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Research Article

A Study of Risk Perceptions in Development of Power Projects in India

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Abstract

Infrastructure, both physical and digital, has been key growth drivers of the economy. They are not only capital intensive but also fraught with numerous uncertainties and risks. The requirement of power is the primary building block of any infrastructure development. Taking cognizance of the numerous stranded power projects in the country there is a vital requirement to establish an effective risk management in power projects.

A research work was undertaken with a view to study the critical risks which have an impact on the power projects and thermal power plants in particular. The expert views of the power plant professionals were utilized to arrive at the list of risks and suitable mitigation measures against the risks were formulated. It is observed that, numerous power plants have failed owing to lack of mitigation measures deployment during design and implementation stage.

A comprehensive list of 67 risks was prepared and grouped under design, construction, financial, legal, procurement, regulatory and safety risks. Along with the risks, suitable mitigation measures were also prepared. The respondents were asked to rate the risks along the lines of probability and its impact using online questionnaire. Likewise, the respondents were asked to rank the risk mitigation action. An option to identify additional risks and mitigation actions from their experience was also given to the respondents. Analysis was carried out to identify whether there are any differences in the perceptions of the risk potential of the critical risk factors and the importance of risk mitigation measures amongst the different groups power sector professionals. Taking into view of extensive research carried out under the study, the results would serve as a useful guide with its list of risks and the mitigation measures.

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Keywords: *Power projects, Risk management, Hypothesis testing, Risk perception, Factor Analysis*

Introduction

There is a considerable significance of elasticity between energy and GDP growth. A small percent of growth in energy sector cascades into a larger impact on the economic growth of the country. India ranked 68th globally competitive country out of 141 countries in a report published by World Economic Forum. In terms of infrastructure the rank dropped even lower to 70th rank. In terms of Non Performing Assets (NPA), the country's rank fell drastically to 106th Rank. This indicates a severe stress in the sector and points to erosion in the competitiveness. Hence taking cognizance of the acute distress in the sector, the study was undertaken to comprehend the prevailing scenario in the Indian power sector and the risks encountered in power projects. The study discussed various risks involved in development of power projects and thermal based power plants in particular. The expert views were sought to evaluate the risk perceptions and critical risk factors that influence the completion of the power plants. The risk mitigation strategy to counter the risks was formulated for early completion of the projects.

It takes about four to five years of gestation period to setup a large conventional power plant and is intricately interwoven with a lot of procedures and regulations. Usually a lot of risks crop up during the construction of the power plant and the risks have to be anticipated and suitably addressed by the project managers. The risk responsibility resolution matrix needs to be in place such that, the risks are mitigated at the suitable level and at an appropriate time. Thus the risk management is an integral part of power projects development.

Literature Review

Sharma & Kar (2018), discovered that, the land aquistion and Resettlement & Rehabilitation were indentified as the most important risks in hydro-electric projects. (Pillai & Kannan, 2002) in their study of time and cost overrun of power porjects in Kerala found that, corruption and labour unrest as the most significant risk. (Batool & Abbasa, 2017) studied the Hydro Power Projects in Pakistan. It was seen that, political reasons, cash flow, improper site investigation and bad Law and order situations are the reasons being delay in Hydro Power projects.

Arya & Kansal, (2016), studied the causes that which lead to construction delays. The top ten delay factors identified are late progress payment, financial problems of owner, improper estimate of quantities, poor qualification of contractor team, poor terrain condition, conflict between contractor and consultant, poor site management, lack of involvement of design team during construction, delay in obtaining permits, and disturbance from public activities. **Kakati & Baruah (2016),** identified revenue generation, demand risk, financial risk, delay in land acquisition, debt servicing repayment, delay in financial closure, geographical/location risk, O&M risk, resettlement & rehabilitation and completion risk as the critical risks in PPP projects.

