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Research paper

Identification of key challenges associated with the implementation of renovation & modernization (r & m) projects in India using factor analysis

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Abstract

The Renovation & modernization (R&M) of coal fired thermal power plants deals with making the power plants units well equipped with the latest technology and systems with an aim of improving their overall performance in terms of output and availability as compared to the original design values, reduce the maintenance cost and enhanced efficiency. The aim of this study was to identify the key challenges associated with implementation of R & M Projects in India. An exploratory study of 42 variables was conducted through factor analysis using the data obtained through a questionnaire survey approach The results obtained 6 key challenges , namely Contractual risks, funding risks, planning risks, regulatory risks, market related risks and management risks which hamper the rate of implementation of R & M Projects in India.

Keywords: *Renovation & Modernization (R & M); Factor Analysis; Challenges and Implementation.*

1. Introduction

Planning and execution of Renovation and Modernization (R&M) projects in India have often been affected by various challenges and risks that have derailed the objectives of the project. Identifying, assessing and mitigating these challenges is crucial for the successful management and implementation of R&M projects. The Central Electricity Authority, CEA had found units with 36,000 MW of capacity to be over 25 years old which should either be converted or retired. Over the course of several meetings with all stakeholders including States, 4,000 MW of units were recommended to be retired. As per the National Perspective Plan of The Central Electricity Authority of India, CEA, as stated under 12th -5 Year Plan, 65 units have been identified across the country for which R&M works need to be taken up amounting to 17,301 MW. R&M works began in the early nineties and continued well till the 9th Plan however many slippages occurred in the subsequent periods.

Some of the major reasons for theses slippages were identified as equipment capacity constraints, contractual concerns, delays in getting permissions & permits for shutdown due to the power shortages in the respective states, fund related issues etc.

The performance of the R & M programme showed slight improvement during the 11th Plan due to certain new reforms in the industry, however not even 50% achievement was achieved(National Electricity Plan and Review Report on Renovation, Modernization and of Thermal Power Stations; 2012, CEA).

It has become essential to take some steps in order to improve the efficiency of the thermal power plants and also maximize the generation from the existing power stations through R&M due to various challenges like the costs associated with new installations & green field projects, financial health of the utilities and oil & coal constraints etc.

2. Need for the research

Various studies carried out in the past have highlighted one common concern of the poor and deteriorating efficiencies of the thermal power plants in India. However none of these studies could provide solutions to improve efficiencies of the plants or even to check the deteriorating efficiencies of the power plants. This has generated a need to look for alternative methods of increasing the production to meet the increasing power need.

Keeping in mind the various constraints with respect to the green field projects like that of land availability, legal and political concerns and majorly the lack of funds, the only alternative is to look at the other ways of improving efficiencies from the prevailing one.

Even though the Renovation & Modernization (R & M,) have been initiated in the early nineties, the policies for its governance were framed in the beginning of the last decade only. However the actual implementation has not been satisfactory (Annual Review Report- R&M of Thermal Power Stations in India -January – March; 2015, CEA).

Reasons of such unsatisfactory implementation have not been reported .Most of these power plants were set up during the late nineties and have been facing the problems of declining efficiency (a power plant is said to be inefficient if the existing inputs are not utilized in an optimum manner and as a result of which its generation becomes lower than its maximum possible generation).

3. Methodology

To achieve the above objectives data was obtained by means of a questionnaire survey which included 42 challenges faced by the R & R Projects. These challenges were obtained through a thorough and rigorous literature review, study of detailed project reports (DPR's), case studies and structured & unstructured interviews with industry experts.

The questionnaire was then administered to 300 randomly selected industry experts from Central Electricity Authority (CEA), Central Electricity Regulatory Commission (CERC), Ministry of Power (MOP), National Thermal Power Corporation (NTPC), Tata Power, KPMG, PWC, BSES, Indian School of Petroleum & Energy, CRISIL, ONGC etc.

Some responses were received through email, some through the Google form circulated and some through visiting the organizations in person. In total, 186 responses reliable for analysis were received out of 400 amounting to 46.5% response rate which is good as in most questionnaire surveys conducted for the construction industry the response rate lies between 20-30% (Akintoye, 2000). The respondents were asked to provide their level of agreement on a Likert type scale of 0-5.

