

STAKEHOLDERS' PERCEPTION ON PROJECT UNCERTAINTY IN PPP PROJECTS IN INDIA

C. Prathapmohan Nair* and Ashwin Mahalingam

BTCM Division, Department of Civil Engineering, Indian Institute of Technology Madras, Chennai, India

ABSTRACT

PPP projects are often complex, unique and dynamic due to high sunk-in costs and long concession period making it vulnerable to risks (known-unknowns) and uncertainties (unknown-unknowns). Previous researches focus on risks associated with PPP projects. But these projects are hit by uncertainties which surfaces as turbulences during the execution as well as the operation stage of the project. The extant literature does not focus much on the uncertainties manifested in these projects nor does it convey the stakeholders' outlook on uncertainties, which has a strong bearing on project management. In order to ensure sustainability of PPP projects, among other factors, it is important to identify uncertainties that affect their performance in various phases or leads to uncertain situations. A superset of uncertainties identified from literature was subsequently expanded and validated by PPP Experts. Stakeholders perceptions on the fifty-four identified uncertainties likely to manifest in various phases was assessed through a survey to identify and evaluate the uncertainties that affect the implementation of transport PPP infrastructure projects as well as explore the perception of stakeholders on project uncertainties for end-to-end sustainability. Differences in opinion among stakeholders on uncertainties often are found to act as a hurdle for effective implementation of PPPs. It is comforting to note that stakeholders have arrived at a general understanding on uncertainties since the inception of PPP projects in India, though there is long way to go. The comprehensive list of the uncertainties brought out in this paper validated by the experts in this field through their experience gained in managing PPP projects in India over the past two decades, when given due consideration while developing Concession Agreements in future will help to institutionalise addressing these unknown unknowns as well as keep the project officers prepared to effectively manage them as and when they unfold.

Keywords: Perception; Project Management; Public Private Partnerships (PPP); Stakeholders; Uncertainty.

1. INTRODUCTION

Public Private Partnership (PPP) in development of physical infrastructure has gained popularity in India over the last couple of decades (Wallack & Singh, 2011). PPP contracts are often complex and long-term, extending over several years with high sunk-in investments and are developed in the context of risks and uncertainties making it vulnerable to opportunistic behaviour by the concessionaires. (Ubbels & Verhoed, 2008; Williamson, 1996). Projects are developed with a set of assumptions applied to the macro-economic scenario and are extrapolated to arrive at demand forecasts and cost estimates. Though the demand forecasts have seldom proved to be less than accurate (Flyvbjerg et al. 2003), risks and uncertainties in socio-political, economic and environmental aspects of the project could also result in unexpected outcomes that are detrimental to the project.

Though the phrases 'risks and uncertainties' are invariably used in project management parlance, they have different and wide connotations in PPP contexts. For gaining clarity, risk is a knowable, conceivable or quantifiable threat that unfolds during the course of the project life-cycle, which may endanger the accomplishments of one or more of the project goals (Knight, 1964; Cleden, 2009; Saunders, 2016). Whereas,

*Corresponding Author: E-mail – cpnair@gmail.com

Uncertainties are poorly to not quantifiable threats resulting from lack of information on the project, hampering decision making thereby threatening the achievements of one or more project goals (Keynes, 1937; Cleden, 2009; Mentis, 2015; Grote, 2015). As PPP projects are developed, projects risks are identified and mitigation measures are incorporated in the project agreements so as to address them as and when such situations occur.

For uncertainties, it is either impossible or difficult to foresee all the long-term eventualities, but has a direct correlation on the unavailability or overlooking of certain facts while planning for the project, making it unfavourable for the private investors as well as public and other stakeholders. This gap creates ambiguity and vagueness in designs and development strategies which can result in decisions that lead to undesirable outputs (Dequech, 2000). The inherent uncertainties in these contracts manifest as various turbulences during the post-award stage of the project (Florice & Miller, 2001). These contractual arrangements are often framed under conditions of uncertainty and are essentially incomplete in nature (Hart, 2003). On the contrary, reducing or coping with uncertainty can also be costly in terms of resources and time (Knight, 1964). Therefore, it is important to plan the evolution of the project into the larger scheme of things and identify the uncertainties as an optimal solution to the existing infrastructure gap.

The uncertainties in the PPP project could be unfavorable for all the stakeholders, especially the private investors for the fact that he has to recoup the sunk investment, its debt service and profit. Therefore, relevant strategies are needed for coping with both negative as well as positive outcomes associated with uncertainty (Dean, 1951). However, for developing strategies it is imperative to understand how the stakeholders perceive the project uncertainties and which of the uncertainties could be the respective stakeholder's priority. This will help in mutually acknowledging the stakeholders leading to a win-win through the project period. This paper looks in to the perceptions of different PPP project stakeholders on uncertainties during the various phases of PPP projects.

