# Contract Risk Influence Factors in Power Transmission Project in India

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## Abstract

Contract risk management is an approach of recognizing factors, classifying and assessing contractual risk in any project, including a power transmission project, which helps make the project successful. Power transmission project is significant to develop the socio-economic condition of any nation. Several studies had been done to assist in managing the contractual risk organizations that execute the power transmission projects. This study used the Analytical Hierarchy Process to normalize uncertainty estimates and ranking of contract risk factors, especially in power transmission projects in India, starting from bidding to project closing. A questionnaire survey was conducted to get feedback and opinions from power transmission project experts in India. The AHP method was used to provide a pair-wise analysis of all contract risk factors and then rank them. Results show that the financial risk is the most critical contract risk, followed by technological, legal, external, and execution. The degree of impact of the contract risk factor will provide a clear picture of what choice is better for the PT project execution business.

## Keywords

Engineering-Procurement-Construction (EPC), Power Transmission (PT), Analytical Hierarchy Process (AHP), Contract, and Risk.

## 1. Introduction

Risk influences starting from concept to finishing off any projects. The power transmission project is commonly large-scale, complicated in admire of various stakeholders' involvement, excessive reliance on socio-economic and external factors, government bureaucracy, economic limitations, and quasi-regulatory and legal contexts. As the power transmission project's risk, the EPC type contract is used to address the risk. Under the EPC contract, a contractor is legally bound to deliver the complete project to the owner, who needs a turn-key to start operating the facility.

The purpose of PT projects (Transmission line and Substation) is to direct the power flow in an electric system by installing equipment. Several activities involve foundation, control building, cable trench, firewall, and equipment erection. Recent challenges (almost all sectors,) including transmission and substation projects, are standstill for the Covid-19 crisis.

The capacity addition and CAPEX in the transmission segment may additionally go through in the brief term; however, the long-term drivers stay intact. As per the national infrastructure pipeline, CAPEX is as below Table-1, is expected in the transmission segment between FY-2020 and FY-2025.

**Table 1: Investment in Transmission Sector**

| **Capex Over FY-20-25 (Rs. In Crore)** | | | | | | |
|---|---|---|---|---|---|---|
| **FY-20** | **FY-21** | **FY-22** | **FY-23** | **FY-24** | **FY-25** | **Total** |
| 54875 | 53897 | 50712 | 51522 | 51522 | 41522 | 304,050 |
| **Major Share** | | | | **In percent** | | |
| State | | | | | | 62 |
| Powergrid | | | | | | 22 |
| Private | | | | | | 16 |
| **Transmission Lines** | | | | | | 86000 Ckt. KM |
| **Substation** | | | | | | 314875 MVA |

Project risk is an incalculable event or situation that positively or negatively influences one or maybe more project objectives, such as scope, timelines, budget, and quality if they occur (PMBOk 2013). There are three types of risk in the project, i.e., manageable known risk, unmanageable known risk, and unknown risk (Kendrick, T. 2015). Without thinking about the risk and its management, the project may turn into an encounter of failure. However, risk management has been considered in many studies. Some of the studies have discussed Risk factors differently. No previous studies have defined and evaluated the contract risk management of the EPC contract in the PT project in India.

## 2. Objective of the Study

This study aims to identify the critical problems in EPC contract risk factors of PT projects and prioritizes them using risk mapping.
The following section provides a brief description of the past literature followed by methodology, analysis, and conclusion.

