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A review on assessment of risk allocation in public private partnership (PPP) projects using analytical hierarchy process (AHP)

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Abstract
Public private partnerships (PPP) is rising as dominant and popular model for fast and efficient development in developing countries. However, this model for sharing developmental responsibilities and assets by the state and people is highly vulnerable to various risks. Success of these projects depends upon assessment and allocation of risks. Assessment of risk allocation in Public private projects is an essence of every PPP project's study. The study includes classification of different criteria which are accumulated from previous studies and literatures. From many modern methods for risk assessment the most popular methodology used is Analytical Hierarchy Process (AHP) which is used to assign weights and perform a Multi-criteria decision making process. The study discusses the process of getting weights for each criteria and process of ranking. The study of first three highly weighted criteria namely "Bear risk at lowest cost", "Control chance of risk" and "Risk attitude" is done and it is tried to impart solutions to minimize their negative impact on PPP projects.

Keywords: PPP project, risk allocation, analytical hierarchy process (AHP)

1. Introduction
Public-Private partnership is basically a collaboration between public and private parties to implement the projects or the provision of services or goods, traditionally provided by public sectors merely. The involvement of private sector in the development and financing of public facilities and other services has increased substantially in the last decade in developed as well as developing countries. In this approach public and private parties have to share the risks and rewards. Private sectors are greatly involved in the financing, design, construction, operation, maintenance and in some cases concessional ownership of facilities and services. This involvement solely depends upon which model of PPP is being implemented in the project.

Public sector looks to the private sector for the provision of finance and expertise. The base of PPP project lies under a government desire to resolve financial constraints and to provide expertise skills to enhance the efficiency, effectiveness and quality of facilities and services delivery [1]. One of the major aspects of the development is the win-win delivery of projects, consequently many policies are developed to strengthen the relationship between public and private sector to minimize risk and maximize reward in the project [3].

"Risk" is the chance of occurring of an event that would cause actual circumstances of a project differing from forecasted circumstances as analyzed for cost and benefits. The need of risk management in PPP projects has been highlighted by many authors and researchers. Success of PPP projects highly depends on how risk is managed during different phases of projects. It has been more than decade but western countries are not able to fulfill their project's objective completely even after adopting PPP as their key [4]. This is because of lack of appropriate risk allocation and management during project duration. Every construction project is bound with risk, no risk no project [5]. "Risk management is an important Project management tool" as said in ISO 31000 (2009). According to Shen *et al* (2006), Risk management has mainly four parts: Risk identification, Risk assessment, Risk reduction and Allocation of contingencies. Hashim in 2001 has discussed how improper risk allocation has negative impact on cost, time and quality of service in PPP project. Risk can never be eliminated but can allocated wisely to reduce its negative impact on the project. Appropriate allocation is only possible when party is having knowledge about different types of risk involved during respective phases of the project.

Table 1: Types of Risks

1. Pre-operative tasks Risks	**Description**
Delays in Land acquisition	Refers to the risk that the project site will be unavailable, unable to be used in time, unpredictable costs and liabilities generated.
External linkages	Refers to the risk involved in failures in connectivity to the project sites. Ex-road and rail links.
Financing Risk	Refers to the risk relating to non-availability of finance. Ex- Lack of funds due to Market conditions and credit transferability.
Planning Risk	Refers to the risk in the non-adequate studies of technical, legal and financial aspects so the outcome faced differs from the forecasted ones.
2. Construction Phase Risks	**Description**
Construction Risk	Refers to the risk in which construction of infrastructures will not be completed on time, on budget, and as per the specification.
Design Risk	Refers to the risk in which design will not meet the service requirement and performance and involves extra costs for redesigning.
Approval Risk	Refers to the risk which involved problems in being approved and which delays construction of infrastructure.
3. Operation phase Risks	**Description**
Technology Risk	Risk relating to outdating of technology in the life of PPP project.
Operation and Maintenance Risk	Risk relating to increased maintenance and operation charges to meet the desired performance in the term of project.
Tariff Risk	Risk refers to change in service demand in contrast with initial prediction and Consequently variation in revenue is noticed.
Payment Risk	Risk is generally seen in public sectors in management contract.
4. Handover Risks	**Description**
Handover Risk/ Terminal value Risk	Risk refers to handing over of the infrastructure in the end of project life without meeting standard quality of the asset.
5. Other Risks	**Description**
Change in Law	Refers to the risk that current legal/ regulatory regime will mend.
Force Majeure	Refers to the risk which is beyond control. Also called as "Act of God".
Sponsor Risk	Refers to the risk relating if sponsor is not proven to be better partne5.
Concessionaire event of default	Refers to the risk in which concessionaire are not able to fulfill its obligations and for compensations government imposes penalties on concessionaire as a result of breach.
Government Law of default	Refers to the risk that government will not fulfill its Contractual obligations.

