RISK MANAGEMENT PRIORITIES FOR PROJECTS IN SAUDI ARABIA: IDENTIFYING PROJECT RISK SOURCES AND POTENTIAL CONSEQUENCES

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ABSTRACT

This paper investigates potential risk sources for projects in Saudi Arabia through different perspective of owners, and contractors, as well as consultant in order to understand the risk contributors and be able to manage such risk. Therefore, we identify risk sources through literature review, preparing survey questionnaire, collecting and analyzing data, and finally draw a clear picture of risk priorities in projects for Saudi Arabia.

Responses from 269 participants were received, among which 23 discarded due to not complete information and the rest of 246 participants were analyzed, summarized and reported for each type of projects objectives in terms of cost, time, quality, and environment, as well as safety. In order to understand different perspectives of projects owners, contractors, and consultants we reanalyzed responses to measure the significance score index for each risk sources. 25 participants were for owner, 87 for contractors, 29 for consultants, and 33 for participants without specifying their roles in projects.

It is clear that there are differences in risk significance index for each risk sources for different project stakeholders. Such differences might shift available resources to mitigate their consequences. Therefore, a consensus between stakeholders should be established early in project planning process through having quick survey to realize the most important risk contributors and be able to manage them accordingly with minimal impact on cost, time, quality, and safety, as well as environment.

KEYWORDS: Project risk management, project risk significance index, project risk priorities

1. INTRODUCTION

Risk is perceived as the potential for unwanted or negative consequences of an event or activity, a combination of hazard and exposure. Recent researches tends to emphasize the two-edged nature of risks, such as a threat and a challenge, the chance of something happening that will have an impact on objectives; may have a positive or negative impact, combination of the probability or frequency of occurrence of a defined threat or opportunity and the magnitude of the consequences of the occurrence. This paper examines mainly the negative impacts of risks inherent in projects through a combined consideration of the likelihood of occurrence and the magnitude of consequence in Saudi Arabia.

Risk management is 'a system which aims to identify and quantify all risks to which the business or project is exposed so that a conscious decision can be taken on how to manage the risks' (Flanagan R, Norman, 1993). PMBOK included risk management as one of the nine focuses in project management and described it as 'the processes concerned with conducting risk management planning, identification, analysis, responses, and monitoring and control on a project'. AS/NZS 4360 defined risk management as 'the culture, processes and structures that are directed towards realizing potential opportunities whilst managing adverse effects'. Contractors and consultants may play major roles in identifying, analyzing, mitigating, and controlling project risks, but project risk management is not a function that the owner can completely delegate to contractors or to consultants with impunity. All projects experience some degree of uncertainty, and some uncertainties can create risks to achieving the project objectives. Project managers are inherently motivated to achieve the intended project goals and meet the project objective in terms of time, cost, quality, and safety, aswell as environment. Therefore they are motivated to manage project risks effectively through identifying and prioritizing risk sources to be able to have proper mitigation measures to prevent, reduce, and compensate human and financial losses. Flyvbjerg (2002) has argued that there are times, especially in large projects, when project managers are motivated to obscure or hide the risks inherent in a project. Uncertainty, as it relates to project performance, cost, quality, and duration, comes from a lack of knowledge about the future. It is neither objective nor measurable but rather based on subjective assessments, which can differ between observers (owner, contractor, consultant). Managers must therefore make

decisions in an uncertain world and, in the absence of good historical data-bases, subjective probability estimates are the only available measures of uncertainty. Projects continually face new risks, which must be identified, analyzed, and understood in order to develop a framework both for selecting the right projects to execute and for successfully executing them. Thus project owners, sponsors, and managers are increasingly concerned with ways to analyze risks and to mitigate them. March and Shapira (1987) observed risks, on the basis of the following general characteristics:

- Managers typically define risk as their exposure to loss.
- Managers aren't necessarily interested in reducing project risks to a single number. Instead, risks are considered multidimensional with the maximum exposure considered for each risk dimension.
- Managers are more likely to take risky actions when their jobs are threatened than when they feel safe. The risks taken on a project are relative to the alternative options and opportunities available. For example, contractors will take more risks (such as submitting very low bids to buy jobs) when business is bad and their survival is under threat than they are willing to take when they have ample backlogs.