2. LITERATURE REVIEW ON UNCERTAINTY AND FLEXIBILITY IN PPP PROJECTS

From the extant literature it is observed that risks and uncertainties are read differently in Economics, Psychology, Philosophy and Organization Theory (Perminova et.al, 2008). As there is a distinctive difference between risk and uncertainties, risk management and uncertainty management are looked upon differently in strategic management literature (Mintzberg, 1994). Projects in different sectors viz. engineering design, engineering systems, manufacturing, smart grids, petroleum etc., also encounter uncertainties due to change in project scenario (De Neufville, 2008). Table 1 presents uncertainties as classified by different researchers.

Table 1: Summary of Classification of Uncertainties from Literature

Author(s)	Types of uncertainties	Description
Milliken (1987)	State uncertainty	State uncertainty is the failure to understand how the components of the environment are changing.
	Effect uncertainty	Effect uncertainty is the inability to understand the impact of events in the environment.
	Response uncertainty	Response uncertainty is the inability to predict the possible consequences of the response are not known.
Lessard and Miller (2001)	Natural	Geology or weather
	Market	Interest rates, risk premium, exchange rates, etc.
	Country/fiscal	Regulatory environment, legal and political stability, contract enforcement, terrorism, etc.
	Industry/competitive	Demand, competition, etc.
Love <i>et al.</i> (2001)	Technical/project	Construction, project management, etc.
	Internal uncertainties	Associated with the project, organization, people and finances involved
Thunnissen (2003)	External uncertainties	Associated with the government, economy, social and legal uncertainties, technological developments, institutional (organizational) influences, physical conditions and force majeure.
	Ambiguity uncertainty	Imprecision due to ambiguity in communication
	Epistemic uncertainty	Lack of data or information to support the model

Author(s)	Types of uncertainties	Description
	Sleatory uncertainty	Corresponds to the inherent variation in the variables of the system
	Interaction uncertainty	Arising from unknown outcomes of agents' interaction
Sakhrani et. al. (2013)	Exogenous	Uncertainties outside of the companies' direct control and arise from the market, their operational environment and the cultural and political context.
	Endogenous in system design	Product context and corporate context.
Rice et al. (2008)	Technical	Technical uncertainties are related to the completeness of scientific knowledge, the reliability of the process, technical specifications etc.
	Market	Market uncertainties are related to the customers' needs, the types of sales/distribution, and the project team's understanding of the technical, relationship between their product and those of their competitors.
	Organizational	Organizational uncertainties are associated with the dynamics of the organization.
	Resource Innovations	Resource uncertainties refer not only to financial resources but also to all types of skills.
Sicotte and Bougault (2008)	External uncertainty	External uncertainties correspond to the lack of information related to external factors
	Internal uncertainty	Organizational interdependence
	Characteristics of activity	The characteristics of the activity assume two dimensions: variety and analyzability. Variety is caused by research and development activities. Analyzability is a well-structured process and can be used to develop problem solutions.
Koppinen and Rosqvist (2010)	Market- oriented changes	
	Technological changes	
	Changes in network	
	Societal changes	
Sanderson (2012)	Uncertainty Category 1 subjective probability	Uncertainty type 1 is equivalent to known unknowns. Known range of possible future events are available but no data to assign objective probabilities to each.
	Uncertainty Category 2: socialized	Type 2 uncertainties are unknown unknowns. The future is inherently unknowable and may bear little or no relation to the past or the present.
Zheng and Carvalho (2016)	Variability or statistical uncertainty	Variability is caused by various influences yielding a range of values for a particular activity.
	Predictable uncertainty or scenarios	Predictable uncertainties are identifiable and influences understood but it is not possible to know whether they will occur.
	Unpredictable or recognized uncertainty	Unpredictable uncertainties are not identifiable and consequently, there are no a priori mitigation plans.
	Chaos or total ignorance.	Projects with the project plan uncertain and reflect a situation in which the project team does not even know what is unknown.

From the above, it is clear that there is a difference in perception about uncertainties across projects and project stakeholders. For long-term and complex project like PPP it is essential to explore the perception on uncertainties of different stakeholders leading to successful implementation, operation and service delivery of the project.

An extensive review of extant literature with focus on fundamental uncertainties in mega projects/ PPP projects was done initially to come up with a superset of uncertainties that manifest in PPP projects as shown in Table 2.