Risk allocation is a complex matter but also is flexible due to the fact that it depends on few parameters such as Risk attitude of participants, ability to manage risk and risk premium [10]. Inappropriate risk allocation directly leads to disputes, disagreements, claims and destructs relationships between parties [11]. Risk allocation is said to be adequate when risk is not allocated to only one of the parties [12]. Risk should be allocated by pair wise comparison of two parties considering their abilities and criteria to make PPP a successful attempt [13]. Risk allocation begins with identifications of risk [14]. When risk event happens, sequence and resources should be ready to compensate the losses [15]. Xu *et al* (2011) found 23 criteria for risk allocation in China's PPP project.

Many authors used different tools for risk allocation. Thomas *et al* (2003) found best risk managing party by using Regression analysis in India [4]. Li *et al* (2005) and Ibrahin *et al* (2006) remarked the preferred risk allocation in percentage counts among parties in UK and Nigeria respectively [17]. Medda (2007) used Game theory for risk allocation decision for transport PPP projects [18]. Lam *et al* (2007) proved fuzzy theory to be suitable for Risk allocation in construction contracts [19]. Roumboutsos (2008) implemented percentage as the tool to rank criteria in risk allocation for PPP projects in Greece [20]. Jin and Doloi (2008) incorporated knowledge of experts and used Fuzzy Interference system methodology in Australia's PPP projects. Wibowo and Mohamed (2010) used Statistical mean method for preferred risk allocation in water supply PPP projects in Indonesia [22]. Ke *et al* (2010) study was based on Delphi survey and percentage as well as Statistical methods were used for ranking. Jin and Zhang (2011) came out with a model on transaction cost economics in construction sectors and utilized concept of Artificial Neural networks and Jin also proposed Multi-linear regression model along with fuzzy logic approach [21].

2. Methodology

2.1 Framework of Risk Assessment in PPP Projects

The methodology used in this study can be systematically drawn in the form of flow chart. Fig.1 shows the framework of Risk Assessment in PPP project and steps followed subsequently [27].

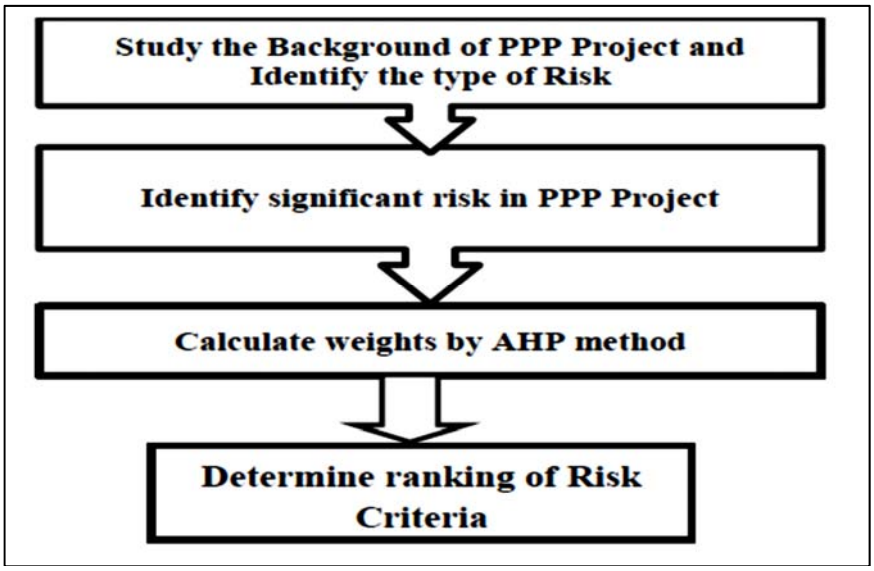

Fig 1: Framework of Risk Assessment in Public Private Partnership

2.2 Data Collection

Data has been collected through reviews of journal papers which incorporated expertise knowledge and experience in PPP projects. Criteria chosen for risk allocation are filtered ones that have frequently repeated in journals. Risk allocation criteria which are found to be substantial these years are mentioned in the next table and also clear vision of criteria incorporated in respective journals.