Studies of projects with low and high degrees of uncertainty (see, e.g., Shenhar, 2001) show that as uncertainty increases there is also an increased likelihood of the following:

- Increased project budgets,
- Increased project duration,
- Increased planning effort,
- Increased number of activities in the planning network,
- Increased number of design cycles,
- Increased number of design reviews,
- Delayed final design,
- Increased need for exchange of information outside of formal meetings and documentation,
- Increased management attention and effort (probabilistic risk assessment, risk mitigation),
- Increased systems engineering effort, and

- Increased quality management effort.

Alexopoulos et al. (2009) stated that decision makers perceive risks differently in various situations, which is affected by factors such as early experience, education background, personal beliefs, and culture. Those subjective perceptions cause variations in decision making, making it impossible for people to make correct decision in all the situations in pursuit of maximum expected value. Wang, J, Yuan, H (2010) studied the factors affecting contractors' risk attitudes in construction projects in China and the found that the ranking of important factors affecting contractors' risk attitudes are the following of importance: Consequences of decision making, engineering experience, completeness of project information, sensitivity to external information, decision motivation, professional knowledge, education background, scope of knowledge, boldness, judgment ability, company's economic strength, social experience, values, interest in the engineering, desire for decision objectives, external economic environment.

Contractors' risk attitudes are influenced and determined by many factors in construction practice. It is neither practical nor necessary to identify and understand all related factors for minimizing their influence on contractors' risk attitudes. Lu et al. (2008) presents that a smarter way is to identify some critical factors to help contractors to be more focused, through which the usage of limited resources such as money, manpower, time, and management efforts can be maximized. Santrock (2007) stated that we carry values with us that influence our thoughts, feelings, and actions, but each individual possesses a unique conception of values. It is the unique characteristic of values that makes contractors' risk attitudes different. For instance, contractors might tend to take risks if extra economic benefits could be obtained by successfully addressing the risk problems, while those who are more conservative might tend to pursue the success accomplishments of project objectives. Shen et. al. (2006) conducted a study to understand the role of public and private partnerships to manage risks in public sector projects in Hong Kong. In this study, it is found that allocation of site acquisition risk and legal and policy risks to the public sector is more effective while private sector could effectively allocate the design and construction risks, operation risks and industrial action risk to the private sector. Also, development risks, market risks, financial risks and force majeure could be shared effectively between the two partners. Shen and Xiang (2002) studies suggest that the tradition of cost and time overruns,

poor safety performance, poor quality and environmental performance in delivering public sector project remain to large extent unchanged. Moreover, Flyvbjerg et al. (2002) examined 258 large transport infrastructure projects covering 20 countries, and they found that cost overruns occurred in almost 90% of the projects examined, with the highest cost overruns of 86% and 28% on average.

A number of studies have been undertaken worldwide to identify the risks that affect the performance of public sector projects for example, Arditi et. al (1985) . According to these studies, risks affecting public sector projects can be grouped into the following major categories:

- Project-related risks: These risks include cost and time overruns, poor contract management, contractual disputes, delays of tendering and selection procedures, poor communication between project parties.
- Government-related risks: These risks consist of inadequate approved project budgets, delays in obtaining permissions, changes in Government regulations and laws, lack of project controls, administrative interference.
- Client-related risks: These risks include inadequate project budgets, poor project brief, variations in project specifications, delays in the settlement of contractor's claims, lack of project control.
- Design-related risks: These risks represent inadequate soil investigation, delays in design, ambiguities and inconsistencies in design and design changes.
- Contractor-related risks: These risks include inadequate estimates, financial difficulties, lack of experience, poor management, difficult in controlling nominated subcontractors.
- Consultant-related risks: These risks represent lack of experience, performance delays, and poor communication with other project parties.
- Market-related risks: These risks include increase in wages, shortages of technical personnel,

