

Developing a Model of Risk Allocation and Risk Handling for Effective Risk Management System in Construction Project

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Abstract - Every construction project consists of various risks. During project life cycle, uncertain events take place. Due to these uncertain events, positive or negative impact takes place on project objectives such as time, cost and quality. It is impossible to remove all risks, so we try to identify and mitigate them to prevent project failure. Risk is also defined as probability of occurrence of undesirable event and will have impact on project objectives such as time, cost and quality. Success of an construction project is greatly influenced by proper management of the risks. Risk management is increasingly a critical success factor for major construction projects. This paper aims to identify risks associated with the construction projects and assessment of risks with and classifies them into six types. The process followed by allocation of risks to different parties. After that mitigation strategies are proposed and implemented for case study and risks are again assessed.

established at the beginning of the project conceptualization but it is a continuous process which has to be carried in all the phases of project lifecycle. Risk management also play a role in strategic decision making for the project stakeholders by improving the strategic management through selection of better objectives and associated targets as a result of risk identification, analysis, evaluation, treatment and monitoring process.

2. METHODOLOGY

The research methodologies are used in order to collect data, analysis data and report on findings and results. The research methodology selected for this risk management project comprised comprehensive literature review, followed by open interviews and distributing questionnaire surveys to the respondents. Qualitative analysis technique used for data analysis

Key Words: Construction, Risk, Project, Assessment, Impact.

1. INTRODUCTION

Risk is the chance that an event would occur which will lead to change in the project objectives. To ensure that these events do not lead to failure of the projects, there is a need to manage the risks associated with the projects through adoption of appropriate risk management framework. The concept of risk management, therefore, deals with identifying the risks associated with the project, assessing their probability of occurrence and their potential impact on critical project performance measures, and employing direct and indirect means for either reducing the exposure of the underlying project activities to these risks or shifting some of the exposure to other. Risk management is an ongoing process which continues through the lifecycle of project. The process of risk management involves following stages:

- Risk identification
- Risk assessment
- Risk allocation
- Risk mitigation

Project gets various benefits on undertaking an effective risk management exercise in a structured manner. Risk management should not be considered as a process

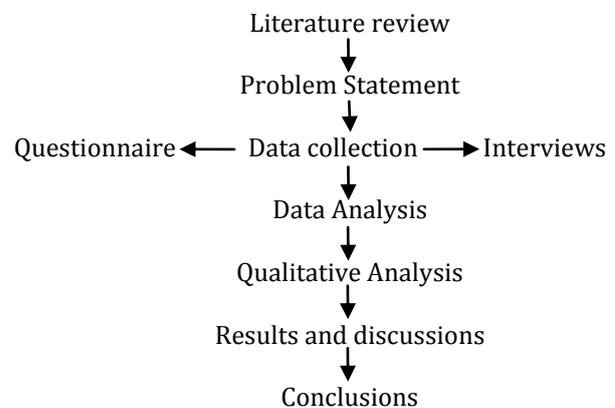


Fig-1: Methodology adopted for research

3. RISK MANAGEMENT PROCESS

A. RISK IDENTIFICATION

The risk identification process can involve, wherever appropriate, participants such as project manager, project team members, risk management team, subject matter experts from outside the project team, customers. For this research, interviewing technique is used for risk identification. Prior set of questions were prepared and

interviews of project team member were taken. Respondents participated in the interview were 28 which includes project managers, senior engineers, junior engineers, supervisors, surveyors and departmental officials.

Prior set of questions

1. What are the current practices of risk management in your organization?
2. What are the risks before starting construction work? (Pre-construction)
3. What are the risks during construction work? (Construction)
4. What are the risks after construction? (Operation & Maintenance)
5. What are the risks related to equipments?
6. What are the risks related to schedule?
7. What are the risks related to the cost?
8. What are the risks related to quality
9. What are the risks related to human resources?
10. What are the risks associated with the procurement?
11. What are the risks related to plants?
12. What are the risks associated with site conditions?