Structured and unstructured interviews were conducted with industry experts dealing with R&M works for understanding their experience in the planning, procurement, and execution of R&M Works. These also included experts from Regulatory Commissions, equipment suppliers, Consultants and Funding Agencies etc.

4. Factor analysis

The Data reduction and analysis was carried out using factor analysis to explore and identify key challenges associated with the implementation of renovation & modernization (R& M) projects in India .It is a statistical tool which is widely used to identify a comparatively small number of factors that are able to represent the relationships among many interrelated variables (Norusis, 1992). The principal element analysis (PCA) has beenemployed for the analysis having data-reduction capability. The main aim of PCA is to represent relationships among sets of variables parsimoniously. (Norusis, 1992).

The process adopted for the study is defined as per fig 1 below:

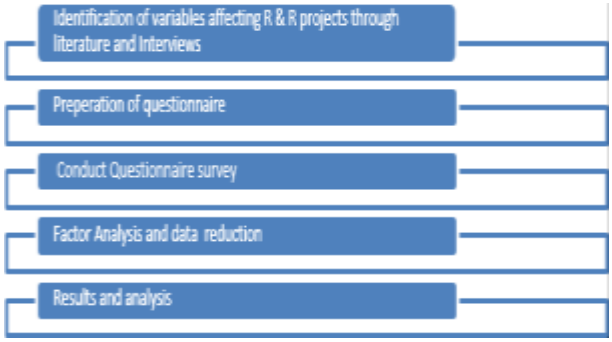

Fig. 1: Research Approach.

Factor analysis uses a two step process -factor extraction and rotation. The aim of factor analysis is to determine the least number of factors which can capture maximum variance in the system, using principal components analysis, whereas factor rotation, is to make the factor more understandable and relatable.

Factor analysis addresses the problem of analysing correlations amongst a large number of variables by defining a set of common dimensions, known as factors (Hair et al., 1998). Various tests are needed to be conducted in order to determine the appropriateness of factor analysis.

The Correlation matrix is a matrix that consists of numbers which gives the correlation coefficients between the single variable and every other variable present in the system. The correlation coefficient between the variable under consideration and itself is always 1, hence the principal diagonal of the correlation matrix consists of all 1s. With respect to Correlation Matrix if any of the pairs of variables have a value which is less than 0.5, are dropped and the process is then repeated for refining the data.

Considering this, the pair of variables having a value less than 0.5 were dropped from the study and 22 variables were them re run for factor analysis.

The study has been conducted using the PCA method as described above and produced a six-factor solution with eigen values greater than 1, these factors were able to explain 63.5% of the variance. The varimax rotation method was employed for easy interpretability of the factors. The factor grouping based on varimax rotation is as shown in Table 3 below. Each of the variables weighs heavily on to only one of the factors and the loading on each factor exceeds 0.4.

Kaiser Meyer Olkin (KMO) and Bartlett's Test helped to measures the strength of correlation among the measured variables under study. The KMO value helps to measures the adequacy of sampling which determines whether the responses given by the respondents are adequate or not. The KMO Value should be close to 0.5 for a satisfactory factor analysis Kaiser (1974) .The value of KMO obtained for the study was 0.528 which indicates the factor analysis is appropriate and the results can be taken up for further analysis and interpretation.In this analysis, the value of the test statistic for sphericity is large (Barlett's test of sphericity = 1563) and the associated significance level is small (p = 0.000).

Communalities explain the amount of variance the variable shares with all other variables n the analysis. Its value should be more than 0.4 to be considered for further analysis. Through the results we obtain the communalities (The values vary between a lowest of 0.425 to a highest of 0.728) which indicate a good fit as shown in table 2 below.

