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RISK MANAGEMENT IN CONSTRUCTION PROJECTS

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Abstract. Risk management is an important field of construction industry and has gained more importance internationally due to the latest researches carried out on a large scale. However, this relatively new field requires more attention to bring some benefit. Construction projects are facing a number of risks which have negative effects on project objects such as time, cost and quality. This study is based on findings of a questionnaire-based survey on risk management in construction projects in Pakistan, reporting the significance of different type of risk, ultimate responsibility for them and the effectiveness of some most common risk management techniques practiced in the industry. Two types of risk management techniques were considered: preventive techniques which can be used before the start of a project to manage risks that are anticipated during the project execution; and remedial techniques that are used during the execution phase once a risk has already occurred. The study revealed that financial issues for projects, accidents on site and defective design are the most significant risks affecting most of construction projects. As further reported, the contractor is responsible for management of most risks occurring at sites during the implementation phase, such as issues related to subcontractors, labour, machinery, availability of materials and quality, while the client is responsible for the risks such as financial issues, issues related to design documents, changes in codes and regulations, and scope of work. Further reported results of the analysis demonstrate that the production of proper schedule by getting updated data of the project and guidance from previous similar projects are the most effective preventive risk management techniques while close supervision and coordination within projects are the most effective remedial risk management techniques. It may be concluded that the most significant risks must be managed with greater effort to reduce/eliminate their effects on the project. As the study concludes, preparation of a proper schedule and good coordination during the implementation stage are very important as they may help project managers to focus on critical areas for better management of projects in Pakistan.

Keywords: risk, assessment, construction.

JEL Classification: D81, L74.

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Introduction

Risk is defined as exposure to loss/gain or the probability of occurrence of loss/gain multiplied by its respective magnitude. Events are said to be certain if the probability of their occurrence is 100% or totally uncertain if the probability of occurrence is 0%. In between these extremes, the uncertainty varies rather widely. Nowadays, risk can be assessed using various types of information (Bon-Gang *et al*. 2014; Zavadskas *et al.* 2010b; Ustinovičius *et al.* 2010). Just as any other economic activity, construction business is risky. Successes and implementation in construction industry depends on the level of risk (Paslawski 2013). However, construction projects are perceived to have more inherent risks due to involvement of many contracting parties, such as owners, designers, contractors, subcontractors, suppliers, etc. (PMI 2004). Conflict-solving among entities has been analysed by Šostak and Makutėnienė (2013).

Risk analysis and management are an important part of the decision-making process in construction industry. Construction industry and its clients are widely associated with high degree of risks due to the nature of micro-, meso- and macro-environments particular to construction (Zavadskas *et al.* 2010a); however, construction industry has poor reputation in coping with risks as many projects fail to meet deadlines and cost targets (Shevchenko *et al.* 2008). Clients, contractors, the public and others have suffered as a result (Zavadskas *et al.* 2012, 2010b). Thus, construction business is related to high risk, which affects each of its participant; while effective analysis and management of construction associated risks remain a big challenge to practitioners of the industry (Kapliński 2009a). The following should be considered: the importance of risks, their current management techniques, the existing status of risk management systems in organisations, and barriers to effective risk management from the perspective of key stakeholders. The analysis reveals that financial and economic factors, followed by quality, are the most important risks, and the industry generally tries to avoid or transfer these risks (Choudhry, Iqbal 2013). As risk perception is an important aspect of risk management, the attitude toward and the barriers to risk management and the benefits perceived are prerequisites for the analysis and management of risks. Although numerous papers have been written on the subject of risk management, most of the surveys are conducted in the developed countries and little information exists on the perception of risk in developing countries (Hameed, Woo 2007).

For effective management of risks, it is important how people in this industry perceive each risk. The main goal of this paper is to know the attitude of construction practitioners toward different types of risk and respective responsibility. In addition, the paper presents the most effective techniques in preventing/mitigating different types of risk. The objectives of the study are as follow:

1. To identify risks in construction projects so they could be managed while achieving project objectives.
2. To identify major risk management techniques practiced in managing risks in the construction industry.