## 3. Review of Literature

The essence of the risk has become so? That it could risk one person an opportunity for another? The risk or opportunity relies solely upon whom perspective the project is being assessed, i.e., selecting potential effects, individual implications, and likelihood (Wang et al., 2004). Power projects deal with an inherently high degree of risk because of unpredicted variations in work activities, processes, (an environmental organization?) and different stakeholders (Ibrahim 2017). According to PMI 2004, risk management is appropriately understanding, identifying, analyzing, and administering risk.
Usually, internal and external are two types of risks belonging to any project. The kind of risk is understood from the source of risks. Internal risks are found from the inside of organizations and can be controlled under specific conditions. On the contrary, extended factors are found outside the organizations that the organization cannot control. An EPC contract implements by replacing the conventional type of contract, considering project risk. The EPC contract implement presumes that completion time and cost will be less than the earlier traditional contract system. The extensive use of EPC contracts in emerging economics resulted in cost reduction and fast delivery of the project (Shen et al., 2016). So, to set up the roles, commitments, rights, and responsibilities among all the different organizations, a contract is needed to be created among them, establishing a collaborative environment to get a project (Pawar, C. S. et al., 2015).
Contracts play a vital role in any project to deliver a successful project. The contract documents help as a tool to control risk by assigning risks to the different agencies via the established contract (Flanagan, R. and Norman, G. 1993). The contract is essential for the owner to properly communicate the project purpose in designing a contract strategy to ensure that the most suitable risk approach has been chosen (Stam, D.W. 2005). Some essential contracting factors that become important across the project's life are managing risk, relationship, resource, responsibility,

record keeping, and acting ethically (Jamil, M. 2008). The contractual stability factor is one of the critical factors that affect project performance to achieve project success (Wu et al., 2018).

Some previous studies identified various risks and analyzed the impact of risk factors on project success, such as technical, human, usability, project teams, project organization, and strategic (Pare et al., 2008). Six risk factors for construction projects' performance have been identified: natural, design, resource, financial, legal, regulation, and construction risk (Chandra 2015). Thirty-nine are identified in the power transmission project and divided into five groups: policy and law, technology, natural environment, society, and management risk (Zhao and Guo, 2014). Five risk factors for the construction project's success have been identified: design, financial, technical, labor, and external (Khan and Gul, 2017). Some risks are identified and grouped into eight categories: physical, economic, legal, construction, political, design, environmental, and contractual risk (Shen L. Y., 2001).

The present study deals with risk management in the PT project construction EPC contract and aims to find an actual problem in PT project, which can be a barrier to project success in terms of project goals. The following contractual risk factor is considered in the present study in Table-2.

**Table 2: Contract Risk Factors of PT Projects**

| Category | Code | Factors of Contract Risk |
|---|---|---|
| **External (ET)** | **R1** | Suspension of Work |
| | **R2** | Opposition from Social Bodies |
| | **R3** | New Government Law |
| | **R4** | Political |
| **Technical (TE)** | **R5** | Changes in Design |
| | **R6** | Tests List with Frequency |
| | **R7** | Valid of Test Report |
| | **R8** | Adequate Conceptual Design |
| **Execution (EX)** | **R9** | Construction Facilities |
| | **R10** | Proper Communication |
| | **R11** | Proper Planning |
| | **R12** | Opposition from Social Bodies |
| | **R13** | Availability of Labor, Material, and Equipment |

| | | |
|---|---|---|
| **Financial (FI)** | **R14** | Extension of Time |
| | **R15** | Penalty for Delay |
| | **R16** | Extra Works Claim |
| | **R17** | Advance Payment |
| | **R18** | Price Variation Clause |
| **Legal (LE)** | **R19** | Labour Regulations |
| | **R20** | Environmental Safeguard |
| | **R21** | New Government Law |
| | **R22** | Safety Regulation |

## 4. Research Methodology

Risks associated with a contract of PT projects are identified using literature reviews and important ones based on the survey from 75 PT project experts from India. These risks are prioritized using AHP as the decision tool. At last, a structure is created outlining the connection between each risk. The itemized steps are mentioned in Figure.1