Table 1: KMO and Bartlett's Test Statistics

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.685
Bartlett's Test of Sphericity Approx. Chi-Square	1563.228
Df	210
Sig.	.000

Table 2: Communalities

	Initial	Extraction
VAR00001	1.000	.672
VAR00002	1.000	.666
VAR00003	1.000	.583
VAR00004	1.000	.571
VAR00005	1.000	.702
VAR00006	1.000	.568
VAR00007	1.000	.703
VAR00008	1.000	.576
VAR00009	1.000	.665
VAR00010	1.000	.425
VAR00011	1.000	.596
VAR00012	1.000	.728
VAR00013	1.000	.541
VAR00014	1.000	.585
VAR00015	1.000	.716
VAR00016	1.000	.753
VAR00017	1.000	.606
VAR00018	1.000	.671
VAR00019	1.000	.687
VAR00020	1.000	.655
VAR00021	1.000	.682

Extraction Method: Principal Component Analysis. Extraction Method: Principal Component Analysis.

Table 3: Total Variance Explained

	Initial Eigen values	Extraction Sums of Squared..	Extraction Sums ...	Rotation Sums of Squared Loadings

Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.744	27.351	27.351	5.744	27.351	27.351	3.77	17.954	17.954
2	2.073	9.87	37.221	2.073	9.87	37.221	2.47	11.762	29.716
3	1.598	7.61	44.831	1.598	7.61	44.831	2.314	11.021	40.737
4	1.562	7.437	52.268	1.562	7.437	52.268	1.653	7.87	48.607
5	1.262	6.01	58.279	1.262	6.01	58.279	1.648	7.846	56.453
6	1.115	5.308	63.586	1.115	5.308	63.586	1.498	7.133	63.586
7	0.946	4.506	68.092						
8	0.907	4.321	72.413						
9	0.857	4.083	76.496						
10	0.76	3.617	80.113						
11	0.665	3.165	83.278						
12	0.605	2.88	86.158						
13	0.558	2.656	88.814						
14	0.512	2.438	91.251						
15	0.43	2.046	93.297						
16	0.314	1.494	94.791						
17	0.288	1.373	96.164						
18	0.277	1.318	97.481						
19	0.208	0.989	98.47						
20	0.195	0.931	99.401						
21	0.126	0.599	100						

Table 4: Rotated Component Matrix

	Component					
	1	2	3	4	5	6
VAR00001	.576		.492			
VAR00002	.797					
VAR00003			.650			
VAR00004			.729			
VAR00005		.749				
VAR00006						
VAR00007		.805				
VAR00008		.611				
VAR00009	.763					
VAR00010	.428					
VAR00011	.658					
VAR00012	.446				.543	
VAR00013		.467				
VAR00014			.496		.444	
VAR00015	.655					
VAR00016						.856
VAR00017				.478		.432
VAR00018				-.401		
VAR00019	.651					
VAR00020				.787		
VAR00021					.805	

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a) Rotation converged in 8 iterations.

5. Results and factors

The 6 factors explained 64% of the total variance. The communalities of all the variables were found to be more than 0.4 and hence it can be said that the model was reliable. A rotation of the reference axes, called varimax rotation was performed. Then the factors and their corresponding loadings were obtained. The final 6 factors obtained and their interpretation is as follows.

The factors obtained from the study are as follows: factor 1 represents contractual risks; factor 2 represents funding risks; factor 3 represents planning risks; factor 4 represents regulatory risks; factor 5 represents market related risks and factor 6 represents management risks

6. Conclusion

The aim of this objective was to identify key challenges associated with implementation of R & R Projects in India. An exploration of 42 variables was conducted through factor analysis using the data obtained through a questionnaire survey approach and as a result the variables have been grouped into 6 main factors, namely Contractual risks, funding risks, planning risks, regulatory risks, market related risks and management risks. Based on an extensive stakeholder consultation certain startegies have also been proposed for mitigating and managing these risks.These are as stated below With these 6 factors obtained from the study it becomes easier to identify the challenges proactively and develop an appropriate model for the assessment of the challenges and their effect on each other and also understand its effect on the rate of implementation of the R & M projects.