3. To find risk ranking and investigate risk-related responsibilities for clients and contractors in order to manage risks effectively.
4. To investigate effectiveness of risk management techniques for managers to manage risks more efficiently.

1. Review of risk in construction industry

Construction industry in general as well as construction project activity are risky (Zavadskas *et al.* 2010a). Risk can be explained as an event that has an impact on objectives, may have a positive or negative outcome and takes place in micro, meso and macro environments. Risk management is a system which aims to identify and quantify all risks, to which a business or project is exposed, so that a conscious decision can be taken on how to manage the risks (Markmann *et al.* 2013). PMBOK lists risk management as one of nine focuses in project management and explains it as a systematic process of identifying, analysing and responding to project risks. It includes maximisation of the probability and consequences of positive events and minimisation of the probability and consequences of events adverse to project objectives.

High importance of project selection in the project life cycle while solving bid/no-bid problems, especially in the construction industry, have been analysed by Abbasianjahromi and Rajaie (2012). Risk can be analysed with the help of the following methods: based on fuzzy TOPSIS bid/no-bid model (Ravanshadnia, Rajaie 2013); in fuzzy environment, applying TOPSIS-F method (Tamošaitienė *et al.* 2013); based on intelligent agents (Smeureanu *et al.* 2012); RAMCAP (Risk Analysis and Management for Critical Asset Protection) by introducing new parameters that affect risk value (Yazdani *et al.* 2011); and Fuzzy Synthetic Model (Abdul-Rahman *et al.* 2013). In terms of risk management, it is important to consider the following issues:

- the origin of risk context;
- identify and allocate processes (Li *et al.* 2013; Jaskowski, Sobotka 2012; Hanna *et al.* 2013);
- analyse information (Zavadskas *et al.* 2010a, 2010b);
- analyse the flexibility of results (Jaskowski, Sobotka 2012; Ustinovičius *et al.* 2010; Kapliński 2008);
- risk assessment and evaluation (El-Sayegh 2007; Ke *et al.* 2012; Markmann *et al.* 2013; Skinner *et al.* 2014);
- treatment;
- function or process of risk (Zavadskas *et al.* 2010a; Kapliński 2009b, 2013); and
- monitoring and communication of risks associated with any activity (Xianbo *et al.* 2014).

All above-mentioned activity aims to minimise losses and maximise opportunities. Extensive literature is available on the importance of risk and its management. The exchange and interest rate risks should be undertaken by the owner (Jaskowski, Sobotka 2012; Hanna *et al.* 2013). As shown in Figure 1, in construction industry, risk related to Build-Operate-Transfer (BOT) should be considered depending on the impact of enterprise activity and the organisation system.

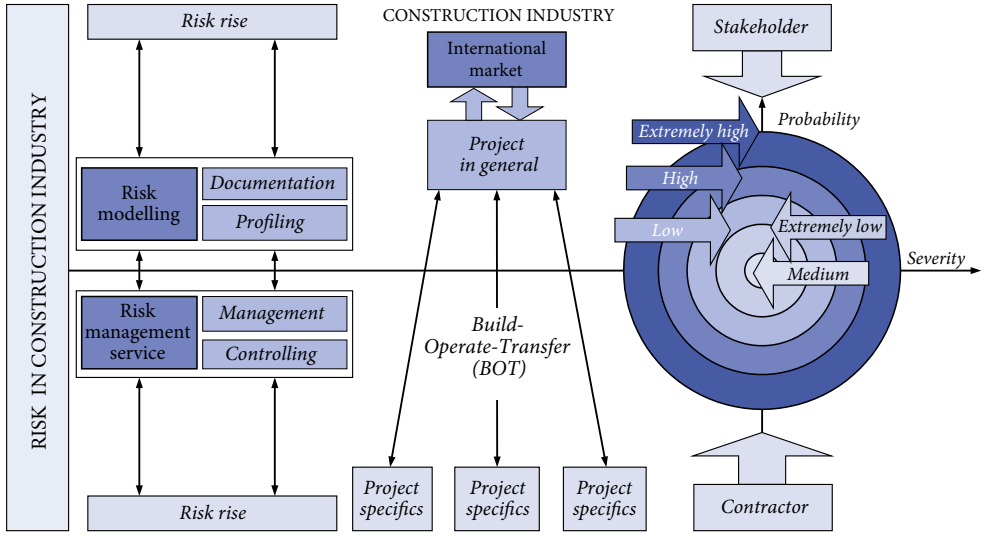

Fig. 1. Risk model in construction industry

Some researchers investigated different risk management approaches used in different countries, e.g. the risk of differences between enterprise stakeholders in several projects (El-Sayegh 2007; Bon-Gang *et al.* 2014).