Muhwezi, Acai, & Otim (2014), used Rrelative Importance Index (RII) to assess the factors that led to delays and the impact it had on the building construction projects in Uganda. (1) delay in assessing changes in the scope of work by the consultant; (2) financial

indiscipline/dishonesty by the contractor; (3) inadequate contractor's experience; (4) design errors made by designers; (5) inadequate site investigation by the consultant were identified as the key significant factors that led to the construction delays. Several such studies have been carried out by researchers across the world on subjects pertaining to infrastructure projects.

Shanmugapriya & Subramanian (2013), highlighted Material market rate, Contract modification, High level of quality requirement, Project location, Change in material specification, frequent breakdown of the construction plant and equipment and Lack of coordination at design stage as the causes of delay.

	Risk Factor	BNEF Report (2013)	David de Jager et. Al (2011)	Marsh(2004 & 2006)	Yati Md Lasa et al (2017)	Gholamreza Dehdasht et al	Jianna Zhao et al.	L. Y. Shen et al.	AMANI SULIMAN BU-QAMMAZ	Dr. B.Vidivelli et al.	Huiru Zhao and Nana Li	Agnieszka Dziadosz, Mariusz Rejment	Esther Cheung, Albert P.C. Chan	No of Mentions
	Location:	Global	Germany	USA	Malaysia	Global	China	China	Turkey	India	China	Poland	China	
1	market risk	■	■	■				■	■		■		■	**7**
2	Regulatory risk			■	■								■	**3**
3	Social Acceptance										■			**1**
4	Grid integration risk													**0**
5	Counter party risk			■										**1**
6	Financial sector risk			■	■	■		■			■			**5**
7	Political risk		■	■	■	■	■		■	■				**7**
8	Currency/ macroeconomic		■		■								■	**3**
9	Construction risk	■		■	■	■	■		■	■			■	**8**
10	Company risk				■					■			■	**3**
11	Environmental risk					■	■							**2**
12	Operational/ Management	■					■		■	■	■	■	■	**7**
13	Design/Technology risk		■	■		■	■	■		■	■	■		**8**
14	Sabotage, terrorism and													**0**
15	Developmental Stage Risk		■				■					■		**3**
16	Commercial Risk			■	■								■	**3**
17	Policy Risk	■	■		■	■		■			■			**6**
18	Weather related risk			■			■			■	■			**4**
19	Legal/Contractual Risk			■		■		■	■	■	■		■	**7**

Sector : Construction, Power, Renewable Energy. Collated by the author.

Table-2.1 : Summary of risks identified by researchers

Research Methodology

The said study on risks in development of the power projects is explorative in nature. The critical risks that would impact the success of the power project and in turn the return on investment were identified. The key mitigation measures to handle the risks were identified with the assistance of the practitioners. The study also focused on identification of additional risks and mitigation measures for further research.

The study covered the lifecycle from Concept to Commissioning of the power plant. Broadly the study analyzed the critical risk factors that impact on the completion of the power plant and suitable mitigation measures to address the same were formulated. Hypotheses were formulated by utilizing the literature survey drawing from the experience of wide national and international research works. The hypothesis was tested subsequently based on the survey conducted among experienced power sector professionals.

A list of risks and mitigation measures was prepared with the aid of literature survey and authors own experience. The same was reviewed by the experts and subsequently, a total of 67 risks were identified for incorporation in the survey. The risks were categorized under 7 categories. The list is given in Table-3.1. Along with the risks, 15 risk mitigation measures were also identified as in Table-3.2. The same were incorporated in the survey.

For each of the 67 risks, the respondents were asked to rate the probability of occurrence of the risk or the risk frequency on a Likert scale of 1 to 5. Similarly, the respondents were also asked to rate the impact of the risk, if it occurs, on the cost and time aspects of the project on a scale of 1 to 5. Additionally, the respondents were asked to identify five risks which in their opinion need to be included in the risk management framework. The additional risks were also scored on a scale of 1 to 5 for probability of occurrence and their impact. The respondents were asked to rate the importance of each mitigation measure on a scale of 1 to 3. The respondents were also asked to list ten additional mitigation measures which are very important based on their own experience.