Table 2: Uncertainties in PPP Projects from Literature

Sl. No.	Uncertainties / Authors	Demirel et.al. (2017)	Zheng and Carvalho (2016)	Mahalingam and seddon, (2015)	Domingues et.al. (2014)	Cardin (2013)	Cruz and Marques (2013)	Perminova (2011)	Athias and Sausier (2007)	Wangand DeNeufville (1984)
1	Delays in land acquisition			X		X			X	
2	External linkages	X					X		X	
3	High finance costs	X			X	X	X	X		X
4	Planning uncertainties	X	X		X			X	X	
5	Poor public decision-making	X	X		X		X	X		
6	Project data and demand assessment	X	X	X	X		X	X		X
7	Project exclusivity		X		X			X		
8	Design uncertainty				X	X	X	X	X	
9	Construction uncertainty		X	X	X		X			
10	Cost uncertainty	X				X	X			X
11	Approvals uncertainty		X			X			X	
12	Additional Site uncertainty			X		X				
13	Completion uncertainty						X			
14	Environmental uncertainty	X	X	X				X	X	X
15	Poor financial market	X					X			
16	Force Majeure	X	X			X	X	X	X	
17	Insolvency of concessionaire							X		
18	Contractual uncertainty				X		X	X	X	
19	Performance uncertainty				X		X	X	X	X
20	Operations uncertainty		X		X		X	X	X	
21	Maintenance uncertainty		X		X		X	X	X	
22	Demand uncertainty		X	X	X	X	X	X	X	X
23	Market uncertainty	X	X	X		X	X			X
24	Revenue uncertainty					X	X		X	
25	Financial uncertainty	X	X	X	X		X		X	X
26	Payment uncertainty								X	
27	Inflation uncertainty		X				X		X	
28	Currency Exchange	X	X				X	X	X	
29	Technical uncertainty		X			X	X	X		X
30	Technology uncertainty	X		X	X	X	X	X		X
31	Insurance uncertainty						X			
32	Political and Regulatory uncertainty	X	X		X	X	X	X	X	X
33	Expropriation and Nationalization uncertainty		X		X		X	X		
34	Operators uncertainty	X				X		X		
35	Terminal value uncertainty		X						X	
36	Sponsor uncertainty	X						X		
37	Social uncertainty	X	X	X				X	X	X

3. METHODOLOGY

3.1. IDENTIFICATION OF UNCERTAINTIES IN VARIOUS PHASES OF PPP PROJECTS

Interactions were carried out with 14 professionals from all stakeholder groups who work or have worked in transport PPP projects in India to take their views and the superset arrived at from the literature was further refined and validated for Indian context. During the interaction a few uncertainties, viz., Uncertainty in change of public needs, Tenor and refinancing uncertainty and Resource uncertainty were proposed and included in the superset. A proposed classification of forty uncertainties evolved as a result of this exercise is presented in Table 3.

Table 3: Classification of Uncertainties

Uncertainty type	Uncertainties	Uncertainty type	Uncertainties
Demand uncertainty	Demand uncertainty	Financial uncertainty	High finance costs
	Project data and demand assessment		Market uncertainty
	Uncertainty in change of public needs		Poor financial market
Public uncertainty	Political and Regulatory uncertainty		Revenue uncertainty
	Poor public decision-making		Financial uncertainty
	Planning uncertainties		Payment uncertainty
	External linkages		Inflation uncertainty
	Project exclusivity		Currency exchange
	Expropriation and Nationalization uncertainty		Insurance uncertainty
	Sponsor uncertainty		Tenor and refinancing uncertainty
Clearances uncertainty	Contractual uncertainty	Private uncertainty	Cost uncertainty
	Approvals uncertainty		Completion uncertainty
	Social uncertainty		Design uncertainty
	Environmental uncertainty		Construction uncertainty
	Delays in land acquisition		Insolvency of concessionaire
Force majeure Uncertainty	Additional site uncertainty	Technical uncertainty	Operators uncertainty
	Force majeure		Technical uncertainty
Operation and maintenance uncertainty	Performance uncertainty	Handover uncertainty	Technology uncertainty
	Operations uncertainty		Handover uncertainty
	Maintenance uncertainty		Terminal value uncertainty

To extract the perceptions of various stakeholders on PPP Uncertainties, the above superset was brought under four different phases of a PPP project, viz., project development, construction, operation and hand over phase. This was again validated and, wherever necessary, modified with the support of 9 PPP experts with adequate experience and exposure to PPP projects to review the comprehensiveness of these uncertainties. A total of 8 uncertainties in project development phase, 16 in construction phase, 23 in operation phase and 7 handover uncertainties, totaling to 54 uncertainties, were assimilated at the end of this exhaustive exercise. These uncertainties that can unfold in various phases of a PPP project are presented in Table 4. Successively a questionnaire survey was conducted among public sector, private investors, consultancy firms, academia and financiers to evaluate the criticality of the identified uncertainties.

