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Case Study

IDENTIFYING AND MANAGING KEY RISKS IN CONSTRUCTION PROJECTS

Introduction

For the last couple of years, we have seen enormous growth in the construction industry of Pakistan due to local and foreign investments in Energy, Power and Infrastructure projects. Projects associated with China Pakistan Economic Corridor (CPEC) also contributing in the development of local construction industry.

However, evaluating and analyzing the risks of a construction project and planning to manage them are the most critical steps that should be done at the initial phase of the project lifecycle. There are numerous definitions of risks in the scientific sources. It is defined as the potential negative consequence(s) of an activity or an occurrence; it can also be defined as discrete happenings with negative or positive effects on the project. Despite of varied definitions for the risk, all contain a unique concept. In most of definitions for the risk, two aspects “loss” and “uncertainty” have been mentioned. Risk management is a system to identify and quantify all risks of a project/business in order to intelligent decision making. Risk management can be defined as the systematic practice of management policies, procedures, and processes related to activities on the risk analysis, evaluation, and control. Thus, the risk management is the documentation process of the final decisions, identifying and applying criteria which are used to reduce the risk to the acceptable level. Risk identification is defined as detecting, classifying, and documenting the risks influencing on the project and their specifications. First, a list including all potential occurrences and a list of different scenarios and causes regarding each occurrence are provided. Risk identification is a repetitive process which is performed by a part of project management team throughout project lifecycle.

Compared with many other industries, the construction industry is subject to more risks due to the unique features of construction activities, such as long period, complicated construction activities, abominable environment, financial intensity and dynamic organization structures.

Managing risks in construction projects is recognized as the insurmountable challenge to management in order to achieve the projects objectives in terms of time, cost, quality, safety and environmental sustainability.

The fundamental aim of this case study is to:

1. Identify key risks inherent in construction projects and provide solutions to transfer these risks from the perspective of project stakeholders. The study will highlight the key risk associated in a project with the comprehensive assessment of their likelihood of occurrence and the level of impact on the project objectives by identifying and prioritizing critical risk and providing solutions in managing these risks through contractual transfers.
2. The study will also aim to prioritize key risks identified by risk ranking and develop a comprehensive risk register in order to mitigate key risks identified during project life cycle.

Key Project Stakeholders

The selected group of respondents are mainly people who work for project companies with leading roles in project planning, financing and project execution. Also respondents from local insurance industry who are dealing in construction project insurance and advisory services. The selected parties in the study is based on their high competency and wide experience in handling various construction projects in Pakistan and overseas.

Key Project Success Factors

Four key Project success factors are considered by the senior management of project companies and as per the practices observed in the construction industry

- Meet financial return requirements (IRR = 15%)
- Meet key deadlines & milestones (financial close & COD)
- Meet and exceed quality, performance, and maintainability requirements
- Cause no harm to staff/3rd parties and environment

Providing Context to Ratings

Consequences are measured in terms of the potential effect of an event or circumstance on project success goals. Accordingly; the impact scale is linked to the project success goals and summarized in Table 1.

Project Success Goal	Level	Definition
Meet Financial Results Requirement (IRR=15%)	Critical (4)	Impact is greater than 20% of the contingency (1% of Budget).
	High (3)	Impact is greater than 10% of the contingency (0.5% of Budget).
	Medium (2)	Impact is greater than 2% of the contingency (0.1% of Budget).
	Low (1)	Impact is less than 2% of contingency until project closure.
Meet Key Deadlines & Milestones	Critical (4)	Risk or issue affects activities on the critical path or close to critical path and delays COD or financial close for more than 1 month
	High (3)	Risk or issue affects activities on the critical path or close to critical path and delays COD or financial close between 1 week and 1 month
	Medium (2)	Risk or issue affects activities on the critical path or close to critical path and delays project for 1 or 2 days
	Low (1)	Risk or issue has negligible effects on activities not on the critical path
Meet Quality, Performance, and Maintainability Requirements	Critical (4)	Critical shortfalls against the agreed quality/performance objectives, high probability of contract termination. Irrecoverable impact on regulator relationship, serious impact on each Partner's reputation in market.
	High (3)	Major shortfalls against the agreed quality/performance objectives. Recoverable but major impact on each Partner's reputation in market.
	Medium (2)	Minor shortfalls against the agreed quality/performance objectives. Rework requirements. No impact on regulator relationship or reputation.
	Low (1)	None or minimal shortfalls against the agreed quality/performance objectives. Minor rework requirements, no impact on regulator relationship or reputation.
Cause No Harm to People and Environment	Critical (4)	Significant hazardous or toxic release/damages Multiple fatality/multiple injuries following an accident
	High (3)	Environmental regulation violation/major clean up Single event leading to death or serious injury
	Medium (2)	Reportable violation resulting minor clean up, Loss time incident
	Low (1)	Minor clean up Near miss, minor incident