Table 3.1 List of risks identified for the survey

Design Risks	Construction Risks	Financial Risks	Legal Risks	Procurement Risks	Regulatory Risks	Safety Risks
D.1 Incomplete or inaccurate cost estimate	C1. Tight project schedule	F.1 Price inflation of construction materials	L.1 Occurrence of disputes/litigation	P.1 Equipment quality/Defective manufacturing of main components of the plant	R.1 Excessive approval procedures in administrative government departments/ Bureaucracy of government	S.1 General safety accident occurrence
D.2 Inadequate or insufficient site information/investigation	C.2 Inadequate project scheduling	F.2 Fluctuation in interest rates	L.2 Labour strike/disputes	P.2 Material Delivery	R.2 Serious noise pollution caused by construction	S.2 Natural disasters/ adverse environmental conditions

D.3 Improper project feasibility study	C.3 Making variations in construction program	F.3 Low credibility of shareholder & lender	L.3 Land acquisition	P.3 Material shortage	R.3 Delay in permits and licenses	S.3 Material theft & damage
D.4 Time constraint (Too little time is provided for design and estimation)	C.4 Low management competency of sub-contractors	F.4 Change in bank formalities and lenders	L.4 Resettlement & rehabilitation	P.4 New technology	R.4 Changes in laws and regulations	S.4 Accidents during commissioning
D.5 Inadequate design due to improper selection of consultants/engineering team	C.5 Site location	F.5 Insurance Risk	L.5 Pollution and safety rules	P.5 Nominated vendors/poor supplier base	R.5 Political conflicts	
D.6 Incomplete specifications	C.6 Design changes)	F.6 Payment delay/Invoice delay	L.6 Bribery/Corruption	P.6 No past experience in similar project	R.6 Fuel allocation risk	
D.7 Effect on terrestrial flora & fauna which can impact the design freedom	C.7 Change in top management	F.7 Owner financial capacity/Paucity of funds/Funding risk	L.7 Law and order/social unrest	P.7 Short tender time	R.7 Environmental clearances.	
D.8 Poor design for construction	C.8 Quality of work	F.8 Tax rate/Exchange rate variation	L.8 Lack of enforcement of legal judgment/Uncertainty and unfairness of court justice	P.8 Type of contract	R.8 Change in fiscal schemes	
	C.9 Damage of major equipment	F.9 Market risk/ Reduction in Power Demand/ Economic crisis: Impact on energy consumption	L.9 Local laws/customs	P.9 Improper verification of contract document	R.9 Change in policy	
	C.10 Contractual risks	F.10 PPA Risk	L.10 Right of way issues	P.10 Order of wrong specifications from manufacturers		
	C.11 Linkages of	F.11 Financial		P.11 Contractors		

	rail, road, water, fuel and power evacuation	market instability/Credit risk		capacity		
	C.12 Force-majeure conditions	F.12 Financial Closure		P.12 Obsolescence of infrastructure		

Table 3.2: List of risk mitigation measures identified

List of Mitigation Measures	
MA.1 Talent Management/Human resource Management	MA.9 Hedging against interest rate/exchange rate variations
MA.2 Completion of land acquisition in the early stages of project	MA.10 Skilled project management
MA.3 Signing of PPA prior to financial closure/commencement of construction	MA.11 Careful selection of vendors/partners
MA.4 Deploying exclusive teams for liasoning with regulatory and Government authorities	MA.12 Good Quality Management
MA.5 Integrated risk management in the project organization	MA.13 Deploying an effective communication system among all stakeholders
MA.6 Making suppliers/vendors equity partners	MA.14 Continuous monitoring of risks identified and looking out for new risks
MA.7 Transferring risk to other parties through contracts/agreements/insurance	MA.15 Develop a process to escalate issues correctly to enable quick resolution of issues
MA.8 Environment management	

3.1 Sampling and Data Collection

As per the National Electricity Plan 2018 published by Government of India, the total technical manpower available in power generation sector is around 1,75,000. Assuming 10 percent are involved in project development, the population size is around 17,500. Considering a population size of 17500, the representative sample size is evaluated as 265 based on the method developed by Krejcie & Morgan (1970).