Respondents' analysis according to years of experience

Table 1: Respondents' analysis

S.N	Years of experience	Numbers	Percentage %
1	0-5	12	42.85
2	5-10	6	21.42
3	10 above	10	35.71

List of Identified Risks

- ❖ Incomplete design
- ❖ Delay in site possession
- ❖ Replacement of consultant
- ❖ Delay in material transportation
- ❖ Labor accidents
- ❖ Delay in owners payment
- ❖ Shortage of approved construction drawings
- ❖ Replacement of material
- ❖ Political bribery and corruption
- ❖ On site congestion
- ❖ Unrealistic cost and schedule estimates
- ❖ Financial delays
- ❖ Inadequate cost planning
- ❖ Unavailability of project charter
- ❖ Untrained manpower
- ❖ Absence of laboratories for testing
- ❖ Defective design
- ❖ Poor allocation of resources
- ❖ Poor motivation

- ❖ Unsafe working conditions
- ❖ Lack of managerial skills
- ❖ Unsatisfactory conduct of status review meetings
- ❖ High cost of legal decisions
- ❖ Poor labor planning
- ❖ Poor quality material
- ❖ Needs requested by stakeholders
- ❖ Lack of specialized staff
- ❖ Force majeure
- ❖ Inexperienced staff
- ❖ Cost overrun
- ❖ Breakdown of plants
- ❖ Low production by plants
- ❖ Unavailability of raw material required for plants
- ❖ Delay in land acquisition
- ❖ Pre investment risk
- ❖ Traffic revenue risk
- ❖ Conflict between actual and contract quantities
- ❖ Insufficient time to prepare bidding document
- ❖ Delay in approval
- ❖ Lack of decision making
- ❖ Inadequate site investigations
- ❖ Unavailability of funds
- ❖ Change in project scope and change orders
- ❖ Design changes
- ❖ Disputes and claims
- ❖ Escalation of material prices
- ❖ Lack of coordination
- ❖ Inadequate project planning
- ❖ Incompetent subcontractor
- ❖ Construction delays
- ❖ Insufficient technology
- ❖ Low labor productivity
- ❖ Unclear scope of work
- ❖ Delay in approval from regulatory bodies
- ❖ Poor documentations
- ❖ Unstable government policies
- ❖ Poor material management & planning
- ❖ Poor equipment management & planning
- ❖ Delay of mobilization
- ❖ Unexpected Surface conditions
- ❖ Unpredicted Weather conditions
- ❖ Construction area (rural/urban)
- ❖ Access conditions
- ❖ Differing site conditions
- ❖ Security requirements
- ❖ Labor availability
- ❖ Drop in Labor productivity
- ❖ Equipment quality

- ❖ Equipment breakdown
- ❖ Equipment maintenance
- ❖ Material theft & damage
- ❖ Material storage
- ❖ Defective work
- ❖ Change in currency rate
- ❖ Fluctuation in prices
- ❖ Unavailability of land
- ❖ Improper construction methods

Risk factor = Probability X Impact
 $R = P \times I$
 Where P= probability occurrence
 I= Impact

Risk factors of identified risks

Table 4: Risk Factors

Risk	Risk Factor
Incomplete design	1.04
Delay in site possession	5.69
Replacement of consultant	1.51
Delay in material transportation	3.05
Labor accidents	1.31
Delay in owners payment	7.14
Shortage of approved construction drawings	1.53
Replacement of material	1.67
Political bribery and corruption	8.41
On site congestion	1.21
Unrealistic cost and schedule estimates	1.99
Financial delays	2.67
Inadequate cost planning	1.41
Unavailability of project charter	1.85
Untrained manpower	0.63
Absence of laboratories for testing	0.54
Defective design	0.95
Poor allocation of resources	1.89
Poor motivation	1.16
Unsafe working conditions	1.26
Lack of managerial skills	2.54
Unsatisfactory conduct of status review meetings	6.89
High cost of legal decisions	5.48
Poor labor planning	1.79
Poor quality material	1.31
Needs requested by stakeholders	8.22
Lack of specialized staff	1.54
Force majeure	7.37
Inexperienced staff	1.20
Cost overrun	7.34
Breakdown of plants	2.73
Low production by plants	1.33
Unavailability of raw material required for plants	1.11
Delay in land acquisition	8.33
Pre investment risk	3.09
Traffic revenue risk	3.05
Conflict between actual and contract quantities	2.46
Insufficient time to prepare bidding document	1.54
Delay in approval	1.33
Lack of decision making	1.58
Inadequate site investigations	1.40

