THE INTERNATIONAL JOURNAL OF BUSINESS & MANAGEMENT

Establishing Risk Management Index in Infrastructure Project in Indian Construction Industry

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Abstract:
Managing risks is a strategic tool for reaping the full benefits of the critical initiatives that are implemented in any organization. Organizations which implement good risk management practices tend to reap the maximum advantage. Considering this aspect in mind, an upcoming thermal power project in the state of Telangana Pradesh (India) has been selected for study. This study has been carried out for the selected project by considering 6 potential risks in various phases of the project that has the ability to cause inordinate delay in project completion. Various factors under each of the major risks was identified and based on the responses received from the respondents, Relative Severity Index (RSI) was calculated for each 33 risk factors. The mean RSI was calculated for each of the 6 major risks and this was used to calculate Risk Management Index (RMI). The RMI is an indicator of the extent to which a construction project is exposed to risk and the mitigation measures need to be taken accordingly for lowering the risks impact to a manageable level, if the risks seem to be quite unmanageable.

Keywords: *Risk Management, Relative Severity Index, Risk Management Index, Risk Indicators*

1. Introduction

Construction industry right from the initial investment appraisal to commissioning of project is subjected to risks, which needs to be faced by the stakeholders concerned. In recent times, the nature, incident and impact of risk in construction industry has become a topic of interest because of its effects on quality, time and cost of construction projects (Ojo, 2010,Windap et al 2010 and Joshua 2010)

Risk is important to contractors, clients and consultants within the construction industry. Construction activities are subjected to plethora of risks which have to be considered by the management if they are to achieve their objectives.

As per Project Management Institute (PMI, 1996) "Risk is uncertainty and result of the uncertainty or lack of predictability about structure, outcome or consequences in a planning or decision situation". Risk management is defined as "entire set of activities and measures that are aimed at dealing with risks in order to maintain control over the project"

Construction risk management is the process of identifying, analyzing and mitigating the risks in the project by proper response (PMI, 2003).According to www.antive.net (2012),project risk management involves risk identification, risk analysis, creating a risk response action plan, monitoring and controlling of risks in a project.

An infrastructure project by its very nature is subjected to barrage of risks and hence the effect of risks on cost and time is substantial. This study is confined to a power project in state of Telangana (India) by considering i.e financial, legal, management, operation, construction and environmental risks which are considered to be quite formidable risks in the project and to formulate a Risk Management Index (RMI) to address the issue of risks in the said infrastructure project.

2. Literature Survey

Al-Bahar and Crandall[1] on systematic risk management approach for construction projects have concluded that brainstorming sessions and analysis of historical data of similar projects were found to be the most preferred methods of risk identification in construction industry and that formal risk management process is used infrequently.Ahmed et al[2] (1999) in his study has concluded that complexities of projects, locations and type of contracts are significant contributors to risk in construction projects. Ijigah Edoka Augustine and others[3] in their study on risk management practices in Nigerian construction industry have concluded that risks are not properly managed and that there is need for strategy to reduce the risks by way of formulation of effective risk management index.YYL Florence and Londa[4] in their study have concluded that every infrastructure project is subjected to multiple risks and it is

the responsibility of promoter to promoter to mitigate the risks by having a strong management team and a comprehensive risk management should be conducted and mitigation plan be prepared for ensuing the success of project. Baloi and Price ADF[5] (2003) did a modeling study on global risk factors affecting the cost performance in construction projects and have concluded that there is need to incorporate global risk factors in any project for effective project mitigation. Kansal RK and Manoj Sharma[6] in their study on risk assessment methods and application in construction have concluded that various methods of risk assessment like brainstorming, checklist, delphi method and risk significant index methods are used and each method has its own limitation and that risk assessment methods can be integrated for applying risk management effectively. Shehu and Sommerville[7] have stressed that construction is a risk prone industry with poor track record of coping with risks as a result of which clients are not able to reap full benefits of their investment. Nerija Banaitiene and Audrius Babaitis[8] have concluded that risk management is the core of project management and that success of any project depends on how effectively uncertainties are handled, complete absence of formal risk management techniques in construction industry and joint venture tool is widely used for risk transfer. DadaJ O and Jagboro G O[9] on evaluation of impact of risk in construction industry have identified political risk as the main risk factor and that contingency amount in the estimate should be based on procurement method. Debasis Sarkar and Goutam Dutta[10] in their study on project risk management in underground construction of metro rail have concluded that cost uncertainties and risks should essentially be carried out for infrastructure projects and that risks involved in infrastructure project from concept to commissioning, if not treated properly, probability of successful completion of project gets diminished. Shen LY and others[11] in their study on risk assessment for construction joint ventures in china have observed that risk transfer is an effective tool for mitigating the risks in infrastructure projects. Martina Claudia Garrido and others[15] in their study have concluded that formal risk identification and application techniques in Brazilian construction industry is rarely used and that more informal methods are applied for risk identification.