Table 4: Uncertainties in Various Phases of PPP Project

Sl. No.	Project development phase uncertainties	Sl. No.	Operation phase uncertainties	Sl. No.	Handover uncertainties
1	Delays in land acquisition	1	Performance uncertainty	1	Handover uncertainty
2	External linkages	2	Operations uncertainty	2	Terminal value uncertainty
3	Project exclusivity	3	Maintenance uncertainty	3	Sponsor uncertainty
4	Project data and demand assessment	4	Demand uncertainty	4	Technical uncertainty
5	Poor public decision-making	5	Environmental uncertainty	5	Technology uncertainty
6	High finance costs	6	Social uncertainty	6	Environmental uncertainty
7	Market uncertainty	7	Market uncertainty	7	Social uncertainty
8	Planning uncertainties	8	Revenue uncertainty		
Sl. No.	Construction phase uncertainties	9	Financial uncertainty		
1	Design uncertainty	10	Inflation uncertainty		
2	Construction uncertainty	11	Currency Exchange		
3	Cost uncertainty	12	Technical uncertainty		
4	Approvals uncertainty	13	Technology uncertainty		
5	Additional Site uncertainty	14	Insurance uncertainty		
6	Completion uncertainty	15	Political and Regulatory uncertainty		
7	Environmental uncertainty	16	Expropriation and Nationalization uncertainty		
8	High finance costs	17	Force Majeure		
9	Poor financial market	18	Operators uncertainty		
10	Social uncertainty	19	Sponsor uncertainty		
11	Political and Regulatory uncertainty	20	Contractual uncertainty		
12	Expropriation and Nationalization uncertainty	21	Uncertainty in change of public needs		
13	Force Majeure	22	Resource uncertainty		
14	Sponsor uncertainty	23	Tenor and Refinancing uncertainty		
15	Insolvency of concessionaire				
16	Contractual uncertainty				

3.2. DATA COLLECTION AND ANALYSIS

In the questionnaire survey the experts were requested to respond to a five point Likert scale with respect the severity of the impact of different uncertainties in various phases of the project. Online survey software QuestionPro was used to distribute the survey and collect the perceptions of stakeholders with experience in handling PPP road infrastructure projects. A total of 285 stakeholders from five sectors were reached out to understand their perceptions on the various uncertainties PPP projects face and 62 responses were received, of which 55 were found to be complete and valid (response rate 19.3%). These were respondents from public sector (20.09%), private (16.36%), consulting firms (21.82%), academia (18.18%) and financiers (14.55%) with a minimum of five years of experience in PPP projects.

Response data was analysed using IBM statistical package SPSS21 software. Initially descriptive statistics such as mean and standard deviation was used. This was followed by Kendall's concordance test, (Kendall's W), Kruskal-Wallis test and Mann-Whitney U test. Kendall's concordance analysis was done to test the level of consistency of the perceptions of five stakeholder groups on the uncertainties listed out in the four phases of PPP project. The mean score ranking analysis was also conducted to ascertain the relative importance of each uncertainty from the perspective of each group of stakeholders. Finally, to investigate the significant

differences on the perceptions of various uncertainties among people from public sector and private consortia, consultants, academicians and financiers the Kruskal –Wallis test was conducted. Further a post-hoc analysis was conducted using the Mann–Whitney U test to understand, where the significant differences in perception lie between the stakeholders from different sectors.

4. RESULTS AND DISCUSSION

As PPP projects are long term, with limited project information, and have different stakeholders than a normal construction project, uncertainties could creep in as new project information's are available. This study has identified all possible uncertainties from project development phase to hand-over and aims to bring out the perception of various stakeholders on these uncertainties. Along with identifying the uncertainties perceived and addressed properly by the stakeholders over a period of time, the exercise will further enable the stakeholders to concentrate on those uncertainties which need to be addressed from now on while developing projects so that projects are undertaken and operated stably leading to sustainability of PPPs.

4.1. TESTS ON AGREEMENT OF RESPONSES

The Kendall's concordance test was done to assess level of agreement/disagreement between stakeholder groups about their perceptions on the severity of impact of uncertainties that may manifest during the various phases of PPP projects. Test was performed at a significance test value of 0.05.

The test was taken with a null hypothesis that "there is no consistency in the perceptions given by the experts". W can range from 0 to 1, where a value close to 1 indicates a strong agreement between the respondents and close to 0 indicates strong disagreement. However, Kendall's W test is suitable only when the number of elements (N) is less than 7 as put forth by Siegel and Castellan (1988). However, if N is greater than 7, chi-square (χ^2) test should be the best option. This suggests that the chi-square value should be referred to rather than W (Osei-Kyei & Chan, 2017). The computed chi-square values on the perceptions of uncertainties in all four phases by the five stakeholder groups exceeded the critical value of chi-square (9.49) in all cases. This required that the null hypothesis be rejected for the five groups, suggesting that there is consistency in the ratings by experts within each group. This also reaffirmed the validity of the survey responses for further analysis.

4.2. MEAN SCORE RANKING OF UNCERTAINTIES

The mean score analysis and rankings of various uncertainties in different phases by the stakeholder groups was done. Wherever mean values were the same, the one with lower variance was ranked higher. There were wide variations observed in the mean rankings among various stakeholder groups for certain uncertainties. At the same time their perceptions with regard to the criticality of certain uncertainties matched very well.