For probability rating, which refers to the potential for risks to occur and lead to the assessed level of impact, it is considered what would be meaningful for the project as it stands now and arrived at the ranges expressed in Table 2.

Level	Definition
Almost Certain (4)	Already an issue, or a greater than 75% of occurring
High (3)	Close to becoming an issue, or a greater than 25% of occurring
Medium (2)	5%-25% chance of risk materializing
Low (1)	Less than 5% probability of risk materializing

A simple table converted the impact and probability ratings to priorities as depicted in Figure 1. As a guide, the level of risk shown in Figure 1 has the following interpretation:

- Very High:** an intolerable risk that might threaten the survival or effectiveness of the project, where immediate action is required at a senior level
- High:** an intolerable risk that would have a significant adverse effect on the project, where senior management attention is needed
- Medium:** a barely tolerable risk where management responsibility must be specified
- Low:** a tolerable risk that can be managed by routine procedures

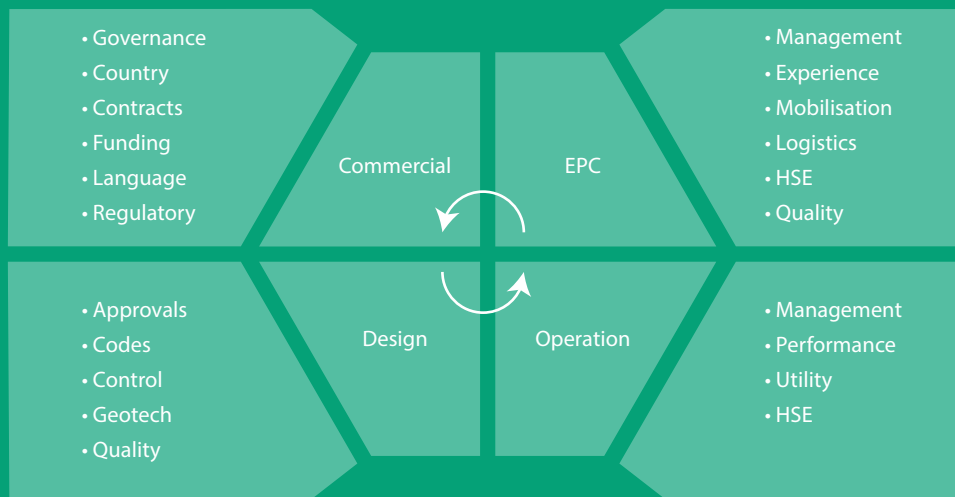
Impact Likelihood	(1) Low	(2) Medium	(3) high	(4) Critical
(4) Almost certain	Medium	High	Very High	Very High
(3) Likely	Medium	Medium	High	Very High
(2) possible	Low	Medium	High	Very High
(1) Unlikely	Low	Low	Medium	High

Initial Risk List

Classification of risks is one of the significant step in the risk management process, as it attempts to capture the various risks that would affect construction projects. To manage risks effectively, many approaches are used in the industry for classification of risks.

An initial risk list was developed from various construction projects which experienced these risks during different project phases. Items are classified into the elements in Figure 2. The list combined the holistic approach of risk identified during construction project which are grouped into four main risk categories: Commercial, EPC, Design & Construction / Operations. The rationale behind classification of below risk categories is based from the perspective of project stakeholders and its lifecycle.

Figure 2: Risk Classification



Interview / Discussion Outcome

Risk Assessment

The Risk Assessment through interviews / discussions with various project stakeholders have been undertaken across a number of areas to determine what the critical risks are; and what mitigation measures the project staff will put in place in order to reduce the impact and/or likelihood of these risks.