3. Research Method

Data for the study was collated through a questionnaire survey that was administered to participants who had stakes in the project which is being executed in the state of Andhra Pradesh. The place was selected for study because of substantial construction activities that is being carried out in this region. The population of the study comprised of clients/ developers, architects, contractors, consultants, engineers etc who were involved in construction risk management. Questionnaire was given to 100 participants and the response received was 45(45%). The responses that were received was analysed using Risk Severity index (RSI) which was then utilized to compute the composite Risk Management Index(RMI).

4. Results and Discussions

Sl. No	Risk Indicators	Degree of severity quoted by respondents					Score	RSI	Standard deviation	Rank
		5	4	3	2	1				
1	Unexpected Technical problems	20	10	7	5	3	174	3.866	5.966	1
2	Practicality of design	17	12	9	5	2	172	3.822	5.253	2
3	Accessibility to site	15	13	11	5	1	171	3.800	5.215	3
4	Change in scope by client	15	12	10	6	2	167	3.711	4.560	4
5	Shortage of skilled manpower	14	12	11	6	2	165	3.666	4.381	5
6	Loss of manhours due to accidents at site	13	13	11	5	3	163	3.622	4.195	6

Table 1: Assessment of construction risk indicators

Mean RSI 3.748

Note: 1) Mean RSI is calculated by multiplying the responses with the degree of severity for each risk indicator and dividing the figure obtained by 45(number of responses received)

2)5=Highly catastrophic 4= catastrophic 3= Significant 2= Fairly significant 1=Not at all significant

The result in Table 1 indicates that unexpected technical problems are very high in infrastructure projects in general and in particular for the selected project. Practicality of design is one of the leading causes of time and cost overrun in projects. The area under study is naxal infested and hence accessibility to site is also a significant contributor to risk. Frequent change in scope by client has got its repercussions in the form of viability of project getting affected. Shortage of skilled manpower in the infrastructure project and loss of man-hours due to accidents at site and are not significant contributors as far this project is concerned.

Sl. No	Risk Indicators	Degree of severity quoted by respondents					Score	RSI	Standard deviation	Rank
		5	4	3	2	1				
1	Improper planning	17	15	6	5	2	175	3.888	5.899	1
2	Absence of structured project organization	14	13	13	3	2	169	3.755	5.329	2
3	No proper feasibility study	12	13	11	7	2	161	3.577	4.979	3
4	No coherent team work	13	12	10	7	3	160	3.555	3.633	4
5	Absence of clear cut instructions from top management in crucial issues	13	10	11	8	3	157	3.488	3.405	5
6	Safety and Quality policy of management	12	11	10	8	4	154	3.422	2.828	6

Table 2: Assessment of management risk indicators
Mean RSI 3.680

Analysis of Table 2 indicates that improper planning by the management is the top contributor to risk followed by absence of structured project organization. Hence, it is absolutely necessary to have proper planning and an organization with clearly defined roles and responsibilities. In the absence of proper feasibility study, one can imagine as to what will be the outcome of the project. Moderately significant contributors are absence of coherent team work and instructions from the management on crucial issues which means decisions are left to the field engineer. The management has good safety and quality policy which is in line with lesser accidents at site as indicated in Table 1.

Sl. No	Risk Indicators	Degree of severity quoted by respondents					Score	RSI	Standard deviation	Rank
		5	4	3	2	1				
1	Maintenance of requisite load factor	14	13	7	7	4	164	3.577	3.847	1
2	Hidden problems	14	11	9	7	4	159	3.533	3.405	2
3	Availability of raw materials at right time	13	12	8	8	4	157	3.488	3.224	4
4	Failure of turbines	13	12	7	8	5	155	3.444	3.033	3
5	Susceptibility to fire	9	11	12	8	5	146	3.244	2.449	5

Table 3: Assessment of Operation risk indicators
Mean RSI 3.457

Analysis of Table 3 indicates that maintenance of load factor is the main contributor to operation risk which is in line with practicality of design in construction risk also being one of the top contributors to risk. Hence, this stresses the importance to be given to design. Hidden problems which are also a high contributor can be mitigated by discussion with experts who have experience in designing such projects. Availability of raw materials at right time is moderately significant risk whereas failure of turbines and susceptibility to fire are not quite significant.

Sl. No	Risk Indicators	Degree of severity quoted by respondents					Score	RSI	Standard deviation	Rank
		5	4	3	2	1				
1	Breach of contract by parties concerned	15	11	10	7	2	165	3.666	4.335	1
2	Absence of proper dispute resolution mechanism	15	12	8	6	4	163	3.622	4.000	2
3	Improper contract documents giving rise to legal complications	13	12	10	8	2	161	3.577	3.898	3
4	Lack of enforcement in case of dispute	12	12	10	8	3	157	3.488	3.346	4
5	Tender process and type of contract	12	11	10	5	7	151.	3.355	2.607	5

Table 4: Assessment of Legal risk indicators
Mean RSI 3.573

Analysis of Table 4 indicates that breach of contract by the parties concerned is the main contributor to operation risk. Absence of proper dispute resolution mechanism is also a catastrophic risk and hence proper steps should be taken to have proper arbitration mechanism. Improper contract document is a significant contributor to risk. Hence, this stresses the importance to be given while documenting a contract. Lack of enforcement in the case of dispute is fairly significant risk and the tender process and type of contract seems to be an insignificant risk.