Table 2. Significant criteria of Risk Assessment

Group of Criteria	Criteria	1	2	3	4	5	6	7	8	9	10	11
1.Risk management Competency	C1: Identification of Risk					▲						
	C2: Foreseeing Risk	▲	▲	▲	▲	▲						
	C3: Evaluation of Risk	▲	▲		▲	▲						
	C4: Bear the risk at the lowest price						▲	▲				
	C5: Capability of control risk				▲	▲	▲		▲	▲		
	C6: Resources of risk control				▲	▲	▲		▲	▲		
	C7: Control the chance of risk	▲	▲	▲								
	C8: Minimize loss if risk occurs	▲		▲			▲	▲				
	C9: Sustain the consequence	▲	▲		▲	▲						
	C10: Expertise of control risk					▲		▲				
2. Incentive mechanism	C11: Reasonable amount of risk sharing						▲	▲				
	C12: Obtain intangible access						▲					
	C13: Level of governmental support	▲					▲					
3.Risk preference	C14: Direct loss						▲				▲	
	C15: Risk attitude			▲	▲	▲	▲					▲

1)Thomas et al., 2003, (2) Lam et al., 2007, (3) Gao and Jiang, 2008, (4) Loosemore and McCarthy, 2008 (5) Khazaieni et al., 2011, (6) Xu et al., 2010 , (7) Hong Kong Efficiency Unit, 2003b, (8) Zhu et al., 2007, (9) Jin and Doloi, 2008, (10) Zhang et al. 2002., (11) Wang et al., 2007.

2.2 Analytical Hierarchy Process

Analytical Hierarchy process (AHP) is widely and popularly used Multi-criteria Decision making (MCDM) method. It is founded by Saaty. The AHP is based on pair wise comparison where DM is asked about the relative importance of criterion i in comparison to criterion j for each pair (i, j). It allows both qualitative and quantitative criteria for evaluation. Many success stories of AHP have been compiled by many authors. Zahedi 1986, Golden *et al* 1989, Vargas 1990, Saaty and Forman 1992, Forman and Gass 2001, Kumar *et al* 2006, Omkarprasad and Sushil 2006, Ho 2008, Nydick *et al* 2008 are main contributors in this field. But the oldest one is Saaty 1972, which was the first publication [35]. Software package supporting AHP, Expert choice which is being used in this study incorporates the same feature as in Saaty's first publication. To derive priorities among criteria, verbal or linguistic scale should be converted to numeric scale. Saaty used scale from 1 to 9 in AHP (fig.2) [36]. Pair wise comparison of criteria is done using this scale in Expert choice. It also uses consistency ratio which should be preferably less than 0.1. But it was also criticized by researchers as it can give contradictory values for matrices [38].

Scale	Numerical Rating	Reciprocal
Extremely important	9	1/9
Very strongly to extremely important	8	1/8
Very strongly important	7	1/7
Strongly to Very strongly important	6	1/7
Strongly important	5	1/5
Moderately to strongly important	4	¼
Moderately important	3	1/3
Equally to moderately important	2	½
Equally important	1	1

Fig 2: Saaty scale used in pair wise comparison

3. Data Analysis

3.1 Determine Pair wise comparison matrix

After implying Saaty scale, pairwise comparison is done between 15 criteria which were found to be significant in Risk Allocation in PPP projects. It is shown in next figure (Table no. 3). Expert choice software package of AHP also takes input in form of pair wise comparison matrix so this is the basic and substantial step as we are moving move forward.