The survey questionnaire was developed online using the Google Forms tool. The questionnaire was forwarded to power sector professionals with differing backgrounds in order to capture the perceptions holistically. More than 500 professionals were approached for taking the survey and at the closing of the survey, 319 responses were received. After

cleaning the data, 310 valid responses were recorded which satisfies the minimum sample size for representing the population.

The details of respondents are summarized in Table-3.1.1. The respondents are a group with a good mix of managerial capabilities which is beneficial for the research study and can present a truthful picture of the risk perception at across the different management levels.

Table 3.1.1 Background details of survey respondents

1) Position in the Organization			
Category	Top management/Strategic decision making	Senior Management/Project In-charge	Line Manager
Percentage	27.7	49	23.3
2) Educational Qualification			
Category	Graduate	Post graduate	Doctorate
Percentage	47.7	47.7	4.6
3) Number of years of work experience			
Category	Less than 10 years	10 to 20 years	20 to 30 years	More than 30 years
Percentage	2.9	22.6	33.9	40.6

4) Type of organization								
Category	Project Developer	Lender/ Financial Institution	EPC Contractor	Government authority/regulatory authority	State Utility	Social Sector/ NGO	Project Engineering Consultant	Others
Percentage	19.0	1.9	23.5	5.2	9.4	1.0	14.5	25.5

5) Type of projects					
Category	Coal based power projects	Renewable Energy Projects (Solar/Wind)	Gas based Power Projects	Combination of all three projects	Others
Percentage	35.5	3.9	1.3	31.9	27.4

Data Analysıs

Reliability of the measurement scale was verified before data analysis. Cronbach's Alpha is the most common measure of scale reliability. The Cronbach Alpha statistic for the 67 risks was 0.98 and for the 15 mitigation measures it was computed as 0.868 which indicates that the scale formulated is reliable. Factor analysis method was utilized for establishing the

validity of the categorization of the constructs being measured. The analysis confirmed that the grouping of risks adopted for the study was in order.

The Risk Potential of each risk has been calculated using geometric mean of risk probability and risk impact. Thereafter, descriptive statistics Mean, Median and Mode have been computed using SPSS for each risk. The mean, median and mode of each risk and mitigation measure are given in Table-4.1

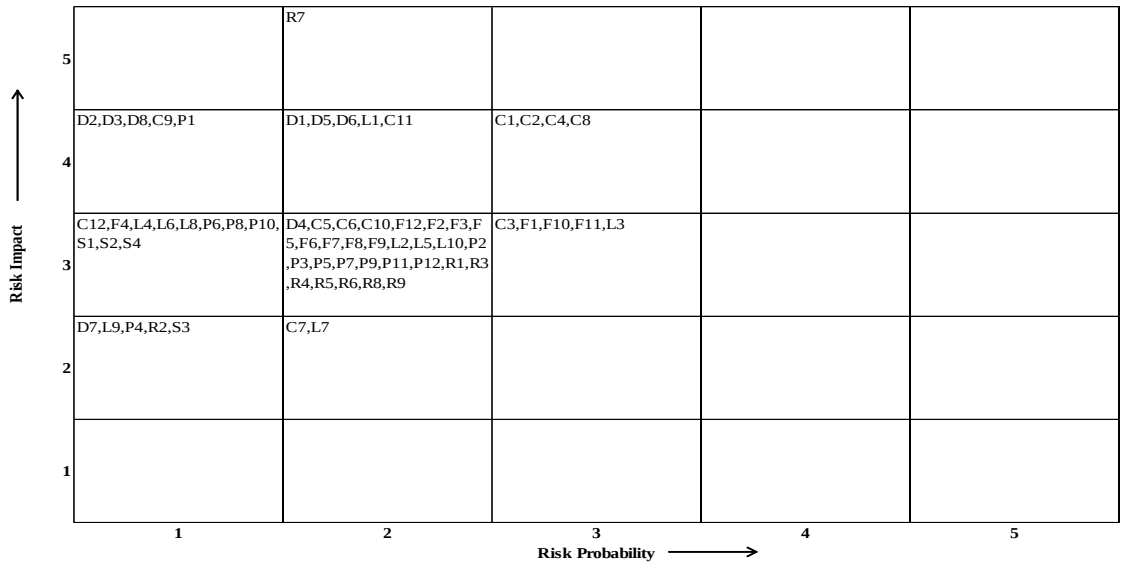
Table 4.1: Descriptive statistics of risks and mitigation measures

