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Conceptual Study on Risk Management Process in Construction Projects: A Review

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Abstract—Construction industry is highly risk prone, with complex and dynamic project environments creating an atmosphere of high uncertainty and risk. The industry is vulnerable to various technical, sociopolitical and business risks. The track record to cope with these risks has not been very good in construction industry. As a result, the people working in the industry bear various failures, such as, failure of abiding by quality and operational requirements, cost overruns and uncertain delays in project completion. In light of this, it can be said that an effective systems of risk assessment and management for construction industry remains a challenging task for the industry practitioners.

This paper aims to identify and evaluate current risks and uncertainties in the construction industry through extensive literature survey and aims to make a basis for future studies for development of a risk management framework to be adopted by prospective investors, developers and contractors in Pakistan. Risk management is a process which consists of identification of risks, assessment with qualitatively and quantitatively, response with a suitable method for handling risks, and then control the risks by monitoring. This study proposes to apply the risk management technique which includes well documented procedures for the one stop solution all types of hazards most likely to occur during any construction project Lifecycle. The paper also concentrates on a case study to determine how RM theories are used in practice for the construction project of a school.

Keywords: *Project management, risk management, risk analysis, contractors.*

1. INTRODUCTION

The development of infrastructure is one of the most important activities that can boost up the business of various industries, thereby increasing the gross domestic product (GDP) of the country. Construction projects are always unique and risks raises from a number of different sources. Risks and uncertainties inherent in the construction industry are more than other industries. The process of planning, executing and maintaining all project activities is complex and time-consuming. The whole process requires a myriad of people with diverse skill sets and the coordination of a vast amount of complex and interrelated activities. The situation is made complex by many external factors. The track record of construction industry is very poor in terms of coping with risks, resulting in the failure of many projects to meet time schedules, targets of budget and sometimes even the scope of work.

2. TYPES OF RISKS

Risk associated with construction industry can be broadly categorized into:

a) Technical risks: Inadequate site investigation, Incomplete design, Appropriateness of specifications, Uncertainty over the source and availability of materials.

b) Logistical risks: Availability of sufficient transportation facilities, Availability of resources-particularly construction equipment spare parts, fuel and labor.

c) Management related risks: Uncertain productivity of resources, Industrial relations problems.

d) Environmental risks: Weather and seasonal implications, Natural disasters.

e) Financial risks: Availability and fluctuation in foreign exchange, Delays in Payment, Inflation, Local taxes, Repatriation of funds.

f) Socio-political risks: Constraints on the availability and employment of expatriate staff, Customs and import restrictions and procedures, Difficulties in disposing of plant and equipment, Insistence on use of local firms and agents.

3. FACTORS AFFECTING RISKS

1. History: Newer projects are more prone to risks as they are different from the other projects. Older projects are likelihood of success against risks because there are similar projects has been done before.

2. Management Stability: Management stability means the whole management share the same goal or objective for any project. Therefore, it will be beneficial to achieve the project objectives with much ease. If the management is unstable then it can lead to affect the project objectives.

3. Staff expertise and experience: If the staff for any project is sufficiently experienced and with different expertise the likelihood of quality, cost and other objectives can be achieved.

4. Team Size: For larger teams of any project there are more chances of occurrence of problem because of miscommunication.

5. Resource Availability: If the project is available with a good amount of resources then the response to the problem will be good. Because if the project is available with greater amount of resources than it can deal with different risks with ease.

6. Time Compression: If the project schedule is highly compressed there are more chances of occurrence of risks in projects. When more time is available for the project, then it can be coped up by reducing risk impact on the project.

7. Complexity: If the project is highly complex there are more chances for the occurrence of problem in the project.

4. RISK MANAGEMENT PROCESS

Risk management is the process which consists of identification, assessment, response, control as shown in Fig. no. 1.

Fig. 1: Risk management process

4.1. Risk Identification.

It can be done by the following methods:

Brainstorming: All relevant persons associated with project gather at one place. There is one facilitator who is briefing about various aspects with the participants and then after note down the factors. Before closing it the facilitator review the factors eliminate the unnecessary ones.

Delphi Technique: This technique is similar to brainstorming but the participants in this do not know each other and they are not at the same place. They will identify the factors without consulting other participants. The facilitator like in brainstorming, sums up the identified factors.

Interview/Expert Opinion: Experts or personnel with sufficient experience in a project can be a great help in avoiding/solving similar problems over and over again. All the participants or the relevant persons in the project can be interviewed for the identification of factors affecting risk.