Table 3: Pair wise comparison matrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15
C1	1	4	3	1/5	5	1/2	1/4	2	4	3	1/3	1/2	1/3	2	4
C2		1	1/3	1/8	2	1/5	1/7	1/4	½	1/2	1/6	1/5	1/6	1/3	1/7
C3			1	1/6	3	1/4	1/6	1/2	2	2	1/5	1/3	¼	½	1/5
C4				1	8	4	2	5	7	7	3	4	3	6	2
C5					1	1/6	1/8	1/4	½	1/3	1/7	1/5	1/6	¼	1/7
C6						1	1/3	3	5	4	½	2	½	3	1/3
C7							1	5	7	6	2	4	3	5	2
C8								1	3	3	¼	1/2	1/3	2	¼
C9									1	1/2	1/6	1/4	1/5	1/3	1/6
C10										1	1/5	1/4	1/5	½	1/6
C11											1	3	2	4	½
C12												1	½	3	1/3
C13													1	4	½
C14														1	1/5
C15															1

After determining comparison matrix, it is processed in Expert choice. After processing, it imparts respective weights of criteria in normalized form. If consistency ratio gained is greater than 0.1, pair wise matrix has to be repeated [37]. Subsequent figures give glimpses of Expert choice with data being processed (fig.3). The weights of 15 criteria are retained for further ranking of criteria of Risk assessment.

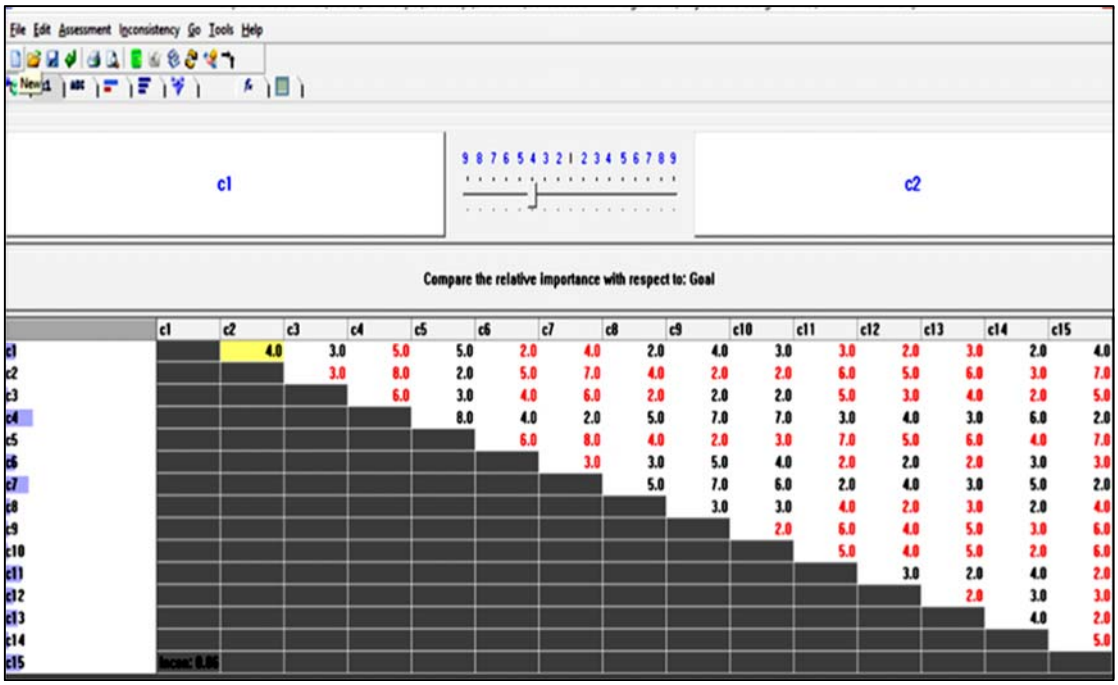

Fig 3: Expert choice Input and Output of Risk Allocation Criteria

3.2 Weighted Risk allocation criteria and Results

After being processed in Expert choice using AHP, normalized weight of criteria is obtained. Weight of criteria is given in tabular form (Table no. 4). "Bearing the risk at the lowest price" found to be maximum weighed as 0.191. "Control the chance of risk" secured second rank with weighing factor 0.156. "Risk attitude of PPP parties" attained next rank with 0.114. Other 13 criteria are also ranked with their decreasing weightages.