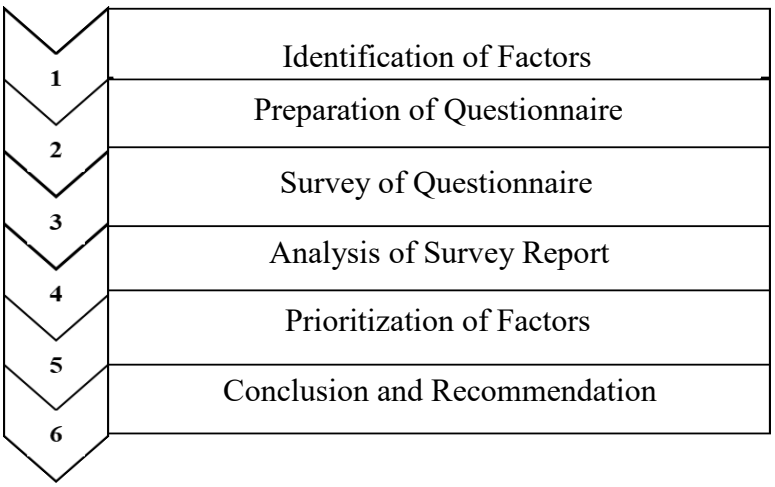


**Figure 1: Research Methodology**

Twenty-two factors into the five categories questionnaire survey were sent to 85 PT project experts through e-mail, and 75 valid responses were received. The first step in the AHP procedure is to make pairwise comparisons between each criterion.

Following the construction of the AHP model, the next step is to measure and collect data, which entails gathering a group of experts and assigning pairwise comparisons to the different risks, using a table of five-point scales (known as the Saaty Scale), and creating a questionnaire collection

that includes all of the factors and sub-factors. The questionnaire is organized based on such that for each question, ratings from 1-5. The expert will assign a score to each risk compare to other risks from the range of 1 to 5 (Table-3).

**Table 3: Scale for Rating**

| Intensity of Importance | Definition | Explanation |
|---|---|---|
| 1 | Equal importance | Two factors play an important role in achieving the goal. |
| 2 | Somewhat more critical | One has a small advantage on the other in terms of experience and decision. |
| 3 | Much more critical | One has a significant advantage on the other in terms of experience and decision. |
| 4 | Very much more Critical | One has a significant advantage of the other in terms of experience and decision. In reality, its significance is illustrated. |
| 5 | Most Critical | The proof that supports one side over another is of the greatest degree. |
| | Reciprocal | When evaluating one risk to another in reverse, the value will be 1/initial contrast. |

The fundamental strides in the detailing of an answer for a choice issue with the guide of AHP are not monotonous:

1. Equal importance
2. Somewhat more critical
3. Much more critical
4. Very much more critical
5. Most important critical

The risk factors (RF) are recognized through related studies and discussed with PT project professional views from Indian organizations. The survey results are then analyzed using a matrix to determine the main risks specified by all the experts. For each question, the survey results from each expert are different. The experts' relevant scores are noted in the table for each question, and the total Weightage is calculated.

## 5. Analysis and Discussion

In this study, various contract risk factors are prioritized by using of AHP model. The Table-4 has shown pairwise comparison results.

**Table 4: Pairwise Comparison Matrix**

| Factors | ET | TE | EX | FI | LE |
|---|---|---|---|---|---|
| **ET** | 1.00 | 1/3 | 2.00 | ¼ | ½ |
| **TE** | 3.00 | 1.00 | 4.00 | ½ | 2.00 |
| **EX** | ½ | ¼ | 1.00 | 1/5 | 1/3 |
| **FI** | 4.00 | 2.00 | 5.00 | 1.00 | 3.00 |
| **LE** | 2.00 | ½ | 3.00 | 1/3 | 1.00 |
| **SUM OF COLM** | 10.50 | 4.08 | 15.00 | 2.28 | 6.83 |

There are a few techniques for figuring the eigenvector. Making every section of the matrix standardized by isolating each estimation of the segment by the amount of a segment would standardize the qualities as demonstrated in Table-5.

**Table 5: Normalized Matrix**

| Factors | ET | TE | EX | FI | LE |
|---|---|---|---|---|---|
| **ET** | 0.10 | 0.08 | 0.13 | 0.11 | 0.07 |
| **TE** | 0.29 | 0.25 | 0.27 | 0.22 | 0.29 |
| **EX** | 0.05 | 0.06 | 0.07 | 0.09 | 0.05 |
| **FI** | 0.38 | 0.49 | 0.33 | 0.44 | 0.44 |
| **LE** | 0.19 | 0.12 | 0.20 | 0.15 | 0.15 |

As indicated by Eigenvector and Principal Vector, the elements are positioned as demonstrated in Table-6. Here Financial is the most basic factor, and afterward Technical, Legal, External, and Execution.