Past Experience: Past experience from the same kind of project, the analogy can be formed for identification of the factors. When comparing the characteristics of projects will provide insight about the common factors.

Checklists: These are simple but very useful predetermined lists of factors that are possible for the project. The check list which contains a list of the risks identified in projects undertaken in the past and the responses to those risks provides a head start in risk identification.

4.2. Risk Assessment.

It can be done by the following methods:

QUALITATIVE METHOD:

Risk Priority Number:

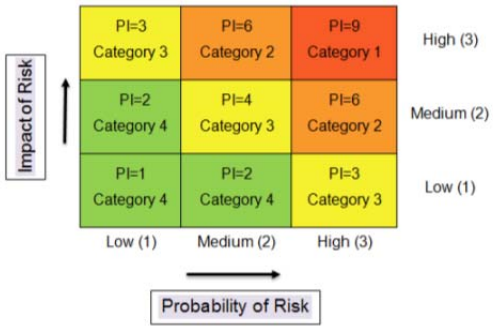

Fig. 2. Risk priority no:

There are 4 categories defined in the above diagram. Category 1 - PI factor 9, which requires maximum attention Category 2 - PI Factor 6, which requires a good amount of attention Category 3 - PI Factor 3, which requires comparatively less attention to be paid Category 4 - PI Factors of 1 and 2, requires less attention to be paid Quantitative methods Sensitivity Analysis:

This is carried out to identify the uncertain project components which will have maximum impact on the outcome of the project. After a risk model is made a sensitivity analysis is carried out to check the sensitivity of different elements of the model on project outcome. To do these the values of one variable at a time is changed and the impact of these changes is then seen on the project.

QUANTITATIVE METHODS

Scenario Analysis: Scenario analysis gives the impact of different scenario of the project or impact of different risk if that occurs simultaneously. A fair decision can be made after

this analysis, the option which will give lesser loss or hazards that option can be opted.

Probabilistic Analysis (Monte Carlo Simulation):A project simulation is done using a model to show the potential impact of different level of uncertainties on project objectives. Monte Carlo Simulation is generally used for this analysis. It can quantify the effect of uncertainties and risks on project budget and schedule. It simulates the full system many times, each time randomly choosing a value for each factor from its probability distribution. It uses three point estimate like most likely, worst case and best case duration for each task in time management.

Decision Trees: This analysis is carried out by decision tree diagram. Decision trees are very helpful to both formulate the problem and evaluate options. In this analysis there are graphical models used to representa project and can clearly reflect the effects of each decision taken in the project.

4.3. Risk Response Planning.

It can be done by the following methods:

RISK AVOIDANCE: Risk can be warded off by removing the cause of the risk of executing the project in a different direction while still aiming to accomplish project objectives. Change project management plan to eliminate a threat, to isolate project objectives from the risks impact, or to relax the project objective that is in jeopardy, such as extending schedule or reducing the scope.

RISK TRANSFER: Transferring risk involves finding some other party who is willing to accept responsibility for its management, and who will bear the liability of the risk should it occur. Transferring a threat does not eliminate it; the threat still exists however it is owned and managed by another party. Transferring risk can be an effective way to deal with financial risk exposure. The aim is to ensure that the risk is owned and managed by the party best able to deal with it effectively.

RISK MITIGATION/REDUCTION: Risk mitigation reduces the probability and/or impact of an adverse risk event to an acceptable threshold. Taking early action to reduce the probability and/or impact of a risk is often more effective than attempting to repair the damage after the risk has passed.

RISK EXPLOIT: This strategy seeks to eliminate the uncertainty associated with a particular upside risk by creating the opportunity definitely happens. Eliminate the uncertainty associated with a particular upside risk. An opportunity is defined as a risk event that if it occurs will have a positive effect on achievement of project objectives.

RISK SHARE: Allocate risk ownership of an opportunity to another party who is best able to maximize its probability of occurrence and increase the potential benefits if it does happen. Transferring threats and sharing opportunities are similar in that a third party is used, those to whom the threats are transferred take on the liability and those to whom opportunities are allocated should also be allowed to share in the potential benefits.

RISK ENHANCE: This response aims to alter the “size” of the positive risk. The opportunity is enhanced by increasing its probability and/or impact, thereby maximizing the benefits gained from the project. Seeking to facilitate or strengthen the cause of the opportunity, and proactively targeting and reinforcing its trigger conditions.