Table 4. Weighted Criteria of Risk

Ranking	Criteria	Weights
1	Bear the risk at the lowest price	0.191
2	Control the chance of risk	0.156
3	Risk attitude	0.114
4	Reasonable amount of risk sharing	0.106
5	Level of governmental support	0.087
6	Identification of risk	0.071
7	Resources of control risk	0.070
8	Obtain intangible access	0.057
9	Minimize the loss if risk occurs	0.036
10	Direct loss	0.029
11	Evaluation of risk	0.023
12	Expertise of control risk	0.019
13	Sustain the consequence	0.016
14	Foreseeing risk	0.013
15	Capability of controlling risk	0.011

4. Criteria Management in Risk allocation

4.1. Bear the risk at the lowest price

A PPP should be adopted when the private sector allows project to generate greater VFM (Value for money) as compared to procuring projects via conventional approach. VFM is defined as optimum combination of life costs and fitness for purpose which meets the consumer's requirements [40]. According to the European investment Bank PPP project can be defined in terms of VFM only if it can impart positive net benefit to the society and is

considered to be the greater than any other procurement route [44]. VFM is comprised of features like i) Cost efficiencies ii) Time savings iii) Quality enhancement. It was found that 60 percent of cost savings can be attained if optimal risk allocation in PPP projects is done [43].

Risk is dynamic and inherently challenging. Risk's management has very straight forward concept. It should be allocated in such a way that the party should be able to manage it till its best level or party which can manage that particular risk should take liabilities, at lowest cost. The party that manages it, also bears its financial costs, so it would create incentives to mitigate risks. Finally, if these principles are adopted for risk allocation, risk can be mitigated at the lowest possible cost and VFM at its greatest level.

Risk allocation should not be only about managing its occurrence but also its impacts. Government is best occurrence manager and Private sector is best impact manager. So this virtue makes PPP model more strengthened [45].

Risk transfer should also be checked with market conditions, with minimum cost to manage it. Systematic risks (ex. Inflation, revenue and interest rate), Coordination risks, long term performance risks (ex. Uncertainty in timing and level of maintenance cost) should also be taken into account while risk transfer [45].

4.2. Control the chance of Risks

Controlling chances of risks is next powerful criteria in PPP projects as proved in previous sections of this study. The World Bank report (1996) provided many reasons that increases the chance of risks in infrastructure projects: Wide gap between public and private sector expectations, lack of public party's commitment, complex decision making, poor policies, inadequate legal framework, poor management of risks, inadequate domestic capital market, poor transparency and lack of competition [46]. Following measures can be adopted to control the chance of risks in PPP projects:

Suitable Legal foundation: Risk can be managed, allocated and avoided to large extent through precise and comprehensive legal documentation. Legal documentation is comprised of: Project documentation and underlying legal regime which provides security and comfort to both the parties [47].

Workable Procurement process: PPP models are much more complicated than traditional routes. Many challenges come in between from longer time horizons, external risks (political, legal, economic, financial, technical and environmental) and multiparty involvement. It's the public client obligation to establish a framework to provide overview of procurement process, appraisals required and decisions need to be taken at each stage [48].

Coordinating and Supportive Authority: A high powered centralized authority should make to be coordinated with PPP programs. Construction and Infrastructure projects require large financial base and gestation period is also long. So to minimize chances of risks their support be in hand [48].

Selection of most suitable concessionaire: Suitable concessionaire in PPP projects should be chosen otherwise it will get laden with risks. Evaluation appraisals are to be conducted of cost and performance level to choose appropriately.

Limiting Risk with insurance: Not all losses are insurable but insurance can limit financial risks. It cannot prevent the chances of occurrence of risk but can compensate losses [47].

4.3 Risk Attitude

Risk attitude is the organization's or individual's view of the perceived qualitative and quantitative value that may be gained related to the potential losses [49]. Risk attitude is different from partner to partner, because each partner needs to overcome the extra cost of risk taking and risk sharing under different circumstances in model (Wang and Yuan, 2011). It is proved in studies that risk attitude is major determinant to handle risk and find solutions (Sulaiman, 2012). Risk attitude also comes up with less desirable and non-desirable outcomes such as disputes to take risk and sharing formula between the parties [50]. Therefore, it can be said that Risk attitude defines largely the risk allocation in PPP projects.

According to Hwang Zhao and Gay (2013), To have a positive attitude in PPP projects:

Reduction of Information asymmetry, Provision of incentives through tariff policy, penalties etc, providing credible commitments through enforcement of contracts. There are 3 preference choices of risk under risk attitude of parties: Risk loving or seeking, Risk neutral and Risk aversion [49]. Following figure (fig. 4) will show their graphs of utility functions.