The information received from respondents through interviews / discussions were analyzed qualitatively based on the likelihood of risk occurrence, its impact and priority considered by project stakeholders – please refer Table 3: Risk Classification Index.

In qualitative analysis, 08 key risks have been identified with Very High & High priority by project stakeholders. Interestingly, most of the key risks identified are clustered from Commercial risk classification, 02 are identified under EPC and 01 under Design risk classification.

Table – 2: Summary of Risk Assessment results

Key Risk Outcomes		
Total number	of risks assessed in the Interview / Discussion	26
Number of risks identified as being:		
-	Very High	3
-	High	5
-	Medium	18
-	Low	-
Risk category	that contain the highest concentration of high risks	Commercial

Table 3: Risk Classification Index

Risk Classification	Very High	High	Medium	Low
Commercial				
Delay in awarding of LNTP (Limited Notice to Proceed)	9	1		
Lenders consent for LNTP (Limited Notice to Proceed) are not captured	4	5	1	
Delay in FC (Financial Close) due to non-availability of Insurance	5	4	1	
Complex Project Organization			6	4
Absence of Specialists in project financial analysis			9	1
Delay in approvals from regulators	5	5		
Deterioration in country security		2	8	
Slow finalization of debt financing	3	6	1	
EPC (Engineering, Procurement & Construction)				
EPC fails to provide skilled manpower at the right time		1	9	
Delay in acquiring commodity items on site (steel, cement, etc.)		1	7	2
Loss or damage to long lead equipment during shipment	1	8	1	
Construction delays due to extended Monsoon Season		1	6	3
Unsuitable construction program planning		3	7	
Low management competency of subcontractors			7	3
Specialist EPC contractor		2	6	2
Design				
Inadequate or incorrect design		4	6	
Plans of design are incompatible with execution			9	1
Many design modifications during execution		1	9	
Designs are changed by the engineers			8	2
Defective design	3	7		
Construction				
General safety accident occurrence		1	7	2
Damaged by natural perils	1	7	1	1
Poor quality of materials procured		2	8	
Property damage or injury to third parties		1	6	5
Environmental leakage and Pollution		4	6	
Inadequate Fire Protection measures at site		3	6	1

Risk Ranking

The overall purpose of Risk Ranking methodology is to provide project stakeholders with an effective and consistent process to evaluate, rank and ultimately manage risks. The purpose of applying risk ranking in project risk management is to support stakeholders in mapping out how well they manage their risk in different phases of the project.

After qualitative assessment of risks, 08 key risks are identified in different risk classification. The next step is to rank these key risks according to their significance and impact on the project cost, time and performance.

For risk ranking, risk significance index (RSI) methodology is used to show the relative significance among the risks associated with construction projects. Each respondent was asked to evaluate two characteristics of each risk: (i) the likelihood of risk occurrence α and (ii) the degree of impact or the level of loss if the risk occurs β .

The RSI, shown in eq. [1], is calculated by converting the four-point scales for α (low–medium–high–certain) and β (low–medium–high–critical) into numerical scales. The scale chosen along with the matrix for the RSI are shown in Table 4.

A	B			
	Critical (1.0)	High (0.75)	Medium (0.50)	Low (0.1)
Certain (1.0)	1	0.75	0.5	0.1
High (0.75)	0.75	0.5625	0.375	0.075
Medium (0.5)	0.5	0.375	0.25	0.05
Low (0.1)	0.1	0.075	0.05	0.01

$$RS_{ij} = \alpha_{ij} \beta_{ij} \quad \text{Equation [1]}$$

Where RS_{ij} is the risk significance index assessed for risk i by respondent j , α_{ij} is the likelihood of occurrence of risk i assessed by respondent j , and β_{ij} is the degree of impact of risk i assessed by respondent j .

Finally, the mean RSI (MRSI) for each risk i was calculated using equation [2] with n number of respondents as:

$$MRS_{ij} = \sum RSI_{ij} / n \quad \text{Equation [2]}$$

The index scores will be used to rank risk factors in the following section. Please note that the method for calculating the significance index score may overlook those risks with a less likelihood of occurrence but a high level of impact on project objectives, which should be taken into account in the risk management practice and however not the focus of this study.