2. Research methodology and practical example

The risk assessment in construction projects has been applied differently from project to project, using various models of risk assessment to evaluate the risk in certain activities of the projects. Many researchers have proposed various types of risk assessment models for precise activities in the construction project assessment (Yafai *et al.* 2014).

This study is aimed at highlighting the main risks that Pakistani construction projects are facing and the risk management techniques used to manage these risks. It also describes the perception of professionals regarding the significance of these risks and risk management techniques used for their management. Expert judgment questionnaire was used as the research methodology.

The presented model of risk assessment for Pakistani construction industry will serve as a supplementary tool for risk assessment of different types of construction projects in Pakistan and can be useful for other establishments in the same category, especially those that have similar construction industry as in Pakistan.

The research used a questionnaire to evaluate the risk in the construction industry of Pakistan. The questionnaire-based survey was used as the main source of data collection. The questionnaire was prepared following a thorough literature review and in-depth interviews with experienced professionals in this industry for questionnaire finalisation as per local conditions. The questionnaire is composed of three parts. The first part consists of 37 different types of risk and discussion with industry practitioners, to modify it as per local

conditions. This part presents the perception of respondents toward significance of these risks. Respondents were required to use the Likert Scale (1–5) indicating the significance of these risks: "1" for the lowest significance and "5" for the highest. The second part investigates the responsibility for each type of risk, using categories client's responsibility, contractor's responsibility or shared responsibility. Respondents were required to choose from these three options. Consultant's responsibility was ultimately attributed to client's responsibility as a consultant is the client's representative. The third part consists of different risk management techniques that are preventive and remedial and finalised after a thorough discussion with industry professionals. The respondents were required to use the Likert Scale (1–5) in order to indicate the effectiveness of these risk management techniques, "1" for the lowest effectiveness and "5" for the highest. The questionnaire was designed aiming to make it as simple as possible. Prior to its use, it was discussed with a professional to ensure easy understanding for respondents.

The non-probability sampling techniques are useful when there are limited resources, inability to identify construction project team members, and a need to establish the existence of a problem (Ling *et al.* 2013; Zavadskas *et al.* 2012; Hashemkhani Zolfani *et al.* 2012). Members of population are chosen based on their relative ease of access, which was used for this survey. The total of 150 finalised questionnaires were distributed for construction projects delivered in Rawalpindi and Islamabad area, out of which 86 were collected in completed form. The response rate amounted to 57%. The questionnaire had to be filled by respondents with at least engineer level position with necessary knowledge of risks and risk management techniques.

3. Results and analysis

3.1. Risk significance

There are different types of risk associated with construction industry. The degree of impact of different risks on the project delay is described as risk importance. 37 most applicable risks were incorporated in the questionnaire, which was finalised following a thorough literature review (Hameed, Woo 2007; Al-Kharashi, Skitmore 2009; López-Alonso *et al.* 2013; Creemers *et al.* 2014) and a discussion with a professional with substantial experience of work with clients, contractors and consultants of the industry. Respondents were required to use the Likert Scale (1–5) to indicate their perception of the significance of each risk: "1" for the lowest significance and "5" for the highest risk significance. The results were summarised and cumulative scores were calculated for each type of risk. Once the cumulative score was calculated, the percentage score was calculated for each risk using the formula given below:

$$AS_{age\ score} = \frac{\sum W}{A \cdot N} \cdot 100\%, \quad (1)$$

where $AS_{age\ score}$ – age score; W – the score obtained from each respondent; A – the minimum score, which is "0", and the maximum score, which is "5"; and N – the total number of respondents, 86 for this survey.