In a survey to understand management perspectives of the state of workplace health and safety practices in Kenya Mbakaya et. al. (1999) found that most respondents (70%) were satisfied with their work safety conditions, only 37% said their workplaces were annually

audited by labor inspectors while 45% said injured workers were not treated well by management. Many workplaces (65%) violated the mandatory legal requirement on the establishment of health and safety committees. Many approaches have been suggested in the literature for classifying risks. Perry and Hayes (1985) presented a list of factors extracted from several sources which were divided in terms of risks retainable by contractors, consultants and clients. Flanagan and Norman (1993) suggested three ways of classifying risk: by identifying the consequence, type and impact of risk. Chapman (2001) grouped risks into four subsets: environment, industry, client and project. Of the 58 identified risks associated with Sino-Foreign construction joint ventures, Shen et al. (2001) categorized them into six groups in accordance with the nature of the risks, i.e. financial, legal, management, market, policy and political, as well as technical risks. In this paper, risks were grouped with reference to Zou et. al. (2007) method in order to study risks from the project stakeholder perspectives. Kanagary (1995) conducted a study to identify risks within the top 100 large USA construction contractors. In this study respondent were asked to identify the importance of risks associated with construction from the owner's and contractor's perspective. Also, they were asked to place these risks into three allocations. Allocated to the owner, construction contractor, or shared between the two parties.

In our research we investigated perspectives in terms of risk likelihood and magnitude which could affect the potential consequences from identified risks. An example of low likelihood with high magnitude events is nuclear facility accident. In which it has low probability of occurrences but when it occurs it could cause high human and monetary losses. On the other hand, conventional power plant facilities might has lower magnitude of risk through exposing human and environment to hazardous gases with high likelihood of occurrences that could be on daily effects. Both events could result in the same level of losses over long time of exposure.

Some risks, once identified, can easily be eliminated or reduced. However, most risks are much more difficult to mitigate, particularly high-impact low-probability risks. Therefore, risk mitigation and management need to be long-term efforts by project managers throughout the project. Some of the options for risk mitigation are: Risk transfer and contracting, risk buffering, risk avoidance, risk control, and risk assumption. Most organizations implement strategies and plans to achieve their goals and objectives through projects. Projects failure to

achieve predefined objectives in terms of time, cost, quality, and safety, as well as environment force public and private organization to shut down their operations and run out of business. Therefore, it is important to understand what the main project risk sources contributors and shed light on them so project stakeholders such as project directors, project executives, project suppliers and others be able to manage them to a degree project objectives could be met effectively and efficiently. Different project stakeholders such as owner, contractor, and consultant could have different perspectives on risk priorities which discard their efforts to manage them. Therefore, in this research we identified the main risk contributors in terms of likelihood and magnitude, as well as consequences and be able to rank them in order of importance. Moreover, we identified the main risk contributors from point view of owner, consultant, and contractor.

2. RESEARCH OBJECTIVES

The objective of this research is to investigate different perspectives for project risks in Saudi Arabia. In particular, the research will:

1. Present the main risk contributors which could prevent project from achieving predefined objectives. These risk are identified from cost, time, quality, safety, and environment sources.

2. Measure significance risk index for each risk source in order to priorities risk sources for each risk group and rank them accordingly to small, moderate, large potential consequences

3. Understand different perspectives for risk priorities from the standpoint of projects' owners, consultants, and contractors.

3. RESEARCH SCOPE AND LIMITATIONS

The aim of this research is to identify risk management priorities for projects in Saudi Arabia. Therefore, the study will investigate different risk sources and classify them after estimating risk index for each risk sources from different perspectives or owners, consultants, and contractors. However, the research has some limitations, such as:

It will not study different perspectives for different types of projects such as infrastructure, housing, public assets and commercial buildings. Also, it will not analyze different perspective within the same role classification. i.e., within contractors the study will not analyze the results based on their company size or classification. Moreover, this research will not make analysis based on project ownership such as public or private one.