Among the eight uncertainties identified in the project development phase the ones that are considered as critical by people from all five sectors are Market uncertainty, Project data and demand assessment and delays in land acquisition. This could be due to the robustness of the markets reflects in the proactive participation of private sector in PPP projects. Project data and demand assessment faces a vital role as base data and demand forecasts have seldom proved to be less than accurate (Flyvbjerg et al., 2003) and reflects adversely on the project. Indian PPP projects used to be delayed due to issues in land acquisition and had a negative connotation on projects' timely completion and commencement of operation.

Among the construction phase uncertainties, completion uncertainty has been perceived as most crucial to the project by all respondents. High finance cost has been ranked second by private, consultants, academicians and financiers and has been ranked fourth by the public. Additional site uncertainty has been positioned third by all, except by the financiers. As the projects get implemented there will be a number of unaccounted but minor issues that may pop-up, for e.g. a pipe-burst, which has potential to stall the construction. These have to be identified and addressed adequately facilitating the completion of the construction. This could also be read with the third uncertainty for additional site to circumvent such challenges. As finance comes at a cost any delay in construction and commencement of operation will strain the debt servicing and hence this will be of concern to investors and financiers.

Demand uncertainty, performance and uncertainty in change of public needs can be considered as crucial in the operation phase of PPP projects and handover uncertainty, terminal value uncertainty and technology uncertainty can be considered critical from among the seven handover uncertainties. PPP projects are developed based on the demand to address a particular gap in the infrastructure. Demand forecasts have proved to be less than accurate (Flyvbjerg et. al., 2003), and this could affect the project especially the project cash flows and debt servicing. Project performance delivering the desired service including quality of construction and of service delivery is a challenge during the operation stage. PPP projects are long-term and have sunk-in costs (Ubbels & Verhoed, 2008) designed to address a particular gap in infrastructure. With time, along with progressive development initiatives and technological advancements, there is a possibility of change in the public needs, which could affect the project. As the project has to be handed over at the end of the agreement period, the process, procedures and compliances should be in place for the same. However, as the project periods are particularly long, no such procedures and compliances exist. Procedure for identification of the terminal value and addressing the technological obsolescence are also unpredictable during the project development/operation stage.

4.3. SIGNIFICANT DIFFERENCES IN THE PERCEPTIONS OF UNCERTAINTIES AMONG STAKEHOLDERS

From the 54 uncertainties grouped in four phases, the stakeholders have consensus on 28 uncertainties. In other words, since the inception of PPP projects in India, in mid-1990s, the stakeholders have arrived at a general understanding on these uncertainties. Difference still exists on many other uncertainties and the stakeholders have to address those to make PPP projects sustainable. Opinions differ in part not only because each group of interviewees have different objectives, but also because each has a different vision of what PPPs should achieve. During the survey and while undertaking the analysis, wherever perceptions differed among stakeholders are discussed in the sections 4.3.1 to 4.3.4.

4.3.1. DIFFERENCES IN PERCEPTION OF UNCERTAINTIES AMONG STAKEHOLDERS IN PROJECT DEVELOPMENT PHASE

The Kruskal – Wallis test was performed for the project development phase, helped examine whether the differences in perceptions of stakeholders are statistically significant or not. The test results indicate that among the eight uncertainties that can manifest in the project development phase, there exist significant differences in the perceptions of the stakeholder groups with regard to the five uncertainties as their p -values are less than 0.05.

Among the 16 construction phase uncertainties, five uncertainties present significant difference in perceptions of stakeholders as regard to their criticality. These are cost uncertainty, completion uncertainty, poor financial market, political and regulatory uncertainty and sponsor uncertainty. Twelve among twenty three uncertainties in the operation phase and four among seven handover uncertainties have significant differences in the perceptions of the stakeholders. Kruskal – Wallis test results only established which among the various uncertainties are statistically different as per the perceptions of the stakeholders. This test did not reflect where the significant differences lie between the stakeholders.

Mann- Whitney U test was conducted subsequently to understand, between which set of stakeholders do perceptions differ. The test was done at recalculated alpha value of 0.01(0.05/5). The test was done on the five uncertainties in project development phase which showed significant differences in perceptions of stakeholders' viz., project data and demand assessment, poor public decision making, high finance costs, market uncertainty and planning uncertainties. The test results of ten pair wise comparisons done between five stakeholder groups on these uncertainties showed that there are differences in opinions between certain stakeholder groups.

With respect to project data and demand assessment uncertainty there existed notable difference in perception of public against other stakeholders. As far this uncertainty is concerned, the rest of the stakeholders run a high uncertainty on the base data and the demand projections based on which the entire project stands. Any change in the data and demand assessment will directly reflect in the operational sustainability of the project.

Difference in perception exists between public and private as well as public and consultants in poor public decision making uncertainty as the latter expect some non-reliability on the public's decisions on the project.