Disregarding the risk category, only key risks are ranked in accordance with the index scores measuring their significance on the project cost, time, quality / performance, environment and people safety. In doing so, use methodology for ranking as per each risk's significance score on individual project objective. This method ranks key risks affecting each project objective.

The result of the ranking is presented in Table 5 on next page.

Key Risks Identified	RSignificance Index Score
Delay in awarding of LNTP (Limited Notice to Proceed)	0.806
Delay in FC (Financial Close) due to non-availability of Insurance	0.669
Delay in approvals from regulators	0.650
Defective Design	0.619
Lenders consent for LNTP (Limited Notice to Proceed) are not captured	
Slow finalization of debt financing	0.613
Loss or damage to long lead equipment during shipment	
Damaged by Natural Perils	0.354

Out of 26 risks assessed in this case study, 08 key risks were identified which would have significant impact in achieving the project objectives i.e. in terms of cost, time, quality / performance and environment / safety. In the risk ranking exercise, it is observed that Delay in awarding Limited Notice to Proceed (LNTP) is the most significant risk having significance index score of 0.806.

In the above risk ranking table, three key risks have same significance index of 0.613 which have equal potential of impacting various project objectives during construction project life cycle.

Risk Treatment

Having reviewed and assessed the risks, appropriate risk mitigation plans need to be put in place to mitigate the potential effects should they occur. A risk owner for each risk has been suggested who should be preparing adequate mitigation plans for each risk. It is recommended that below items to be considered when developing adequate action plans:

- Risks with a high probability of occurring but a small impact respond better to risk reduction while risks with a low probability of occurring but a high impact respond better to prevention plans. This philosophy should be carried into the development of action plan. It is not uncommon for clients to record whether an action plan is prevention, mitigation or monitoring.
- There should be a clear definition of what needs to be done with enough detail to ensure that the person executing the action plan knows exactly what he/she is to do. If there is an action that will be performed more than once, "periodic reporting" for example, then a standard form should be implemented with an associated procedure so that all of the information that is to be collected is collected, in accordance with the procedure. This provides for more consistency in how the risk is managed.

Risk Register

The risk register is developed based on the risk assessment and ranking and is provided in Table 6. The risk register incorporates all potential key risks to the project – in this regard a ‘risk’ exposure is an event that could affect the schedule and/or cost of the project should it materialise.

The register is based on interpretation of the key project risks facing the Project following review of the data provided. The risk register also considers the mitigation plan for key risks identified either through insurance / contractual options for transferring the identified risk exposures. Each risk exposure is ‘mapped’ against insurances to determine overall insurability. For those risks that are ‘uninsurable’ recommendations are provided to manage these exposures either through:

- Contractual allocation of risk
- Other risk mitigation activities

Table 6: Risk Register

Key Category	Key Risk	Assumptions	Mean Risk Significance Index	Mitigation	Owner
Commercial	Delay in awarding of LNTP results in delay COD	LNTP award has land transfer, PPA, financing due diligence initiation preconditions.	0.806	Lender's insurance requirements must be agreed. Lender's risks in the construction project must be adequately addressed and covered under insurance & contracts.	Project Head
Commercial	Delay in FC (Financial Close) due to non-availability of Insurance	Inability to obtain insurance in a timely manner delays financial close	0.669	Appointment of Insurance Broker on Construction Project. Insurance Broker responsible for insurance / re-insurance placement.	CFO
Commercial	Delay in approvals from regulators	Delayed/adverse consent/ approvals from regulators	0.650	Regularly monitor any changes in regulations. Must aware all local regulations & compliance.	Company Secretary
Design	Defective Design	Inadequate or incorrect design impacts the project's ability to meet its performance requirements and therefore the overall success of the project	0.619	Design defects lead to rework, delay of project and cost increases (designers lack of experience in Pakistan, complex organization, language) Local environmental conditions/standards/practices not considered in design leading to increased maintenance costs and downtime The designers and EPC contractors do not fully comply with the local codes and standards Insurance: London Engineering Group (LEG) clauses to cover design defects and its consequential losses.	Project Head
Commercial	Lenders consent for LNTP (Limited Notice to Proceed) are not captured		0.613	Commitments should already be made from sponsors.	CFO
Commercial	Slow finalization of debt financing	Delays the project due to clarification requirements during due diligence/inexperience of bank project financing teams	0.613	Experienced finance team Make best use of the credible status of the client in arranging the financing Junior facilities/owner resources will be provided in case of cost overruns.	CFO
EPC	Loss or damage to long lead equipment during shipment	Loss or damage to long lead equipment during transport from OEM to site or during storage	0.613	Insurers inspections and OE packaging inspections will be used as mitigants Accelerated corrosion of equipment can take place during transit. Marine Project Cargo Insurance cover.	Project Head
Construction	Damage by Natural Perils	Damage to New Plant during construction by natural perils including earthquake shock, wind storm, flood and fire	0.354	Firefighting capabilities, and emergency response plans during construction. Insurance cover available.	Project Head