4. SIGNIFICANCE OF THIS STUDY

Projects fail to achieve their main objectives due to different reasons that are related to time, cost, quality, and safety, as well as environment. Identifying and priorities risk sources from different perspectives such as owner, contractor, and consultant enable project owners to draw clear picture to secure their future project investment successfully. Risk assessment is the first step toward risk management. Since sometimes, we are not able to prevent or reduce project risk due to lack of understanding the potential project risk consequences. Project risks consequences come from two elements. The first is the risk likelihood, i.e., how likely the risk could occur which could be expressed as high, low or moderate. The second one is the risk magnitude, i.e. how large is it to have such risk sources. This magnitude could be related to the size of business interruption that prevent achieving project objectives. Therefore, this research will facilitate project successes through guiding future project stakeholders toward the main risk contributors and be able to manage them.

5. RESEARCH METHODOLOGY

The research methodology will include the following steps:

Step one: A comprehensive literature review of the available work reported on risk management, allocation of risks and the importance of these risks.

Step two: Definition of important risk parameters and categories related to risk allocation, risk importance and effects of risks on projects.

Step three: Design of a questionnaire related to the allocation of risks, importance and effects of these risks.

Step four: Data was collected and compiled

Step Five: Collected data was analyzed

Step six: Results from the analyzed data were summarized and presented

Step seven: Conclusion of the research, recommendations and suggestions for further studies were incorporated.

6. DESIGN OF QUESTIONNAIRE

The questionnaire was designed to be distributed to bilingual respondents in both English and Arabic. It starts with greeting participants and explaining the reasons behind the survey and it's for scientific purpose only and the content will not disclosed to other party.

Section A of the questionnaire asked for general information about respondents to know their type of job or position, educational background, years of work experience and types of projects that they are currently involved in such as: infrastructure, housing, public assets and commercial buildings.

Section B of the questionnaire ask question to see the key risks according to iIndividual project objectives. These objectives help project owners to complete project according to their expectations in terms of time, cost, quality, and safety, as well as environment. The following section contains the items that will be analyzed for each project objective from different perspectives of project owner, contractors, and consultants.

7. SAMPLE SURVEY

In this research we are trying to understand the main risk contributors for projects in Saudi Arabia from different perspectives of owner, contractor, and consultant. Therefore, choosing a sample size was critical to be able to reach the right one and get better representation. Zou et. al (2007) used a sample size of 177 construction practitioners in China to understand key risks in construction projects in China. In this research a response rate of 46% with total 83 responses that are used for analysis. In this research, we are trying to understand different risk sources for diverse kinds of projects from various project roles such as owner, consultant and contractor. Therefore, we decide to have sample size of 500 that contains different spectrum of research interest. 269 responses were received but 23 of them were identified as invalid due to much incomplete answers. 246 responses represent a valid response rate of 49%, which is acceptable according to Moser and Kalton's assertion.

8. DATA ANALYSIS AND SCORING

The survey feedback includes three groups of data: The likelihood of occurrences of each risk, and its magnitude of consequences, as well as potential effects in terms of owners, contractors, and consultants.

The three point scales for the likelihood α(highly, moderate, low) and the consequences β (high magnitude, medium magnitude, low magnitude).

These point scales need to be converted into numerical scales. Zou et al.(2007) used a value of 1 for high, 0.5 for medium, and 0.1 for low. In our research we will use a value of 3 for high, 2 for medium, and 1 for low as shown in Table 1. The risk index for each hazard is calculated through equation (1)

$$rij = \alpha ij\ \beta ij\ /9 \qquad (1)$$

Where rij= Significance score assessed by respondent j for the impact of risk i, i= ordinal number of risk, i Є (1, m); m= total number of risks; j= ordinal number of valid feedback to risk i, j Є (1, n); n= total number of valid feedbacks to risk i; αij= likelihood of occurrence of risk i, assessed by respondent j; βij= consequence of risk i assessed by respondent j.