The percentage scoring technique was used because it is generally used in our daily life and is easy to understand by everyone. Risks were arranged in the sequence of decreasing risk significance.

3.2. Risk responsibility

In the questionnaire, risk responsibility was arranged into following categories: client responsibility, contractor responsibility and shared responsibility. A consultant's responsibility was not considered separately as a consultant usually acts as the client's agent and has no contractual relations with the contractor; thus, the responsibility is ultimately shifted to the client and is considered as his. The collected data was summarised and percentage responsibilities were calculated for each category as per data supplied by respondent's. For each category, risk responsibility was ultimately considered as the responsibility of that specific category, provided the percentage was equal to or more than 50%.

In terms of the standard set of risk responsibility for each category, 8 risks came under the responsibility of a client with more that 50% of responsibility as per data supplied by respondents and provided in Table 1; while 16 risks came under a contractor's responsibility provided in Table 2. In total, respondents indicated 8 risks as shared responsibility as displayed in Table 3. 5 risks were undecided as none of the category received more than 50% score as represented in Table 4.

3.3. Risk management techniques

Risk management means minimising, controlling and sharing of risks rather than merely passing them on to another party. There are different types of risk management techniques, such as risk avoidance (prevention), risk retention, risk reduction (mitigation) and retention and risk transfer.

In the questionnaire, two types of risk management techniques were incorporated to be considered by respondents using the Likert Scale (1–5), i.e. preventive techniques and remedial techniques. "1" means the lowest effectiveness and "5" means the highest effectiveness. Following a discussion with an industry professional and aiming to ensure ease of understanding for respondents, six risk management techniques were incorporated into the questionnaire for each type of techniques.

3.4. Preventive risk management technique

The optimal choice to manage a risk is to avoid it. A risk can be avoided at the planning stage before the start of a project by incorporating necessary changes stemming from consideration of necessary risks. Preventive management techniques are used during the planning stage to avoid/minimise a necessary risk by considering it before the start of a project and planning for it. The data regarding the attitude of the respondents toward the effectiveness of the considered preventive risk management techniques was collected as well as arranged in the order of declining effectiveness.

Table 1. Client's Responsibility

No	Risks type		Obtained score			Age responsibility, AS (%)		
			Client	Contractor	Shared	Client	Contractor	Shared
1	Risk of defective design	R_1	68	3	15	79	3	17
2	Risk of funding problems for project	R_2	77	2	7	90	2	8
3	Delays in obtaining permits	R_3	50	16	20	58	19	23
4	Delay in availability of drawings	R_4	75	4	7	87	5	8
5	Risk of change in codes and regulations	R_5	50	5	31	58	6	36
6	Risk of Changes in scope of work	R_6	61	6	19	71	7	22
7	Improper scope of work definition in contract	R_7	50	4	32	58	5	37
8	Payment delays	R_8	67	5	14	78	6	16

Table 2. Contractor's Responsibility

No	Risks type		Obtained score			Age responsibility, AS (%)		
			Client	Contractor	Shared	Client	Contractor	Shared
1	Accidents/safety during construction	R_9	6	55	25	7	64	29
2	Risk of bad quality material/equipment	R_{10}	3	75	8	3	87	9
3	Inaccurate execution plan/schedule	R_{11}	4	73	9	5	85	10
4	Risk of insufficient technology	R_{12}	6	62	18	7	72	21
5	Theft/robbery of material at site	R_{13}	2	77	7	2	90	8
6	Third party delays	R_{14}	8	49	29	9	57	34
7	Risk of labor, materials and equipment availability	R_{15}	2	80	4	2	93	5
8	Risk of labor disputes and strikes	R_{16}	0	80	6	0	93	7
9	Poor performance of subcontractor	R_{17}	2	80	4	2	93	5
10	Poor coordination with subcontractor	R_{18}	4	77	5	5	90	6
11	Risk of defective material from supplier	R_{19}	2	77	7	2	90	8
12	Shortage of plant and equipment	R_{20}	3	78	5	3	91	6
13	Poor productivity of plant and equipment	R_{21}	2	83	1	2	97	1
14	Shortage/delay of material supply	R_{22}	2	79	5	2	92	6
15	Lack of qualified staff	R_{23}	0	45	41	0	52	48
16	Poor competence and productivity of labor	R_{24}	1	82	3	1	95	3