Recommendations

Based on our survey, it is recommended for project companies that risk management should be a regular agenda item for project management meetings; with very high and high risks maintained in a Risk Register. As issues are resolved or change or as new risks emerge the Risk Register should be updated.

In the project meeting agenda under the Risk Management heading, it is advised that below items to be considered by the project company:

- For each item on the lead risk register, the progress and effectiveness of mitigation actions should be reviewed, and adjustments to Action Plans should be made as needed.
- Very high and high risks for which effective mitigation action has been completed should be re-assessed and re-classified, and removed from the risk register if appropriate.
- Medium/low risks that have changed in status and become important enough to be reclassified should be included in the risk register, and responsibilities and timings for preparing detailed Action Plans should be allocated.

- Any emerging risk, including those that have been identified by in other parts of the project, should be considered and Very High/High ones should be added to the risk register. Action Plan summaries should be included in the Risk Register and in appropriate project plans.
- Issues in project risks and in overall risk management framework should be considered, and any necessary changes should be discussed.
- Review the risk register, including the description of risks and their ratings.
- Review owners for each risk and assign responsibilities for developing options for avoiding/controlling major risks, and set times by which action plans should be prepared.
- Ensure that agreed actions for treating risks are included in project plans, necessary resources are allocated in personnel and financial budgets and adequate processes are in place for monitoring the status of implementation of the action plans.
- Regularly (at least monthly) monitor, review and update the risk register. The update should identify emerging risks, remove obsolete risks, and evaluate the status of the action plans.

Conclusion

This case study endeavored to identify key risks associated with the achievement of all construction project objectives in terms of cost, time, quality / performance, environment and safety. On the basis of interviews / discussions with industry practitioners owning robust experience and knowledge of construction projects.

All participants in the discussion had an opportunity to share their knowledge and they developed an understanding of all aspects of the construction project and where their own specific areas of interest contributed to the achievement of project outcomes.

Based on a comprehensive assessment of the likelihood of occurrence and their impacts on the project objectives, this paper identifies twenty six major risks. This study found that these risks are mainly related to (in ranking) contractors, clients, designers and lenders, with few related to government bodies, subcontractors/suppliers and external issues. Among them, “tight project schedule” is recognized to influence all project objectives maximally, whereas “design variations”, “excessive approval procedures in administrative government departments”, “high performance/quality expectation”, “unsuitable construction program planning”, as well as “variations of construction program” are deemed to impact at least four aspects of project objectives which we outlined in this paper.

Mostly “Commercial Risks” were found to have significant impact on all four aspects of project objectives while the rest risks can significantly influence at least one aspect of project objectives.

The study also found that these risks spread through the whole project life cycle and many risks occur at more than one phase, with the construction stage as the most risky phase, followed by the feasibility stage. It is concluded that clients, designers, lenders and government bodies must work cooperatively from the feasibility phase onwards to address potential risks in time, and contractors and subcontractors with robust construction and management knowledge must be employed early to make sound preparation for carrying out safe, efficient and quality construction activities.

This study also generated a risk register for construction projects, covering finance, design, manufacture, construction, and commissioning phases, and also the overall approach for project governance/management with agreed ratings of consequences, likelihoods and risk ratings.

Risk register for the key risks identified in construction projects are also developed which is based on their priority and risk ranking. Risk register also covers mitigation plan for managing these key risks in an effective manner.