The average score for each risk considering its significance from the perspective of stakeholders can be calculated through equation (2). This average score is called the risk significance index score which will be used to rank among all hazards.

$$Ri = = \frac{\sum_{j=1}^{n} rij}{n} \qquad (2)$$

Where Ri= significance index score for hazard i. Risks are ranked in accordance with their significance index (Ri) for the project objectives that are based on different viewpoint from stakeholders such as owner, consultants, contractors, , and others. It is important to mention that the hazards which have been identified in this study have been taken from stakeholders' perspective and not from scientific findings. As shown in Table 1 the maximum score for consequences will be 9 and when we divide it by 9 the maximum will be 1. Therefore, the maximum number for risk index for any risk contributors will be 1. Significant

risk index from 0.333 to 0.666 will be moderate ones. Less than 0.333 low and greater than 0.666 is high.

Likelihood of Occurrence α	High (3)	3	6	9
	Moderate (2)	2	4	6
	Low (1)	1	2	3
		Low (1)	Moderate(2)	High(3)
		Consequences β		

Table 1 Risk Screening Based on Impact and Likelihood

9. STUDY SAMPLE

Our sample contains 25 responses as owner, 87 responses as contractor, 59 responses as consultant, 42 responses for other with 33 responses missing without identifying their role within projects. Percentages for each category are shown in Table 2, below.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Owner	25	10.2	11.7	11.7
	Contractor	87	35.4	40.8	52.6
	Consultant	59	24.0	27.7	80.3
	Other	42	17.1	19.7	100.0
	Total	213	86.6	100.0	
Missing	System	33	13.4		
Total		246	100.0		

Table 2 Role within project for sample

In our sample 70.7% hold bachelor degree and 9.3% hold masters degree with chances that had chances to study risk related issues and make them familiar with project risks. Other percentages are shown in Table 3, below.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Diploma	39	15.9	16.2	16.2
	Bachelor	174	70.7	72.2	88.4
	Masters	23	9.3	9.5	97.9
	Doctorate	5	2.0	2.1	100.0
	Total	241	98.0	100.0	
Missing	System	5	2.0		
Total		246	100.0		

Table 3 Educational background of sample

In the study sample 75.9% has an experience more than 5 years as shown in Table 4. and 39.4% were involved in public assets and commercial building such as shown in Table 5.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 5 years	59	24.0	24.1	24.1
	5-10 years	76	30.9	31.0	55.1
	10-15 years	48	19.5	19.6	74.7
	More than 15 years	62	25.2	25.3	100.0
	Total	245	99.6	100.0	
Missing	System	1	.4		
Total		246	100.0		

Table 4 Number of years of work experience for sample

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Infrastructure	66	26.8	27.2	27.2

	Housing	80	32.5	32.9	60.1
	Public assets and commercial buildings	97	39.4	39.9	100.0
	Total	243	98.8	100.0	
Missing	System	3	1.2		
Total		246	100.0		

Table 5 Types of projects they are currently involved

10. RESULTS OF RISK SOURCES

Previous researchers addressed project risk management from different perspectives. In this research we will classify risk results in terms of the following risk sources:

Project cost overrun risks include: inaccurate cost budget; price escalation of material and material-availability uncertainties; labour-market and labour cost increase; supplier or subcontractors' default; unpredictable weather; fluctuation in currency and interest rates; excessive interface on project management; political instability, corruption and unfamiliarity with local regulations.

Project time delay risks include: poor project scope definition; project complexity; inadequate planning; impropriate project schedule; design variations; inaccurate engineering estimate; inaccuracy of material estimate; material and equipment shortage; long lead-time items; shortage of skilled labour; poor labour productivity; unpredictable weather conditions.

Project quality risks include: iterative cycles resulting from unanticipated errors and changes; problems due to inappropriate design; lack of appropriate design check; time availability problems; non-availability of experienced design personnel; reduced tender times; reduction in design fees, poor workmanship, use of sub-standard materials, not following specifications or standards, inappropriate construction processes.

Project safety risks include: lack of safety regulations and legislation; poor safety awareness of top management and project managers; reluctance to input resources to safety;

lack of training; poor accident record keeping and reporting system; reckless operation; disorganized labour; poor site conditions, layout and space; severe weather conditions.