Opinion differ on financing costs between private and academicians, as private may have critical and first hand understanding of the intricacies of financing and cost involved in mobilizing and servicing the finance.

Private, Consultants and financiers have higher impacts due to market uncertainty which will ultimately generate lesser interests in bidding and/or difficulty in financial closure of the project. This was reflected in the difference in mean ranking between the three stakeholders and public. Akin, the consultants and financiers have a higher and first hand understanding on market uncertainty than academicians as they work in the cutting edge of PPP projects.

Private and financiers are meticulous in planning the development and implementation of PPP projects addressing all possible avenues of uncertainties making them more efficient in the field, where as academicians might be process oriented and extends more emphasis on in-house planning exercises than other stakeholders. This might be the reason for difference in perception between Academicians and financiers on planning uncertainties.

4.3.2. DIFFERENCES IN PERCEPTION OF UNCERTAINTIES AMONG STAKEHOLDERS IN CONSTRUCTION PHASE

Mann Whitney test on uncertainties in construction phase was done where Kruskal Wallis test results indicated significant differences in perceptions of stakeholders.

In the construction stage, significant variations in perception were observed among stakeholders in cost uncertainty, completion uncertainty and poor financial market. In cost uncertainty there was variation between private and consultants as well as consultants and financiers. The variation between private and consultants could be because the financiers have hands-on and on-the-field knowledge on the cost implications of the projects as well as the possible over-runs that can creep in during the construction phase than consultants who generally works on thumb rules. In consultant verses financiers, financiers with a higher mean rank have a better understanding on cost uncertainties than consultants. Learnings accrued from previous experiences in change in cost during the construction phase can be attributed to this understanding by the financiers.

Between public and consultants, consultants are more hands-on with the project and thereby are more aware of project and construction related challenges. They interact more with project stakeholders and also have analyzed construction operations in associated locations and this is depicted in the higher mean rank of consultants in completion uncertainty.

With respect to poor financial market uncertainty, mean ranking of Public is low and there exists significant difference in perception of public with all other stakeholders. In all the cases, p-value is less than the significant test value of 0.01. The difference between public and private could be such that private investor invariably works in line with the financial market and funds are available at attractive rates only when financial markets are good. On the contrary, funds will be costly in poor markets scenario limiting the private sector to take up PPP projects, whereas public may be more concerned on the timely completion of the project.

Reason for difference in perception between public and consultant can be attributed to consultant's interaction with the private sector as well as financiers to elicit and identify their interests on projects which makes them more aware of the projects affinity toward the financial market trends. With robust financial trends, the consultants will be confident on the number of players for the bidding process. The variation between public and academicians could be possibly due to academician's critical emphasis on better financial markets against the evidences on poor interests in bidding for PPP projects during poor financial markets. The public sector, on the other hand, will be interested only on timely completion of the project and may not be interested on the source of funds. Significant difference on ranking of 'poor financial market uncertainty' between public and financiers can be attributed to less availability of cheap finance during poor markets for deployment for construction of the project and hence financiers see it as a major uncertainty.

4.3.3. DIFFERENCE IN PERCEPTION OF UNCERTAINTIES AMONG STAKEHOLDERS IN OPERATION PHASE

Of the twelve uncertainties identified during the operation phase, seven of them viz., demand uncertainty, market uncertainty, revenue uncertainty, financial uncertainty, technical uncertainty, technology uncertainty, resource uncertainty and, tenor and refinancing uncertainty yielded significant differences during pair wise comparison during Mann Whitney test.

Between public and academicians, academicians may have extended more weight to demand uncertainty on the possible academic evidence that demand has a positive correlation in the operating phase leading to operating cash flows and debt servicing keeping the project on track. Private must have extended more weightage to market uncertainty because they are more involved in the sector and hands-on with the market trends than the academicians. Between consultants and academicians, consultants must have perceived market uncertainty as critical since they are more involved with the sector developments and connected trends while developing projects than the academicians.

In public verses consultants, consultants consider higher revenue uncertainty as crucial because revenue (as well as cash flows) is required to keep the project performing and hence they would have looked into various options of revenue other than fare box collections. With adequate avenues of revenue, the consultants make sure that the project will be a profitable venture. Mann Whitney pair wise comparison between private and academicians on revenue uncertainty yield a higher mean ranking for the private. This could be because the private sector may be aware of the fact that the fare box collection will not be sufficient to keep the project performing and to service the debt, and hence need alternate sources of income. Therefore, private will rate revenue uncertainty at a higher scale, whereas academicians will be looking at service delivery of the project. Mean ranking for revenue uncertainty of consultants is higher than the academicians. This could be because they will be in pursuit for making the project financially viable and hence will be looking at additional revenue streams along with fare box collections.

