		Foreign Exchange Rate Fluctuations	14	14	14
5	Commercial Risk	Traffic / Level of Demand Risk	24	24	24
		Lack of Demand / Slow Economic Development of The Country	11	12	11
		Delay By Govt. Notification	16	16	16
6	Partnership Risk	Different Working Methods Between Partners	17	17	17
		Inadequate Experience in PPP Project	22	22	21
		Lack Of Commitment From Public / Private Partner	15	15	15
		Organization and Coordination Risk	30	30	30
7	Operation Risk	Operation Cost Overrun	25	25	27
		Maintenance Cost Higher Than Expected	20	20	20
		Low Operating Productivity	29	29	29
		Quality of Operation	31	31	31

From the above table we can analyze that “Unavailability and high cost of financing” is ranked 1st in Ahmedabad and 2nd in Bhavnagar by respondents, while “change in law” is given 2nd in Ahmedabad and 1st in Bhavnagar. Likewise the first 5 rank in Ahmedabad and Bhavnagar cities are highlighted in the above table.

Conclusion:

According to the Analytical Hierarchy Process (AHP), development of the Criteria Framework in Indian context was prepared for Risk Categories and factors in PPP projects. Total 31 nos. of Risk factors were identified which affect in PPP projects which are included into major 7 Risk Categories: Political Risk, Regulation social and legal Risk, Construction Risk, Financial Risk, Commercial Risk, Partnership Risk, and Operation Risk.

With the help of Analytic Hierarchy Process (AHP) technique, the relative ranking of Risk Categories and factors were generated through the responses of three stakeholders: Contractors/Project Manager, Client/Consultant, and Engineer. Targeted cities were Ahmedabad and Bhavnagar. According to the population, sample size was calculated of 60 responses but for safety purpose it was taken of 100 responses.

After the analysis of both the cities, overall ranking of the main Risk Categories are as follows:

1. Political Risk
2. Construction Risk
3. Financial Risk
4. Regulation Social and Legal Risk
5. Commercial Risk
6. Partnership Risk
7. Operation Risk

On the basis of analysis of both the cities, the critical Risk Factors of different risk categories in PPP projects from Table 5 are compared with both the cities and Top 5 most critical risk factors as calculated by AHP process are as mentioned below,

1. Unavailability and High Cost of Financing
2. Change in Law
3. Lack of Suitable Economic Conditions
4. Corruption and Lack of Respect for Law
5. Delay in Project Approval and Permits

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