Sl. No	Risk Indicators	Degree of severity quoted by respondents					Score	RSI	Standard deviation	Rank
		5	4	3	2	1				
1	Environmental impact of project	18	12	9	3	3	174	3.866	5.692	1
2	Proper working environment for workers	16	13	9	5	2	172	3.800	5.099	2
3	Change in climatic condition	13	15	7	7	3	163	3.622	4.381	3
4	Rehabilitation and Resettlement	12	14	10	6	3	161	3.577	4.000	4
5	Loss of flora/fauna and fertile land	10	15	9	7	4	155	3.444	3.633	5

Table 5: Assessment of Environmental risk indicators
Mean RSI 3.662

Analysis of Table 5 indicates that the environmental impact of the project is very high followed by providing of proper environment for workers. Change in climatic condition due to project appears to be moderately significant risks while the risk due to rehabilitation and resettlement is fairly significant thereby meaning that this issue has been taken care of adequately. Risk due to loss of flora/fauna is negligible.

Sl. No	Risk Indicators	Degree of severity quoted by respondents					Score	RSI	Standard deviation	Rank
		5	4	3	2	1				
1	Time overrun	15	13	11	5	1	171	3.800	5.215	1
2	Fluctuations in interest rate	17	13	5	6	4	168	3.733	5.099	2
3	Delay in achieving financial closure	13	14	11	5	2	166	3.688	4.690	3
4	Delay in finalization of funding	10	12	11	7	5	160	3.577	3.847	4
5	Fluctuations in exchange rate	14	11	10	5	5	159	3.521	3.533	5
6	Changes in lending formalities and regulations	10	15	7	6	7	150	3.286	3.333	6

Table 6: Assessment of Financial risk indicators
Mean RSI 3.611

Analysis of table -6 indicates that time overrun and fluctuations in interest rates are highly catastrophic risks whereas delay in achieving financial closure is a catastrophic risk. Delay in finalization of funding is a significant risk whereas fluctuations in exchange rates are changes in lending formalities are not significant risks. There is an urgent need to have tight control over the time overrun in the project or else the project may become unviable.
The risks assessed are arranged in descending order as per the mean RSI and rank is allotted from 1 in serial order starting from the risk with highest RSI. Since 6 categories of risks are considered, weight of 6 is allotted to risk with highest RSI. Weighted values of various risks are tabulated below**:**

Risk type	Mean RSI	Rank	Weight
Construction risk	3.748	1	6
Management risk	3.680	2	5
Environmental risk	3.662	3	4
Financial risk	3.611	4	3
Legal risk	3.573	5	2
Operation Risk	3.457	6	1

Table 7
$\sum W=21$

- Establishing of Risk Management Index (RMI)

Indices are used widely in performance evaluation and have proven to be very strong in identifying weak points in the overall system (Bell and Morse, 1999).Index is a number that is derived from broad range of individually generated indicators that evaluates the specific aspects of the system (Gray and Carton-Kenny, 2004).
Risk comprised of 33 indicators characterized by construction, environmental, financial, legal, operations and management factors. The overall score of the risk index of the project under study is calculated using the formula given below:
RMI = $\sum$((Mean RSI) * weight)/ (N *$\sum$Weight) where N represents the number of risks i.e 6

$$RMI = \frac{(3.748*6)+(3.680*5)+(3.662*4)+(3.611*3)+(3.573*2)+(3.457*1)}{6*21} = 0.61 \text{ or } 61\%$$

The project is exposed to 61% risk which is the result of all factors put together. By industry standards, this risk is very high and result is in tune with the high risks to which a infrastructure project is exposed to.

5. Conclusion

The study evaluated the procedures, practices and policy issues involved in risk management and establishment of RMI for the project under study in state of Andhra Pradesh (India). A framework was developed to rate the project risk by taking into account high risk factors. Data received from respondents was analyzed to calculate the RSI and the mean RSI was used to calculate RMI. The result of the weighted average risk taking into account all the risk factors in the project is 0.61 which means that risk is not properly managed.
In conclusion, RMI will reduce cost and time overrun and it is hoped will improve the quality of construction project. This will also help in developing a strategy to mitigate the risks and will improve the viability of project. Insurance companies rate the risk in construction projects using RMI and hence it becomes imperative to have efficient risk management in the project which will boost the development in the vicinity of project and will also significantly contribute to increased GDP of the nation.

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