Project environmental sustainability risks include: direct environment risks such as dust, harmful gases, noises, solid and liquid wastes; and indirect environmental risks which are influenced by a project but are not necessarily a direct result of the project, such as the exposure of contaminated materials during the excavation of soil for footing.

10.1 Cost

The average score for cost risk was 0.50228 which could be classified with moderate potential consequences. The following were the most significant risk sources in order: Price inflation of construction materials, unavailability of sufficient amount of skilled labor, unavailability of sufficient professionals and managers, bureaucracy of government, contractors' poor management ability, suppliers' incompetency to delivery materials on time, inadequate safety measures or unsafe operations.

10.2 Time

The average score for cost risk was 0.525209 which could be classified with moderate potential consequences. It is clear that time related risk is larger than cost related ones. The following are the risk with the largest significant index in order: Price inflation of construction materials, unavailability of sufficient amount of skilled labor, bureaucracy of government, suppliers' incompetency to delivery materials on time, poor competency of labor, project funding problems, contractors' poor management ability.

10.3 Quality

Low management competency of subcontractors' significance index score was 0.612466 which could be classified as high even though the total risk index for quality of 0.448641 was less than that for cost and time. Other sources of quality related risks are the following: Poor competency of labor, contractors' poor management ability, price inflation of construction materials, unavailability of sufficient professionals and managers, tight project schedule, as shown in Table 4.8.

10.4 Environment

Significance index scores for cost related risks are shown in Table 4.9, below. The average score for cost risk was 0.5476 which could be classified with moderate potential consequences. The following were the most significant risk sources in order: Serious noise pollution caused by construction, serious air pollution due to construction activities, prosecution due unlawful disposal of construction waste, water pollution caused by construction, contractors' poor management ability

10.5 Safety

Inadequate safety measures or unsafe operations ranked number one in terms of significance score index and it was 0.6576 that could be considered high significant risk source. Significance index scores for safety were 0.5235. The most risk contributors were in order: Low management competency of subcontractors, Poor competency of labor, Unavailability of sufficient professionals and managers, Contractors' poor management ability.

11. Results of Risk Stakeholders

11.1 Owner

The owner thing that low management competency of subcontractors is the most quality risk contributor which has a significance risk index of 0.6889 followed by price inflation of construction materials with a significance risk index of 0.68. There were four risk sources ranked high score of potential risk consequences with a significance risk index greater than 0.666 and ten of them between 0.6 and 0.666. These risk sources along with their impact on project objective are in order: Low management competency of subcontractors (quality); price inflation of construction materials (cost); contractors' poor management ability (cost); unavailability of sufficient amount of skilled labor (cost); bureaucracy of government (time). Table 6 shows the owner average significance index scores for all risk sources from each category. In this table environmental issues were ranked the least significant and the safety issues were the most significant ones.

Cost		Time		Quality		Environment		Safety	
Risk	Signifi	Risk	Significa	Risk	Signific	Risk	Signific	Risk	Signifi

Source	cance index scores	Source	nce index scores	Source	ance index scores	Source	ance index scores	Source	cance index scores
CR1	0.42	TR1	0.53	QR1	0.41	ER1	0.34	SR1	0.44
CR2	0.68	TR2	0.52	QR2	0.57	ER2	0.41	SR2	0.5
CR3	0.46	TR3	0.46	QR3	0.46	ER3	0.37	SR3	0.48
CR4	0.47	TR4	0.48	QR4	0.41	ER4	0.44	SR4	0.62
CR5	0.5	TR5	0.45	QR5	0.4	ER5	0.44	SR5	0.64
CR6	0.4	TR6	0.4	QR6	0.43	ER6	0.38	SR6	0.5
CR7	0.46	TR7	0.54	QR7	0.52	ER7	0.43	SR7	0.6
CR8	0.67	TR8	0.43	QR8	0.41	ER8	0.49	SR8	0.6
CR9	0.42	TR9	0.42	QR9	0.51	ER9	0.48	SR9	0.52
CR10	0.35	TR10	0.64	QR10	0.52	ER10	0.42		
CR11	0.61	TR11	0.61	QR11	0.61	ER11	0.51		
CR12	0.57	TR12	0.57	QR12	0.69	ER12	0.52		
CR13	0.67	TR13	0.58	QR13	0.51	ER13	0.52		
CR14	0.6	TR14	0.57			ER14	0.46		
CR15	0.45	TR15	0.52			ER15	0.56		
CR16	0.6	TR16	0.42			ER16	0.51		
CR17	0.5								
CR18	0.39								
Average	0.49		0.51		0.51		0.46		0.55