Design Risks	MEAN	MEDIAN	MODE	Construction Risks	MEAN	MEDIAN	MODE	Financial Risks	MEAN	MEDIAN	MODE	Legal Risks	MEAN	MEDIAN	MODE
D.1	2.809	2.828	2	C.1	3.047	3	4	F.1	2.68	2.828	3	L.1	2.587	2.449	2
D.2	2.638	2.639	2	C.2	2.937	3	3	F.2	2.367	2.449	2	L.2	2.425	2.449	2
D.3	2.781	2.828	2	C.3	2.841	3	3	F.3	2.491	2.449	2	L.3	2.936	3	3
D.4	2.749	2.828	2.449	C.4	3.133	3	3	F.4	2.23	2	1	L.4	2.608	2.449	3
D.5	2.796	2.828	2	C.5	2.575	2.449	2	F.5	2.343	2	2	L.5	2.665	2.449	1
D.6	2.845	2.828	2	C.6	2.63	2.449	2	F.6	2.75	2.828	2	L.6	2.382	2.449	1
D.7	2.333	2	1	C.7	2.28	2	2	F.7	2.881	2.828	2	L.7	2.297	2	2
D.8	2.78	2.828	4	C.8	2.865	3	3	F.8	2.376	2.449	2	L.8	2.27	2	2
Safety Risks	**MEAN**	**MEDIAN**	**MODE**	C.9	2.625	2.449	2	F.9	2.843	3	3	L.9	2.124	2	2
S.1	2.421	2.449	2	C.10	2.75	2.828	3	F.10	2.861	3	3	L.10	2.549	2.449	2
S.2	2.316	2	2	C.11	2.955	3	2.449	F.11	2.672	2.828	3				
S.3	2.163	2	1	C.12	2.502	2.236	2	F.12	2.695	2.828	2				
S.4	2.332	2	2												

Procurement Risks	MEAN	MEDIAN	MODE	Regulatory Risks	MEAN	MEDIAN	MODE	Mitigation measures	MEAN	MEDIAN	MODE	Mitigation measures	MEAN	MEDIAN	MODE
P.1	2.642	2.449	2	R.1	2.791	2.828	3	MA.1	2.64	3	3	MA.13	2.57	3	3
P.2	2.715	2.828	2	R.2	2.129	2	1	MA.2	2.7	3	3	MA.14	2.58	3	3
P.3	2.583	2.449	2	R.3	2.718	2.449	3	MA.3	2.64	3	3	MA.15	2.53	3	3
P.4	2.28	2	2	R.4	2.498	2.449	3	MA.4	2.46	3	3				
P.5	2.483	2.449	2	R.5	2.505	2.449	2	MA.5	2.57	3	3				
P.6	2.509	2.449	2	R.6	2.709	2.828	2	MA.6	1.86	2	1				
P.7	2.398	2.449	2	R.7	2.883	3	2	MA.7	2.2	2	2				
P.8	2.212	2	1	R.8	2.395	2.449	1	MA.8	2.5	3	3				
P.9	2.532	2.449	2	R.9	2.638	2.828	3	MA.9	2.19	2	2				
P.10	2.528	2.449	2					MA.10	2.71	3	3				
P.11	2.693	2.449	2.449					MA.11	2.66	3	3				
P.12	2.383	2.343	2					MA.12	2.71	3	3				