RISK ACCEPTANCE: Ultimately it is not possible to eliminate all threats or take advantage of all opportunities we can document them and at least provide awareness that these exist and have been identified, some term this „passive acceptance. This strategy is adopted when it is not possible or practical to respond to the risk by the other strategies, or a response is not justified by the grandness of the risk. When the project manager and the project team decide to accept a risk, they are agreeing to address the risk if and when it happens.

CONTINGENCY PLAN: This involves the use of a fallback plan if a risk occurs. Contingencies can also be in the form of sometime kept in reserve to deal with unknown risks or in the form of costs to deal with unknown risks.

4.4. Risk Control.

It is the final step of the process. After we have implemented response actions, we must track andrecordtheir effectiveness and any changes to the project risk profile. Did the response actions have a positive or negative effect on achieving project objectives? Responses taken in risks should also be documented for future reference and project plans.

5. A CASE STUDY

To determine how RM theories are used in practice, a construction project of a school was used as a case study. Next, to get an overview of RM practices used by different professionals, all parties participating in the project were asked to take part in the research. An inquiry was sent by e-mail to all 27 parties and answers/acceptance to an interview were received from seven recipients out of the total 27. The respondents were engineer, architect, client, final users and project managers. Each interview took approximately 40 minutes.

As a follow up to the interview, an on-line questionnaire was sent out to each respondent, and the answers were used to demonstrate how one of the RM methods can be used in practice. For this purpose, one of the qualitative RM methods, probability and impact assessment, was chosen. The respondents were asked to answer four questions with pre-defined answers regarding each risk they identified in the main interview. The number of identified risks had varied among respondents and thus sent out questionnaires consisted number of questions. Firstly, respondents were asked to evaluate the probability of risk occurrence. In three other questions impact on time, cost and quality was evaluated separately. The scale used for assessing probability was from 0.1 (low probability)

to 0.9 (high probability) and the possible choices were 0.1, 0.3, 0.5, 0.7, and 0.9. Whereas impact was evaluated in a range from 0.05 (low impact) to 0.8 (high impact) and the possible choices were 0.05, 0.10, 0.20, 0.40, and 0.80. The same scale was used to evaluate impact on all three project objectives. The results were later combined in a matrix and used for further analysis.

5.1. Risk Definition

Within the construction industry, RM is a concept which is very rarely used in the structured form as mentioned in the literature. Actors within the studied project perceived risk and RMP in various ways. While asking what a risk meant to them, the word was defined as a difficulty, uncertainty, threat, unpredictable event or danger, but also more descriptive as challenging the project success, obstacles on the way to achieve the set goal or not meeting the project objectives. An interesting observation was that everyone perceived risk as something negative which should be avoided.

5.2 THE RISK MANAGEMENT PROCESS

Fig. 3, provides a summary of the literature research, in order to facilitate the use of the RMP. All four steps are included and are placed on the left hand side. On the right, the follow up procedures are listed to clarify some of the techniques used to manage the risks in the most effective way. By following the arrows on the graph, all the necessary steps of RM will be performed. This process should be continuously performed throughout the whole project in order to keep track of all potential risks.

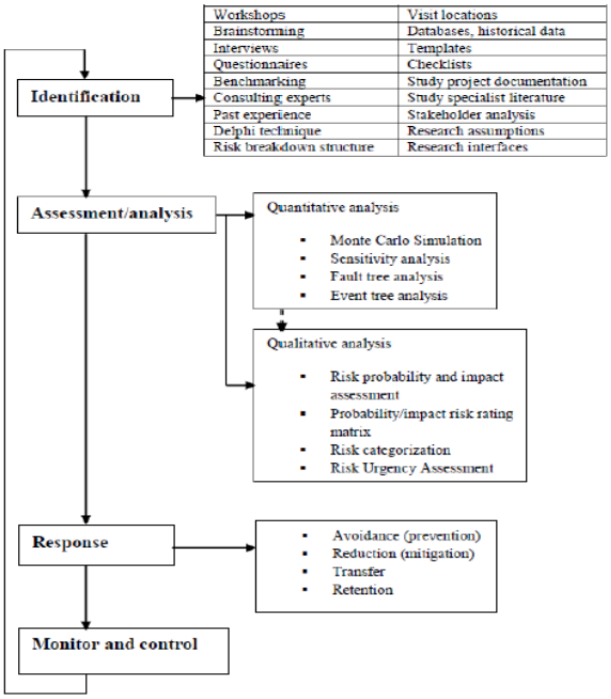

Fig. 3. A coherent picture of how to manage risks

Table 1. Risk Identification and Response From the Interviews.