B. RISK ASSESSMENT

After identifying the risks in the projects, the next stage in the risk management process is to carry out risk assessment in order to quantify the risk by estimating the probability of occurrence of the risk and the impact of the consequence if the risk occurs. Qualitative risk analysis quantifies the magnitude of the potential consequences and the likelihood that those consequences will occur in linguistic terms using words. Qualitative risk analysis is normally use as a technique for prioritization of the identified risks for further detailed analysis. Linguistics scale with descriptions can be used to describe the probability and impact of risks. Linguistic scale to solicit responses from experts on probability of risk event occurring could be a five point scale with the levels described by the linguistic terms, very low, low, medium, High and very High, in ascending order. Similarly, the scale for soliciting consequence of risk can be a three point scale with the five levels described with the linguistic terms: low, medium, High in ascending order.

Table 2: Values of linguistics scale for Probability

Linguistics scale	Very low	Low	Medium	High	Very high
Probability score	0.1	0.3	0.5	0.7	0.9

Table 3: Values of linguistics scale for Impact

Linguistics scale	Low	Medium	High
Impact Score	03	05	10

Risk factor

Probability of occurrence and impact is taken from respondents by distributing questionnaire among them. For every risk events risk factor is calculated for all the respondents and average of the every event is calculated and risk factor used for risk prioritization. Risk factor is important to know which risk will have significant impact on project objectives. According to risk factor risks are prioritized. After assigning values to the probability and impact risk factor (R) is calculated.

Unavailability of funds	8.00
Change in project scope and change orders	2.15
Design changes	2.36
Disputes and claims	7.55
Escalation of material prices	2.67
Lack of coordination	1.70
Inadequate project planning	1.60
Incompetent subcontractor	1.04
Construction delays	7.52
Insufficient technology	1.43
Low labor productivity	1.96
Unclear scope of work	1.20
Delay in approval from regulatory bodies	1.66
Poor documentations	0.98
Unstable government policies	1.47
Poor material management & planning	1.40
Poor equipment management & planning	2.43
Delay of mobilization	4.04
Unexpected Surface conditions	1.16
Unpredicted Weather conditions	1.28
Construction area (rural/urban)	3.39
Access conditions	1.56
Differing site conditions	2.18
Security requirements	1.44
Labor availability	2.33
Drop in Labor productivity	2.20
Equipment quality	1.57
Equipment breakdown	6.51
Equipment maintenance	1.90
Material theft & damage	2.98
Material storage	1.75
Defective work	0.94
Change in currency rate	1.19
Fluctuation in prices	1.37
Unavailability of land	8.05
Improper construction methods	1.63

Risk Priority

Risk prioritization is necessary to find out which risk has significant impact on projects objectives. Most significant risks are mitigated using mitigation strategies. Risk prioritized according to their risk factor in ascending order. Most significant risk according to risk factors.

Table 5: Most significant risks

S.N	Risk	Risk Factor
1	Political bribery and corruption	8.41
2	Delay in land acquisition	8.33
3	Needs requested by stakeholders	8.22
4	Unavailability of land	8.05
5	Unavailability of funds	8.00

6	Disputes and claims	7.55
7	Construction delays	7.52
8	Force majeure	7.37
9	Cost overrun	7.34
10	Delay in owners payment	7.14
11	Unsatisfactory conduct of status review meetings	6.89
12	Equipment breakdown	6.51
13	Delay in site possession	5.69
14	High cost of legal decisions	5.48
15	Delay of mobilization	4.04

C. RISK ALLOCATION

As per the risk allocation principles, risks should be allocated to the party who is in the best position to manage the risk. If the party responsible for mitigating the risk uses its capacity for the overall interests of the project, then there is opportunity to maximize the value for money outcome for the government. After taking questionnaires from respondents, the identified risks are allocated to the parties according to respondent’s experience.