A summary of the variables which have been grouped into the 6 factors has been summarized as below:

S. NO	Description
1.	Factor 1: Contractual Challenges
1.1	Award of Contract through nomination and not competitive bidding
1.2	Delays in bid evaluations and award of work
1.3	Improper contractual conditions for the execution of R & M works.
1.4	Poor dispute resolution mechanism
1.5	Delays in the supply of critical equipments and the shutdown period
1.6	Lack of proper risk and reward system between the utilities and contractors
2.	FACTOR 2: Fund related Challenges
2.1	Non availability of funds with utilities to take up R & R projects
2.2	Credit limit for power sector reaching limits with commercial banks
2.3	Focus on technical criteria's only with limited focus on financial

	& economic concerns
2.4	Due to limited success stories for R & M projects in the Country there is low confidence among financers for funding R & M projects
3.	FACTOR 3: Planning Challenges
3.1	Poorly defined objectives
3.2	Limited past operating & performance data with the utility, which makes it difficult to identify the actual improvement areas.
3.3	Incomplete studies/Energy audits carried out before taking up R & R Work to identify actual problem areas
4.	FACTOR 4: Regulatory Challenges
4.1	Lack of government support in obtaining permissions & permits for shutdown etc
4.2	Lack of Government support and incentives
4.3	No bench marks set for R & M works
5	FACTOR 5: Market Challenges
5.1	Non-availability of schedule for sale of power generated.
5.2	Lower vendor participation because of limited competition, which leads to higher procurement cost.
6.	FACTOR 6: Management Challenges
6.1	Inadequate exposure of the utility professionals in the area of planning & execution of R & M with project appraisal skills & authority
6.2	Lack of dedicated personnel to carry out the R & M Activities
6.3	Required number of personnel with appropriate skill sets are not available

1) Contractual challenges

The way the Contract is drafted plays a significant role in the kind of involvement of different stakeholders in a project; it also can have an encouraging or a discouraging impact on the players. It has been observed the risk sharing mechanism is missing in the general Contracts which are being followed by the Generation Companies. During discussions and expert sessions with vendors and consultants, many issues with regards to the Contract were highlighted .The most important issue that was highlighted was the weakly defined scope of work and problems with respect to the commercial aspects of the contract which deliberately shift the risk towards the bidders/Contractors.

It has been highlighted that there are various kinds of guarantees that need to be taken by the contractor that results in an unfair and non -balanced risk-reward system and this in turn high prices of the through put.

Due to limited competition in this industry there are very few technical consultants available to actually take up the detailed technical studies like the RLA , Preparation of the DPR etc . This process takes about 3-4 years in general. This long period makes it difficult for the bidders to accurately define the scope, model and predict the actual condition of the existing equipments which are actually due for R & M, ultimately increasing the risk profile of the project.

2) Funding related challenges

R & M projects in India are currently being funded by the International Financial Institutions through the public sector in forms of loans & grants. The normative financial structure being followed in India is primarily dependent on 70% loans from banks or other financial institutions and 30% through State Equity

Expert discussions and data from the questionnaire survey highlighted that the non-availability of funds especially with the State Electricity Boards (SEB'S) to take up R&M works is one of the biggest challenges in India.

As per the12th 5 year plan a total fund requirement by the power sector alone scheduled through commercial banks is approximately Rs. 2705 billion. Keeping this under consideration the financial limits of the power sector is likely to exhaust in various commercial banks.

If this trend continues at an increasing demand rate it may lead to serious financial issues for the R&M projects making it even more difficult for implementation of these projects.

If the Government is able to introduce Private-Public-Partnership (PPP) models for R&M (and also for O&M) as a way to generate competition in the market and also solve the problem of financing, it would definitely help in easing the pressure on the financial institutions.

Another major challenge with the R & R projects lies in the poor financial health of the State utilities resulting in the limited debt servicing ability of the utilities. Due to lack of proper planning the available finance is consumed in firefighting and inappropriately planned schemes rather than being utilized in the useful schemes with long payback and short-term costs, such as R&M projects.

When the R&M is financed through the Govt schemes generally, the lowest capital expenditure option is given first priority. The Capital Expenditure for R&R needs to be managed in such a way as to reduce the short-term increase in power cost from the generating units. However, the finance traditionally available for these R&M works has been of relatively short period of up to 7 years hence increasing the cash outflows of the generating utilities and thereby increasing the tariff requirement.