PLC		PHASE NO	TYPE OF RISK	RESPONSE	
				TYPE OF RESPONSE	DESCRIPTION
Pre-project phase	Identifying business opportunity	1	misunderstand the client	mitigate	Frequent discussions with the client.
			Miscalculation [1]	mitigate	Detailed discussions with the client
	Choosing delivery system		Miscalculation [2]	mitigate	checklists
	Choosing contract type		choosing not the right consultants [1]	mitigate	check up on the companies
			choosing not the right consultants [2]	retain	biding process is regulated by law and they have no impact on it
Planning and design phase	Establishing project objectives and draw up of project brief	2	lack of cooperation between actors in the project	mitigate	facilitate cooperation by organizing project team meetings
			Shortage in resources	mitigate	making adjustments in a number of resources used in order to fit in the schedule
	Actual design		cheap, not efficient solutions which can be more expensive over time	mitigate	By being active in the project and questioning unclear issues
			problems with design	transfer	Transferring risk by involving experts in the process
			users do not take decisions necessary for work progress	mitigate	make a pressure for decisions being make on time
	Preparing contract documents		not achieve a good final result	mitigate	highlight all potential risks or problems on the workshop or a meeting
			gap of knowledge	mitigate	Being active in the process and take an action when any problem occurs
Contractor selection phase	Setting tender conditions by the owner	3	Not finding the right contractor [1]	avoid	make sure that the contractor has enough knowledge and resources to perform the project
	Contractors decisions whether to bid or not		Not finding the right contractor [2]	mitigate	check up on the companies
	Submitting offers				
Contractor mobilisation phase	Preparation for construction phase		Not finding the right contractor [3]	mitigate	well prepared bidding requirements
Project operation phase	Monitor and control	4	contractor has not enough knowledge or experience	avoid	well prepared procurement
			moisture	mitigate	involve specialists from the field
	Resource management		loosing control over the project	mitigate	using quality systems and self control
	Documentation and management		Delays in construction schedule	mitigate	Being active in the process and take an action when any problem occurs
			Delays in construction schedule	transfer	transfer risk to the project team
Project closeout and termination phase	Final inspections	5			
	Project summary				

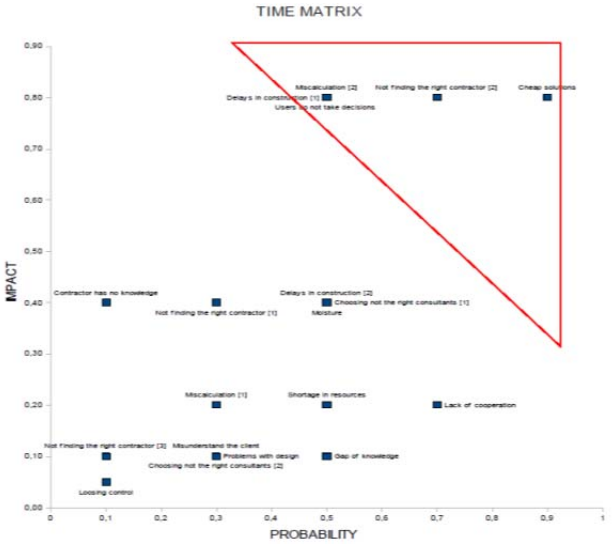

Fig. 4. Time Matrix.

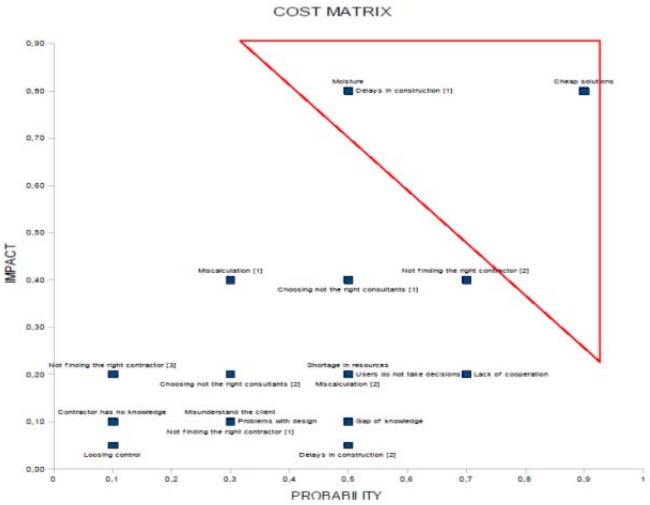

Fig. 5. Cost Matrix.