Table 3. Shared Responsibility

S/No	Risks type		Obtained score			Age responsibility, AS (%)		
			Client	Contractor	Shared	Client	Contractor	Shared
1	Risk of natural disasters	R_{25}	30	4	52	35	5	60
2	Delays due to disputes with contractor	R_{26}	15	9	62	17	10	72
3	Inappropriate risk allocation in contract	R_{27}	27	9	50	31	10	58
4	Risk of exchange rate fluctuation and inflation	R_{28}	30	11	45	35	13	52
5	Terrorism/war threats	R_{29}	25	2	59	29	2	69
6	Adverse weather conditions	R_{30}	22	4	60	26	5	70
7	Political instability	R_{31}	23	5	58	27	6	67
8	Corruption including bribery at sites	R_{32}	5	17	64	6	20	74

Table 4. Undecided Responsibility

S/No	Risks type		Obtained score			Age responsibility, AS (%)		
			Client	Contractor	Shared	Client	Contractor	Shared
1	Risk of unforeseen site conditions	R_{33}	29	16	41	34	19	48
2	Risk of differing site conditions	R_{34}	37	14	35	43	16	41
3	Inaccurate estimation of quantities of work	R_{35}	28	38	20	33	44	23
4	Inadequacy of insurance	R_{36}	17	30	39	20	35	45
5	Delays due to lack of availability of utilities	R_{37}	39	19	28	45	22	33

3.5. Remedial risk management technique

Preventive risk management techniques do not eliminate risks; consequently, they can arise from time to time during the execution of a project and remedial management techniques need to be used to reduce their effect and eliminate them if possible. In Saudi Arabia, Assaf and Al-Hejji (2006) found that only 30% of construction projects were completed within scheduled completion dates with the average time overrun between 10% and 30%. The questionnaire investigated the perception of respondents toward the significance of given remedial risk management techniques. The collected and summarized data is given in Figure 2.

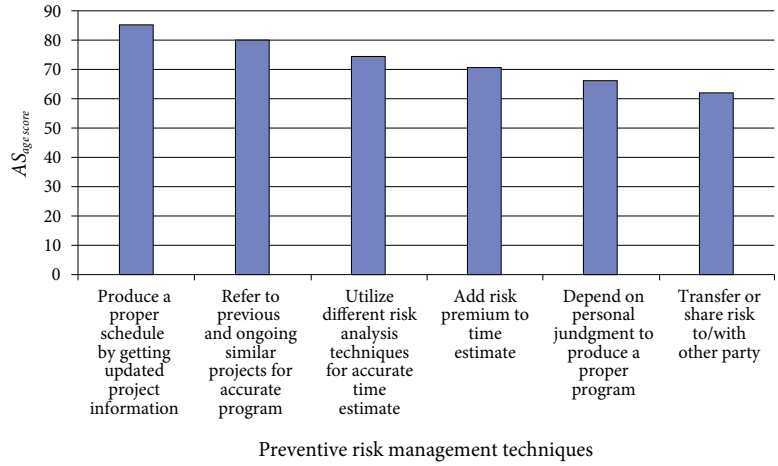

Fig. 2. Effectiveness of preventive risk management techniques

4. Discussion

4.1. Risk significance and responsibility

The significance of the risks was found using the percentage scoring technique already described earlier in this paper. The results regarding the top 10 most significance risks and their ultimate responsibilities are discussed in this section.

Payment delays ended up at the top of the list with the maximum percentage score for significance and the responsibility falling on the shoulders of a client resulting from 78% response rate. This shows that the maximum delays occurring in construction projects in Pakistan are due to late payment to a contractor by a client.

Funding problem for projects is the second on the list and the responsibility again goes to a client with the response rate of 90%. This superimposes the significance of the first risk that is "payment delays" as the funding problem arises on numerous construction projects and ultimately contributes toward time and cost overruns.