For financial uncertainty a comparison of public and private indicated that the private sector has prioritized financial uncertainty since it has a direct correlation on operation of the project and especially in the alternate and additional revenue streams helping them in debt servicing and proper Operation and Maintenance of the project. With respect to technology uncertainty when compared to public mean rank obtained for private, consultants, academicians and financiers are higher. This might be due to the reason that private, consultants, academicians and financiers might have associated more weightage to technology uncertainty as technology can be obsolete over a period of time and can affect the project adversely especially the operational efficiency. In other words, public may look at satisfactory operation of the project while the rest of the stakeholders placed emphasis on the operational efficiency of the project.

Resource uncertainty had a lower mean rank by the public, compared to that of the private sector. This implies that the private sector rated the resource uncertainty far higher than the public. The private must have considered that resources are vital for efficient and effective operation of the project which can result in superior service delivery along with operational profits and debt servicing.

As far as tenor and refinancing uncertainty is considered significant difference in ranking was observed between public and consultants. A possible reason for this may be because, consultants keeps the options open for tenor and refinancing if the project runs into some trouble during its operations, whereas the public expects the project to be stand-alone from day one of operations.

4.3.4. DIFFERENCE IN PERCEPTION OF UNCERTAINTIES AMONG STAKEHOLDERS IN HANDOVER PHASE

Kruskal Wallis test results brought out that significant difference existed in four out of seven uncertainties. p-values obtained was less than 0.05 for terminal value uncertainty, technology uncertainty, environmental uncertainty and social uncertainty. To find out where these differences lay Mann Whitney test was carried out.

Between public and private, public and consultants, public and financiers, people from the private sector, consultants and financiers consider terminal value uncertainty to be significant. This might be because there could be situations of default, expropriation or a force majeure, so as to cover the losses and other commitments the project has committed. There is a significant difference in mean ranking between academicians and financiers with financiers extending a high priority to terminal value uncertainty. Financiers with their practical knowledge and understanding in managing similar projects would have prioritised terminal value at a higher ranking than academicians, who would look for the framework and process for assessing terminal value.

For technology uncertainty, pair wise comparison results of public and consultants, public and academicians and public and financiers indicate that consultants, academicians and financiers have prioritised technology uncertainty, may be because technology can become obsolete over a period of time and can affect the project adversely. While public may be more concerned with handover of a project which is operational the rest of the stakeholders may emphasise upon the operational efficiency.

5. SUMMARY

The present study has identified 40 uncertainties associated with PPP projects in an endeavour to address them while developing future initiatives. These uncertainties were then grouped under the four phases of the PPP project and with some of them found to manifest in more than one phase a total of 54 uncertainties are listed and analysed in this study. The perceptions of stakeholders on these uncertainties associated with Indian PPPs were received through a questionnaire survey. The data was used to identify uncertainties which the stakeholders consider as critical to the project life cycle. Of the 54 such uncertainties across the phases, for which perceptions were analysed, it was found that stakeholders were in thorough consensus for 53 percent of the uncertainties. This implies that the stakeholders must have arrived at a general understanding on these uncertainties since the inception of PPP projects in India. For the remaining 47% of the uncertainties, analysis was further done to determine those stakeholder groups' who differed in their perception on the criticality of uncertainties. This was carried out in an attempt to reason out the causes for difference in perceptions between stakeholders. Opinions differ in part not only because each group of interviewees have different objectives, but also because each has a different vision of what PPPs should achieve. Nevertheless, narrowing down these differences in opinion on uncertainties will significantly help effective implementation of the uncertainty management strategies leading to sustainable PPPs. In addition, the comprehensive list of the uncertainties brought out in this paper validated by the experts in this field through their experience gained in managing PPP projects in India over the past two decades, when given due consideration while developing Concession Agreements in future will help to institutionalise addressing these unknown unknowns as well as keep the project officers prepared to meet unforeseen situations.