**Table 6: Average Value Matrix**

| Factors | Eigen Vector | Principal Vector | Rank |
|---|---|---|---|
| **ET** | 0.10 | 0.23 | 4 |
| **TE** | 0.26 | 0.62 | 2 |
| **EX** | 0.06 | 0.15 | 5 |
| **FI** | 0.42 | 1.00 | 1 |
| **LE** | 0.16 | 0.38 | 3 |

To ascertain λmax (max Eigen Value), duplicate on the privilege the framework of decisions by the eigenvector, getting another vector as demonstrated in Table-7.

**Table 7: Average Eigen Value**

| Factors | New Vector | λ (New Vector/PV) |
|---|---|---|
| **ET** | 0.49 | 5.02 |
| **TE** | 1.34 | 5.10 |
| **EX** | 0.31 | 5.03 |
| **FI** | 2.13 | 5.11 |
| **LE** | 0.81 | 5.06 |

In Analytic Hierarchy Process (AHP) strategy Finally, a Consistency Index can be determined utilizing the formula (λmax-N)/(N-1). That should be surveyed against decisions made totally aimlessly, and Saaty has determined huge examples of arbitrary lattices of expanding request and the Consistency Indices of those frameworks. A legitimate Consistency Ratio is determined by isolating the Consistency Index for the arrangement of decisions by the Index for the relating irregular grid, as demonstrated in Table-8.

Consistency Index (CI) = (λ max - N)/(N – 1)

Consistency Ratio (CR) = CI/RI corresponding to N

λmax = average of the RFs of λ. (see Table-7)

Where RI: Random Consistency Index (see Table-8) and N: Number of RFs

**Table 8: Random Consistency Index**

| N | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **RI** | 0 | 0 | 0.58 | 0.9 | 1.12 | 1.24 | 1.32 | 1.41 | 1.45 | 1.49 | 1.51 | 1.48 | 1.56 | 1.57 | 1.59 |

$$\lambda_{max} = 5.06$$

$$N = 5$$

$$CI = \frac{\lambda_{max}}{N\text{-}1} = 0.0158$$

$$CR = \frac{CI}{RI} = 0.0141$$

As per the most elevated prime vector, the level of consistency of pairwise examination risk is positioned as a count of consistency proportion (CR), which is viewed as consistency if a worth is under 10 percent. In this investigation, CR esteem is 0.0141 (1.41 %< 10%) implies risk factors are consistent. Saaty proposes that if that proportion surpasses 0.1, the arrangement of decisions might be too conflicting to possibly be dependable. By and by, CRs of more than 0.1 in some cases must be acknowledged. Assuming CR rises to that implies that the decisions are totally predictable.

Along these lines, it is proposed that the EPC Company appropriately oversee and control risk variables to be finished effectively.

## 6. Conclusion, Limitation, and Recommendation

The Power Transmission (Line and Substation) projects represent a dynamic environment where various activities are done simultaneously as agreed contracts between contractors and owners. Several contract risk factors are found in PT projects. This study discusses five contract risk factors: External, Technical, Execution, Finance, and Legal, along with 22 sub factors, from related studies and experts. The questionnaire survey was done to collect data from PT experts of different companies in India, and 75 valid responses were received. In this study, the AHP method is used to priorities the most critical contract risk factor. According to rank, Finance is the most critical contract risk factor, followed by Technical, Legal, External, and Execution.

The degree of impact level of contract risk factor will give a clear idea, which gives maximum benefit to PT project execution company.

The limitation of this study is a smaller number of responses, and survey was done from India only. Further research can develop a decision-making framework that can give optimal solutions for identifying and mitigating the most critical factors in PT projects.

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