Accidents/safety are also among the top risks which are mostly ignored in Pakistan but are the main delay factor as per this survey and must be properly addressed. The responsibility goes to a contractor with 64% response rate but in the view of the article authors, a client should also take this responsibility to improve safety on sites and affecting the projects positively.

Defective design is also the major risk factor as per this survey, securing the 4th position and responsibility with a client due to 79% response rate. Consequently, steps should be taken by a client and consultant to work closely and also involving the contractor if the contract permits to have correct design and avoid problems during the execution of a project.

Inaccurate schedule is also on the top of the list, for which contractor is responsible with 85% response rate. Thus, a thorough study of project and contract documents should be undertaken by a contractor and different risk factors should be considered for preparation of an accurate schedule, which can help to avoid time and cost overruns.

Poor performance of subcontractors is also one of the major risk factors and responsibility lies with a contractor due to 93% response rate as the client has no direct contract with subcontractors and the responsibility is directly of the main contractor. Efforts should be made for selection of competent subcontractors with good previous tract record to avoid this risk.

Exchange rate fluctuation and inflation are also among the most important risk factors in developing countries such as Pakistan. A mixed response was received regarding this risk with response rate of 52% for shared responsibility and 35% for client responsibility, which may be due to the fact that this risk in not under control of any contracting party and very little can be done to reduce effects of this risk.

Improper scope of work definition in a contract is also important. This risk has a mixed response with a client responsibility amounting to 58% of response rate and shared responsibility securing 37%. This may be due to the fact that although a client is responsible for the scope of work definition, the contractor should also play its part in thorough understanding of all contractual documents and clarify any ambiguity that may have negative effects on the project.

Poor quality of materials and equipment are also among the main contributing risk factors with a contractor allocated responsibility due to 87% of response rate. In most of construction projects in Pakistan, a contractor is responsible for provision of materials and equipment and, thus, this activity is under the direct control of contractors.

Shortage/delay of material supply is among the top 10 most significant risks and a contractor is directly responsible for this risk with 92% response rate as supply of materials in most contracts is the contractor's responsibility and should be planned accordingly to avoid this risk.

4.2. Effectiveness of risk management techniques

Preventive management techniques: On the basis of the conducted survey, the top two most effective preventive risk management techniques are a) production of a proper plan by getting updated project information and b) referral to previous and ongoing projects for an accurate schedule. Both of these techniques are pointing toward the preparation of an accurate schedule considering all risk factors by getting updated project information and taking guidelines from similar projects that gave been already executed or are under execution, so that the schedule may be feasible. Once all risk factors are considered, there is a high probability for the project to be completed within the planned schedule.

Remedial management techniques: It is obvious that all risk cannot be managed during the planning phase and some risks are going to occur during the implementation phase, for which remedial risk management techniques are required. As per this survey, the two techniques that are at the top of the list are a) close supervision by subordinates aiming to minimise unsuccessful work and b) close coordination with subcontractors. These two techniques indicate that good coordination with subordinates or subcontractors is necessary for a successful project. The likelihood of a project to go out of schedule diminishes provided there is a close supervision and coordination and all parties work as a single team.

Conclusions

This study describes the way respondents perceive different types of risk particular to construction projects in Pakistan. Out of 37 risks incorporated into the questionnaire, top ten risks have been highlighted and discussed in detail: a) payment delays; b) project funding problems; c) accidents/safety during construction; d) defective design; e) inaccurate execution plan/schedule; f) poor performance of subcontractors; g) exchange rate fluctuation and inflation; h) improper scope of work definition in a contract; i) poor quality of materials and equipment; and j) shortage/delay of material supply. In terms of risk responsibility, 6 risks were allocated to a contractor, 8 – to a client, and 8 – as shared responsibility. Responsibility of 5 risks was undecided. This shows that a contractor is responsible for most of risks under his direct responsibility. Those risks which are under direct control of a client were allocated under a client's responsibility. Risks that were not allocated to either party, were classified as shared responsibility.

Regarding the results of data on the effectiveness of risk management techniques, the preventive technique "the production of accurate schedule by getting updated projected information and referring to similar projects" gained respondents attention while the most effective remedial technique was "close supervision and coordination with the contracting parties".

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