The risk map based on the mode of each risk factor is given in Figure-4.1. The risk factors which appear towards the top-right corner of a risk map are very critical for project success. In the present study, it is seen that most of the risks fall the in the moderate zone of the risk map.

Figure 4.1: Risk Map showing the 67 risks



4.1 HYPOTHESIS TESTING

The data was tested for normality using the Shapiro-Wilk test. As the data was not normally distributed the hypothesis formulated about the risk perceptions were subjected to statistical testing using the Kruskal-Wallis non-paramteric test. The summary of findings is given here.

1. Experienced professionals irrespective of their position in the organization, from line manager to top management executive, have identified similar risk factors to be critical.
2. The educational qualification of the power sector professionals does not lead to any difference in the risk perception.
3. The number of years of work experience of the power sector professionals does not lead to any difference in the risk perception.
4. However, there is significant difference in the risk perception across the risk groups of. Respondents belonging to State Utilities have differed with Project Developers, Project Engineering consultants and EPC contractors in the case of financial risks, legal risks and safety risks. The financial risk perception of respondents from State utility is lower than Project Engineering consultants but higher than Project developers and EPC contractors. The legal risk perception of respondents from State utility is lower than Project Engineering consultants but higher than Project developers. The safety risk perception of respondents from State utility is lower than Project Engineering consultants but higher than Project developers and EPC contractors.
5. The field of working of the power sector professionals does not lead to any difference in the risk perception.

Similarly, the hypothesis formulated about the mitigation measures were subjected to statistical testing and summary is presented below.

1. Irrespective of the position in the organization, there is no difference in the importance of risk mitigation measures.
2. In case of mitigation measure MA7, power section professionals who are Graduates have attributed lower importance to the mitigation measure compared to Post graduates. In case of MA14, Doctorates have attributed lower importance to the mitigation measure compared to Post graduates.
3. There are no significant differences in the importance attached to mitigation measures across groups based on type of organization, number of years of work experience and filed of working.

Conclusıon

The most important risk having significant impact identified by the study was Linkages of rail, road, water, fuel and power evacuation. Thus it is imperative that the proposed power plant has all the required approvals. It was seen that, few of the UMPP projects were stranded due to lack of fuel. The risk could be mitigated by deploying an exclusive team for obtaining necessary approvals from regulatory & Government authorities along with deploying an

effective system amongst key stake holders. Feasibility study is very vital during the design phase of the power projects. Large power plants involve complex integration of several modular equipments and machinery. Therefore there needs to be a seamless of communication between the sub-contractors such that the integration could be carried out. It is essential that, right vendor is utilized to conduct and carryout the feasibility study.

Further Research

The research primarily focussed on thermal power projects. Other power projects like renewable and hydro power plants etc could be studied in future. The research could be expanded taking into view of other countries scenario. Further the author has evaluated the overall risk level of power project development in India using Fuzzy Synthetic evaluation technique. A more detailed study on a global scale can be taken up using the technique.

References

Arya, A., & Kansal, D. R. (2016). Analysing Delays of Construction Projects in India: Causes and Effects. *International Journal of Science Technology & Engineering* , 66-74.

Batool, A., & Abbasa, F. (2017). Reasons for delay in selected hydro-power projects in Khyber Pakhtunkhwa (KPK), Pakistan. *Renewable and Sustainable Energy Reviews* , 196-204.