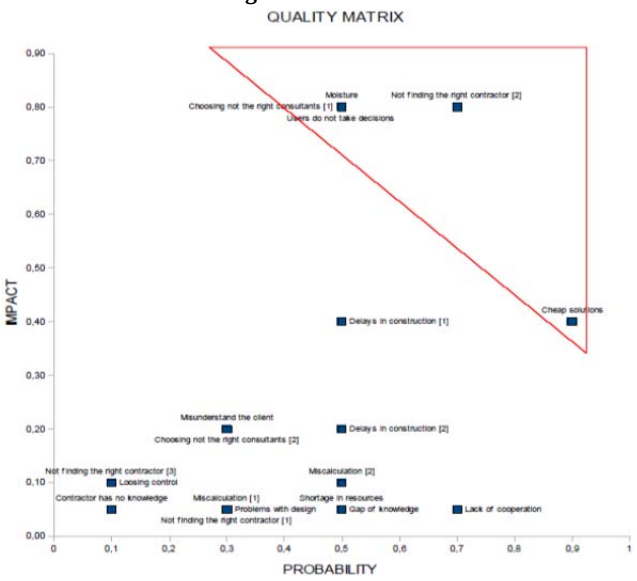

Fig. 6. Quality Matrix.

5.3. How is the Risk Management Process Used in Practice?

To show how the RMP is used in practice, it is helpful to divide the process into the different main parts such as identification, assessment and response.

Identification: Among respondents, past experience and discussions were the most commonly used techniques to identify potential risks. This finding corresponds with the research by Lyons and Skitmore (2004) that showed brainstorming and case based approach as the most popular risk identification tools. In fact, no time in the project was reserved for RM and respondents declared that potential risks were handled at the time of their occurrence. In order words, the members of the project team were not identifying risk in a structured way as described in the literature.

Assessment: In this part of the RMP, the greatest differences can be discovered between the theory and how the industry actually works. As previously stated, the respondents were not familiar with any method used to analyze potential risks. Overall not many practitioners in the construction industry who work with residential projects use these structured methods. Lyons and Skitmore [5] found that intuition, judgment and experience are the tools most often used in risk analysis while structured methods like Monte Carlo or risk impact assessment are used only to some small extent.

One of the reasons for not using structured methods according to respondents was limited budget. One interviewee explained that most residential projects have limited profit margins; this prevents major changes or implementations of new solutions. Moreover, the general lack of knowledge within the area of RM can result from limited resources such as time or money. This statement corresponds with previously quoted research done by Lyons and Skitmore [5] which indicates lack of time as the factor which prevents organizations from implementing risk management. Furthermore, the industry is not willing to change. Only some of the companies are willing to implement RMP in their operation if only a tangible outcome will be granted.

As indicated by Lyons and Skitmore (2004), the qualitative approach is the most common type of technique to analyze risks.

Response: In the theory, four of the most common actions to be taken against potential identified risks were explained. As concluded from the interview, actors have no knowledge about any type of response. Only few respondents gave answers which could be interpreted as transferring risks and by this, mitigating the problem. However, discussion and checklists were the main tools to support the actions. It is clear that there is also lack of knowledge within this area.

6. CONCLUSION

Risk is perceived as a negative term, even though in theory it can have two dimensions. Professionals in the construction industry are using techniques described in the literature concerning RM, but are not aware of it. Risks are being managed every day in the industry, but not in such a structured way as the literature describes. As also other researchers confirmed, the knowledge of RM and RMP is close to zero, even though the concept of risk management is becoming more popular in the construction sector. There is a willingness among respondents to start using RMP, but it has to bring profits to the organization. By applying a simple method, it is possible to identify potential risks in an easy way. Moreover it gives possibility to detect which of the identified risks has the biggest impact on time, cost and quality. Those risks should be eliminated or mitigated by taking an appropriate action. The research showed that the most common action was risk mitigation.

As the research showed, unstructured form of RM is to some extent used in the construction sector. Thus application of actual RM into companies should not be difficult. As proved by the research, knowledge is the factor which is missing for organizations to implement RM. Thus, this aspect of application of RM could be further investigated in terms of how to facilitate use of RM in a construction sector. Moreover a simple RM manual could be developed including basic theoretical information as well as ready-to use guidance for one of the RM methods.

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