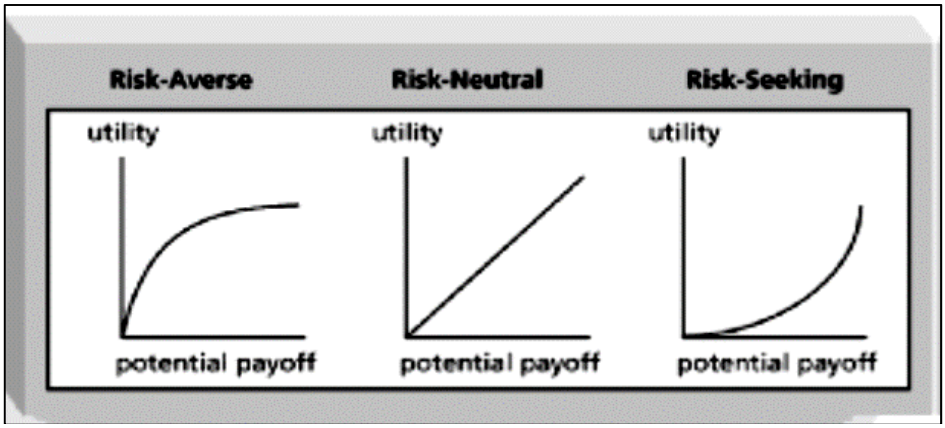

Fig 4: Risk Utility Function and risk Preference; Source (Grable, 2008)

Risk Loving/ Seeking: One of the crucial questions which come in front of partners in PPP model is how each one of them are linked with risks [51]. Indications of risk loving/seeking in any of the partners: Active acceptance of all sorts of risks, Open door strategy with selected interventions and Strategic targeting of prime risks [52].

Risk Aversion/ Risk Prevention: Risk aversion is another type of risk handling which tries to make it non-destructive [53]. It is a common behavior amongst consumers and investors while facing uncertainty, tries to reduce uncertainty. According to Coudert and Gex, It is also the reluctance of people to accept a bargain with uncertain payoff rather than being certain but with less payoff. Ex- If he/she gets would accept payment of less than 50$ (say 40$), rather taking gamble and possibly receiving nothing.

Risk attitude can also be represented in a general way with respect to response to uncertainty and comfort level as shown in the following figure (Fig. no.5).

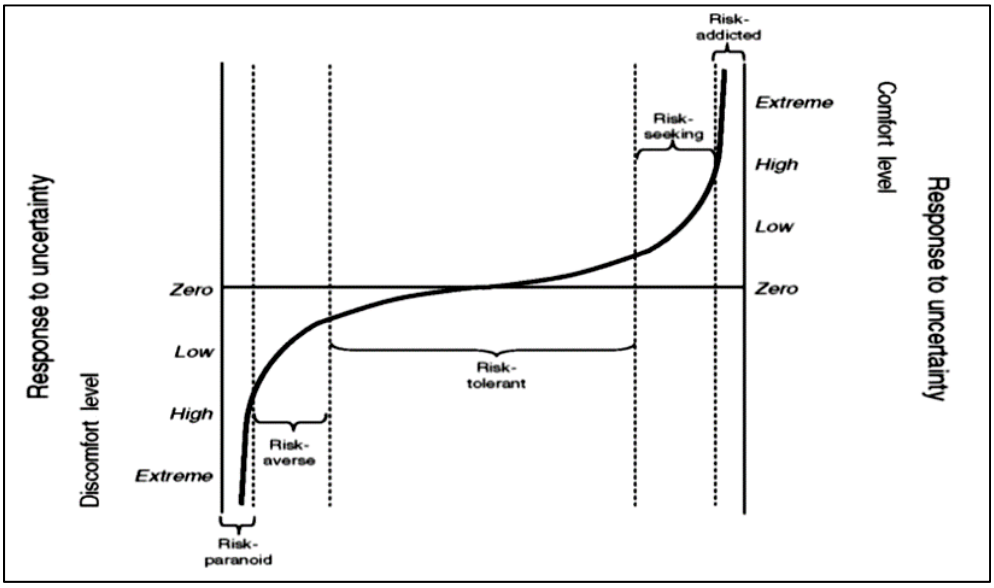

Fig 5: Spectrum of Risk attitude [49]