Table 6 Owner average Significance index scores for all risk sources

11.2 Contractor

In Table 7 we tried to show different significant risk index in terms of project objectives for contractors. It shown that only three risk sources get score higher than 0.60 for their significance index that could be classified as moderate one. These are related to quality (unavailability of sufficient amount of skilled labor), Safety (inadequate safety measures or unsafe operations), and cost (price inflation of construction materials)

Table 7 shows the owner average significance index scores for all risk sources from each category. In this table, environmental issues were ranked the least significant and the safety

issues were the most significant ones. Owner sees that risks related to safety are more important than the contractors think.

Cost		Time		Quality		Environment		Safety	
Risk Source	**Significance index scores**	**Risk Source**	**Significance index scores**	**Risk Source**	**Significance index scores**	**Risk Source**	**Significance index scores**	**Risk Source**	**Significance index scores**
CR1	0.42	TR1	0.44	QR1	0.38	ER1	0.33	SR1	0.48
CR2	0.68	TR2	0.53	QR2	0.53	ER2	0.38	SR2	0.46
CR3	0.46	TR3	0.52	QR3	0.39	ER3	0.41	SR3	0.45
CR4	0.47	TR4	0.43	QR4	0.49	ER4	0.45	SR4	0.5
CR5	0.5	TR5	0.58	QR5	0.45	ER5	0.49	SR5	0.63
CR6	0.4	TR6	0.53	QR6	0.44	ER6	0.37	SR6	0.51
CR7	0.46	TR7	0.5	QR7	0.52	ER7	0.41	SR7	0.51
CR8	0.67	TR8	0.4	QR8	0.5	ER8	0.4	SR8	0.5
CR9	0.42	TR9	0.41	QR9	0.65	ER9	0.42	SR9	0.44
CR10	0.35	TR10	0.55	QR10	0.55	ER10	0.42		
CR11	0.61	TR11	0.55	QR11	0.58	ER11	0.42		
CR12	0.57	TR12	0.54	QR12	0.57	ER12	0.41		
CR13	0.67	TR13	0.49	QR13	0.41	ER13	0.56		
CR14	0.6	TR14	0.5			ER14	0.53		
CR15	0.45	TR15	0.47			ER15	0.59		
CR16	0.6	TR16	0.39			ER16	0.5		
CR17	0.5								
CR18	0.39								
Average	0.478		0.488		0.497		0.443		0.498

Table 7 Contractor average Significance index scores for all risk sources

11.3 Consultant

As for consultant cost, safety, time, and environmental issues ranked the most risk contributors with average significance risk index of 0.51. Five risk sources have risk index

that could be considered large with greater than 0.66. They are price inflation of construction materials (cost); inadequate safety measures or unsafe operations (safety); price inflation of construction materials (time); bureaucracy of government (time). The rest of factors which consultant think they are related to project risk are shown in Table 8.