Results of risk allocated to parties

Table 6: Risks allocated to parties

S.N	Risk	Risk allocated to
1	Political bribery and corruption	Contractor
2	Delay in land acquisition	Owner
3	Needs requested by stakeholders	Contractor
4	Unavailability of land	Owner
5	Unavailability of funds	Owner
6	Disputes and claims	Consultant
7	Construction delays	Contractor
8	Force majeure	Consultant
9	Cost overrun	Contractor
10	Delay in owners payment	Owner
11	Unsatisfactory conduct of status review meetings	Consultant
12	Equipment breakdown	Contractor
13	Delay in site possession	Owner
14	High cost of legal decisions	Contractor and owner
15	Delay of mobilization	Contractor

D. RISK MITIGATION

Risk mitigation is often referred to as risk control, which involves handling risks in a manner that achieves project and business goals efficiently and effectively. Based on these approaches, there are basically four strategies for risk mitigation. Responses of respondents are taken. From that

which approach has maximum responses of mitigation is used approach for mitigation of risks. The strategies are:

- Risk Avoidance
- Risk Reduction
- Risk Transfer and
- Risk Retention

Results of Risk mitigation

Table 7: Results of mitigation approaches

S.N	Risk	Mitigation approach
1	Political bribery and corruption	Risk Reduction
2	Delay in land acquisition	Risk Transfer
3	Needs requested by stakeholders	Risk Avoidance
4	Unavailability of land	Risk Transfer
5	Unavailability of funds	Risk Transfer
6	Disputes and claims	Risk Reduction + Risk Transfer
7	Construction delays	Risk Avoidance
8	Force majeure	Risk Retention
9	Cost overrun	Risk Reduction
10	Delay in owners payment	Risk Transfer
11	Unsatisfactory conduct of status review meetings	Risk Avoidance
12	Equipment breakdown	Risk Avoidance
13	Delay in site possession	Risk Reduction
14	High cost of legal decisions	Risk Reduction
15	Delay of mobilization	Risk Avoidance

E. IMPLEMENTATION OF MITIGATION STRATEGIES

It is necessary to implement the strategies for significant risks. It is helpful to know which mitigation strategies are working effectively.

Results of risk factors after implementing mitigation strategies

Table 8: Risk factors after implementing mitigation strategies

S.N	Risk	Risk factor
1	Political bribery and corruption	3.60
2	Delay in land acquisition	3.74
3	Needs requested by stakeholders	0.86
4	Unavailability of land	3.69
5	Unavailability of funds	1.14
6	Disputes and claims	1.24
7	Construction delays	2.34
8	Force majeure	4.44
9	Cost overrun	2.89

10	Delay in owners payment	0.6
11	Unsatisfactory conduct of status review meetings	0.36
12	Equipment breakdown	1.24
13	Delay in site possession	1.76
14	High cost of legal decisions	2.8
15	Delay of mobilization	1.96

4. CONCLUSIONS

- 1) For the road projects total 77 risks identified after taking interviews of the respondents.
- 2) Most significant risks are taken into account according to risk factors.
- 3) These are political bribery and corruption, delay in land acquisition, needs requested by stakeholders, unavailability of land, unavailability of funds, disputes and claims, construction delays, force majeure, cost overrun, delay in owners payment, unsatisfactory conduct of status review meetings, equipment breakdown, delay in site possession, high cost of legal decisions, delay of mobilization.
- 4) Risks are allocated to parties according to responses of respondents. Six risks are allocated to contractor, five risks to the owner, three risks to the consultant and one risk is shared between contractor and owner.
- 5) Mitigation approaches which are used for mitigation of risks. Risk Transfer and risk reduction approach used for risk Dispute and claims. Mitigation strategies are used for mitigating risks.
- 6) Risks are assessed after implementing mitigation strategies. Before implementation highest risk factor was 8.40 for political bribery and corruption .After implementation it was reduced to 3.6 and after implementation highest risk factor is 4.44 for force majeure initially it was 7.37. For the risks whose risk factor is less than 2.5 after implementing strategies are mitigation strategies are effective. These risks are needs requested by stakeholders, unavailability of funds, disputes and claims, construction delays, delay in owners payment, unsatisfactory conduct of status review meetings, equipment breakdown, delay in site possession, delay of mobilization.

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