Risk and Return: Next figure, fig. no. 6, shows relationship between Risk appetite, Risk capacity, Risk tolerance, Risk limits and Return in PPP model. The red line is showing risk capacity. Risk capacity is the absolute maximum risk which can be bear by PPP parties. The blue line represents risk appetite and the purple line represents risk limits. The risk limit is below the risk appetite at every point. The risk appetite is the addition of risk limit and buffer (risk tolerance). Risk tolerance is given by green line.

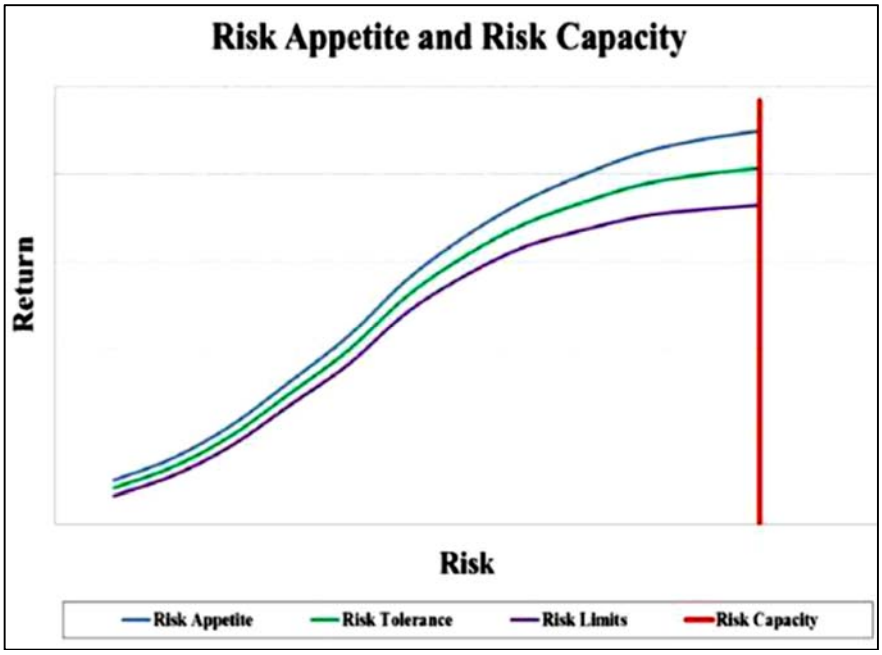

Fig 6: Relationship between Risk and Return; Source: Goldstein and Mcelligot, 2014

The risk and return trade off graph in fig. 6 illustrates that PPP arrangement can be only successful when parties take risks. They have to take risks to get return payoff. But, risk allocation is inherently complex and should be allocated judiciously and the top three risk allocation criteria namely "Bear at the lowest cost", "Control chance of risks" and "Risk attitude" should be emphasized while drawing framework of PPP Projects especially in construction sectors.

5. Conclusion

The results for weightages for each and every criteria is obtained. This study shows that Risk management Competency contributes the most among the criteria presents when it comes to risk assessment capabilities. In further detailed explanation, it can be aid that top most priority for decision makers and experts comes out to be the ability to "Bear risk at lowest cost". This prioritization accounts for 19.10% weightage to the criteria when compared among 15 different preferences. Further elaboration of the study clearly indicates that the ability to "Control chances of risk" have second most preference for decision makers with a 15.6% weightage. Results for "Risk attitude" and ability of "Reasonable amount of risk sharing" comes out to be almost equally prioritized with weightage contribution of 11.40% and 10.6% respectively. Some less prioritization is observed in some of the most important criteria like "Identification", "Control resources" and "Governance support". The study finally concludes with surprisingly low weightage for ability to "forecasting" & "Control risk" itself, some relatively preferences are given to controlling the chances for risk over the risk itself.

There is a future scope of this risk assesment review as public facilities and construction firms are not only pertaining to Public sectors but also in public sector. This new trend is PPP arrangement, and it brings complexity and risks that can be assessed with proper expertise. Risk allocation have been a major concern and modern methods need to be developed for more accuracy and robustness.

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