3) Regulatory challenges

Another major challenge lies in the fact that an upfront commitment for the capital costs required and the possible plant performance may be difficult because of the inadequate methodologies adopted for the RLA studies, which cases there intermediate issues and hampers the pace of work. There needs to be a proper analysis comparing the financial cost based tariffs as against the economic pricing of additional power that can be made available by taking up R & M works.

The question still remains that who is the deciding Authority for such issues, the lack of a system makes it even more difficult for investment decisions and decision making procedure becomes extremely slow and non-reliable.

The Generation Companies should be allowed to retain a certain percentage of their benefit achieved by implementing R & R this is also consistent with the Tariff Policy that envisages providing incentives to utilities for undertaking R&R . Obtaining the power plant shutdowns are very difficult in the prevailing power shortage scenario. Regular R&R works require shutdowns varying from 4-5 months at best, provided all conditions are fulfilled this can go upto even up to 8-12 months in the worst cases of technical surprises, non-availability of spares, funds etc. Sometimes the shutdowns for carrying out the RLA studies are difficult to obtain especially in areas of acute shortage of power.

If the actual execution costs are more than the estimated approved amount by the state regulators, then the process would require a new set of approvals to be granted by the regulator which may further the delay work and may also lead to contractual issues and disputes.

4) Market challenges

Through various studies it has been highlighted that there is tremendous R&M potential in India, however the commercial opportunities within the market are very limited. The actual achievement with respect to the planned R&R during the 10th and 11th Plan has been only a mere 9% and 17% respectively. This is attributable to various reasons as mentioned above. There are various market challenges that the investors face while investing in a R & M Project.The award of R & M projects is generally done on nomination basis in India .The work is directly awarded to the existing O & M Contractors without any bidding.This restricts the competition in the market and hence leads to a major obstacle for various other suppliers.

5) Management challenges

Some of the major management related challenges that the R & M projects face are the inadequate training of R & M professionals in the area of planning, execution & management of R&M projects, lack of a dedicated team at the management level to plan & execute R& M projects, allocation of the best personnel's to new generation projects only and frequent transfers etc This has in turn lead to the limited skills and expertise of the generating company to plan, implement and execute R&M projects.

Interviews & interactions held with various industry experts & stakeholders including the equipment suppliers highlighted that once the project is awarded, the complete risk for the project execution is passed on to the suppliers with very limited support provided by the utilities. This has been a major hindrance in the successful implementation of R&M projects in India . Hence lack of a

collaborative approach has serious implications on the R&M projects.

Further through the detailed project reports (DPR's) studied during the course of the study it was observed that lack of strong project management team within the utilities was a key for successful implementation of R&M projects. Further, frequent transfer of employees should be avoided in case of such projects this would help in building the institutional capacity.

Also by creating a dedicated and experienced team of professionals significant benefits can be obtained in terms of better planning and execution by learning from the past experience and issues encountered etc.which can also be incorporated in implementation of subsequent R&M projects and such issues can be handled in a more effective manner.

6) Planning Challenges

It has been highlighted through the various industry expert interviews and discussions that there is no structure for carrying out the residual life analysis (RLA) and it is done on ad hoc basis which has a more reactive approach than a reactive one. This tends to create non uniformity and lack of clarity amongst bidders if tender is floated. Only a Simple benefit cost analysis is generally undertaken to justify the investments in R& M with no major emphasis on the socioeconomic analysis for selection of different R & M options.

It is important for the utilities to create a system to document the issues faced during the execution of the R&M project including the risks ,technical surprises and also the lessons learnt and this document should be compulsorily be referred while planning for new R & M Projects

This formal approach within the Central & State Utilities would help in creating a learning document and would also benefit the entire R&M market, help in better planning & management as well as help in increasing competition.

A comprehensive plan for identification and assessment of various options including financial analysis , payback period, shutdown time requirements and conformance to the set objective should be prepared and implemented for all projects to reduce the risks associated with the R & M Projects.

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