6. REFERENCES

- Athias, L. and Saussier, S., 2007. Un partenariat public-privé rigide ou flexible? *Revue économique*, 58(3), 565-576.
- Cardin, M., 2013. Enabling Flexibility in Engineering Systems: A Taxonomy of Procedures and a Design Framework. *Journal of Mechanical Design*, 136(1), 11005.
- Cleden, D., 2009. *Managing Project Uncertainty*. Farnham, UK: Gower Publishing Limited.
- Cruz, C.O. and Marques, R.C., 2013. Flexible contracts to cope with uncertainty in public-private partnerships. *International journal of project management*, 31 (3), 473-483.
- Dean J., 1951. *Managerial Economics*, Prentice Hall, New York.
- De Neufville, R., 2008. Low-Cost Airports for Low-Cost Airlines: Flexible Design to Manage the Risks. *Transportation Planning and Technology*, 31(1), 35-68.
- Demirel, H.C., Leendertse, W., Volker, L. and Hertogh, M., 2017, Flexibility in PPP contracts-dealing with potential change in the pre-contract phase of a construction project. *Construction Management and Economics*, 35 (4), 196-206
- Dequech, D., 2000. Fundamental uncertainty and ambiguity. *Eastern Economic Journal*, 26, 41-60.
- Domingues, S., Zlatkovic, D. and Roumboutsos, A., 2014 Contractual Flexibility In Transport Infrastructure PPP. Association for European Transport Conference. 1-18
- Floricel, S. and Miller, R., 2001. Strategic systems and templates. In: *The Strategic Management of Large Engineering projects*, Miller, R. and Lessard, D. (eds.). MIT Press, Cambridge, MA.
- Flyvbjerg, B., Bruzelius, N. and Rothengatter, W., 2003. *Megaprojects and risk*. Cambridge: Cambridge University Press.
- Grote, G., 2015. Promoting safety by increasing uncertainty – implications for risk management. *Safety Science*, 71, 71-79.
- Hart, O., 2003. Incomplete contracts and public ownership: Remarks, and an application to public-private partnerships. *The Economic Journal*, 113(486).
- Keynes, J. M., 1937. The general theory of unemployment. *Quarterly Journal of Economics*, 51, 209-223.
- Knight F. H., 1964. *Risk, uncertainty and profit*. Augustus M. Kelley: New York.
- Koppinen, T. and Rosqvist, T., 2010. Dynamic Project Portfolio Selection in Infrastructure Sector. In Brown, K, Willett, R and Mathew, J (eds.) (2010) "Definitions, concepts and scope of engineering asset management", Springer. London: Springer.

- Lessard, D. R. and Miller, R., 2001. The strategic management of large engineering projects: shaping institutions, risks and governance. MIT Press, Cambridge, MA
- Love, P.E., Holt, G.D., Shen, L.Y., Li, H. and Irani, Z., 2002. Using systems dynamics to better understand change and rework in construction project management systems. *International journal of project management*, 20(6), 425-436.
- Mahalingam, A. and Seddon., 2015. Designing for change: Flexibilities in infrastructure PPPs Version: August 14, 2015. 1-31
- Mentis, M., 2015. Managing project risks and uncertainties. *Forest Ecosystems*.
- Milliken, F. J., 1987. Three types of perceived uncertainty about the environment: state, effect, and response uncertainty. *Academy of Management Review*, 12(1), 133-143.
- Mintzberg, H., 1994. The rise and fall of strategic planning. Preconceiving roles for planning. New York: The Free Press.
- Osei-Kyei, R. and Chan, A. P. C., 2017. Perceptions of stakeholders on the critical success factors for operational management of public-private partnership projects. *Facilities*, 35 (1/2), 21-38.
- Perminova, O., Gustafsson, M. and Wikström, K., 2008. Defining uncertainty in projects—a new perspective. *International Journal of Project Management*, 26, 73-79.
- Perminova, O., 2011. *Managing Uncertainty in Projects*. Abo Akadem University Press, Abo.
- Rice, M. P., O'Connor, G. C. and Pierantozzi, R., 2008. Counter Project Uncertainty. MIT Sloan Management Review, Winter, 54-62.
- Sakhrani, V., Alsaati, A. and De Weck, O., 2013. Modeling the Dual-Domain Performance of a Large Infrastructure Project: The Case of Desalination, 1315-1323.
- Sanderson, J., 2012. Risk, uncertainty and governance in megaprojects: a critical discussion of alternative explanations. *International Journal of Project Management*, 30(4), 432-443.
- Saunders, F., 2016. Differentiating between Risk and Uncertainty in the Project Management Literature, 1-9.
- Siegel, S. and Castellan, N. J., 1988, *Nonparametric Statistics for the Behavioural Sciences*, 2nd ed. McGraw-Hill, New York.
- Sicotte, H. and Bourgault, M., 2008. Dimensions of uncertainty and their moderating effect on new product development project performance. *Research and Development Management*, 38, 468- 479.
- Thunnissen, D. P., 2003. Uncertainty classification for the design and development of complex systems. *3rd Annual Predictive Methods Conference*, June, Newport Beach, California.
- Ubbels, B. and Verhoed, E.T., 2008. Auctioning concessions for private roads. *Transportation Research Part A* 42 (1), 155-172.
- Wallack, J. S. and Singh, N. K., 2011. Moving India: The Political Economy of Transport Sector Reform. In *Stanford Center for International Development Sixth Annual Conference on Indian Economic Reforms*. Stanford, CA.
- Wang, T. and De Neufville, R., 1984 Identification of Real Options “in” Projects. 1- 10.
- Williamson, O. E., 1996. *The Mechanisms of Governance*. Oxford University Press.
- Zheng, H. and De Carvalho, M. M., 2016. Managing uncertainty in projects: a review, trends and gaps. *Revista de Gestão e Projetos – GeP*, 7 (2), 2236-0972.