Kakati, P. M., & Baruah, M. P. (2016). OPTIMAL RISK ALLOCATION IN PUBLIC-PRIVATE-PARTNERSHIP (PPP) PROJECTS IN INDIA. *The 2016 WEI International Academic Conference Proceedings* (pp. 144-166). Boston: The West East Institute.

Muhwezi, L., Acai, J., & Otim, G. (2014). An Assessment of the Factors Causing Delays on Building Construction Projects in Uganda. *International Journal of Construction Engineering and Management* , 13-23.

Pillai, N. V., & Kannan, K. P. (2002). Time and Cost Overruns of the Power Projects in Kerala. *Journal of Social and Economic Development* , 148-161.

Shanmugapriya, S., & Subramanian, D. K. (2013). Investigation of Significant Factors Influencing Time and Cost Overruns in Indian Construction Projects. *International Journal of Emerging Technology and Advanced Engineering* , 734-740.

Sharma, S., & Kar, S. (2018). Risk Management and Analysis in Hydro-Electric Projects in India. *SSRG International Journal of Civil Engineering* , 1-7.

David De Jager et al(2011), IEA- Renewable Energy Technology Department, Altran GmbH & CO. KG. Risk Quantification & Risk Management in Renewable Energy Projects, IEA-RETD Report, 53-84.

Gholamreza Dehdasht et al(2017). DEMATEL-ANP Risk Assessment in Oil and Gas Construction Projects. Article, mdpi.com, 07-08.

Jianna Zhao et al(2017). Evaluation of Investment Risk in Thermal Power Project Based on Risk Matrix. International Conference on Computer Science and Intelligent Communication (CSIC 2015), 201-202.

L. Y. Shen et al(2001). Risk assessment for construction joint ventures in China. Journal of construction engineering and management, 77-78.

Amani suliman bu-qammaz(2007). Risk assessment of international construction projects using the analytic network process. Master of Science thesis, 61-74.

K. Jayasudha Dr. B.Vidivelli and E.R. Gokul Surjith(2014). Risk Assessment and Management in Construction Projects. International Journal of Scientific & Engineering Research, Volume 5, Issue 8,August-2014, 387-395.

Huiru Zhao and Nana Li(2015). Risk Evaluation of a UHV Power Transmission Construction Project Based on a Cloud Model and FCE Method for Sustainability. Sustainability, ISSN 2071-1050, 2892.

Agnieszka Dziadosz Mariusz Rejment(2015). Operational Research in Sustainable Development and Civil Engineering - meeting of EURO working group and 15th German-Lithuanian-Polish colloquium (ORSDCE 2015). Procedia Engineering 122 (2015) 258 – 265.

Esther Cheung and Albert P.C. Chan(2011). Risk Factors of Public Private Partnership Projects in China – A Comparison between the Water, Power and Transportation Sectors. Journal of Urban Planning and Development. Submitted June 21, 2010.

Yati Md. Lasa et.al(2017, Critical factors in securing finance for PFI projects in Malayasia. Malayasian Construction Research Journal, Vol-23, No.3, 43-53.

De Jager, D., Rathmann, M., Klessmann, C., Coenraads, R., Colamonico, C., & Buttazzoni, M. (2008). Policy instrument design to reduce financing costs in renewable energy technology projects. Ecofys, by order of the IEA Implementing Agreement on Renewable Energy Technology Deployment (RETD), Utrecht, ther Netherlands.

Turner, G., Roots, S., Wiltshire, M., Trueb, J., Brown, S., Benz, G., & Hegelbach, M. (2013).White paper on profiling the risks in solar and wind . Bloomberg New Energy Finance Limited.

Frisari, G., Hervé-Mignucci, M., Micale, V., & Mazza, F. (2013). Risk Gaps: A Map of Risk Mitigation Instruments for Clean Investments. Climate Policy Initiative Organization.