Cost		Time		Quality		Environment		Safety	
Risk Source	**Significance index scores**	**Risk Source**	**Significance index scores**	**Risk Source**	**Significance index scores**	**Risk Source**	**Significance index scores**	**Risk Source**	**Significance index scores**
CR1	0.41	TR1	0.52	QR1	0.38	ER1	0.31	SR1	0.36
CR2	0.71	TR2	0.67	QR2	0.58	ER2	0.36	SR2	0.44
CR3	0.5	TR3	0.51	QR3	0.43	ER3	0.44	SR3	0.47
CR4	0.44	TR4	0.54	QR4	0.47	ER4	0.49	SR4	0.55
CR5	0.6	TR5	0.6	QR5	0.51	ER5	0.51	SR5	0.7
CR6	0.5	TR6	0.53	QR6	0.48	ER6	0.39	SR6	0.54
CR7	0.53	TR7	0.56	QR7	0.59	ER7	0.45	SR7	0.51
CR8	0.55	TR8	0.38	QR8	0.39	ER8	0.46	SR8	0.56
CR9	0.37	TR9	0.45	QR9	0.54	ER9	0.48	SR9	0.53
CR10	0.45	TR10	0.66	QR10	0.54	ER10	0.5		
CR11	0.6	TR11	0.57	QR11	0.6	ER11	0.45		
CR12	0.54	TR12	0.6	QR12	0.61	ER12	0.51		
CR13	0.59	TR13	0.58	QR13	0.5	ER13	0.64		
CR14	0.54	TR14	0.59			ER14	0.51		
CR15	0.38	TR15	0.45			ER15	0.56		
CR16	0.5	TR16	0.43			ER16	0.53		
CR17	0.41								
CR18	0.43								
Average	0.503		0.54		0.508		0.474		0.519

Table 8 Consultant average Significance index scores for all risk sources

12. ANALYSIS OF RISK SOURCES VS. STAKEHOLDERS

In this section we categorized risk index for each risk contributes into three categories, small, moderate, and large. For small category risk index will be between 1 and 3. In this category, risk likelihood or consequences should have value of 1. Table 9, below show each risk categories for significance index score.

Low category when the following likelihood α and consequences β combination: (1, 1), (1, 2), (1, 3), (2, 1). Scores between 1-3. Moderate category when the following likelihood α and consequences β combination :(2, 2). Large category when the following likelihood α and consequences β combination :(3, 2), (2, 3), (3, 3)

Since the largest value of significance index is one. I.e, 9 divided by 9 categories, the following significance risk categories will be considered. Low when significance index when risk index less than 0.33. Moderate significance index when risk between (0.33-0.66). Finally, High significance index when risk larger than 0.66

Likelihood of Occurrence α				
	High (3)	3 Low	6 High	9 High
	Moderate (2)	2 Low	4 Moderate	6 High
	Low (1)	1 Low	2 Low	3 Low
		Low (1)	Moderate(2)	High(3)
		Consequences β		

Table 9 Significance risk index category

12.1 SMALL RISK CONTRIBUTORS

In this research there was only one risk contributor which scale below 0.33 which is variation by the client from consultant perspective.

12.2 MODERATE RISK CONTRIBUTORS

Most significance risk index were considered to me moderate one. Table 10 show the highest scores for moderate risk contributors. This results shows that most risk factors are considered by owner to be considered as risk contributor.

Risk Factor	Risk Description	Significance index scores	Owner	Consultant	Contractor
QR9	Unavailability of sufficient amount of skilled labor	0.65			✓
TR10	Bureaucracy of government	0.644	✓		
ER13	Serious noise pollution caused by construction	0.637		✓	
SR5	Inadequate safety measures or unsafe operations	0.636	✓		
CR2	Price inflation of construction materials	0.627			✓
SR4	Contractors' poor management ability	0.618	✓		
CR11	Bureaucracy of government	0.613	✓		
TR11	Suppliers' incompetency to delivery materials on time	0.613	✓		
QR11	Poor competency of labor	0.609	✓		
QR12	Low management competency of subcontractors	0.606		✓	
TR12	Unavailability of sufficient amount of skilled labor	0.605		✓	
CR16	Inadequate safety measures or unsafe operations	0.604	✓		
SR7	Poor competency of labor	0.604	✓		
SR8	Low management competency of subcontractors	0.604	✓		

Table 10 Moderate significance risk index for owner, contractor, consultant

12.3 LARGE RISK CONTRIBUTORS

Large risk contributors which score larger than 0.66 for average risk index were mostly considered by owner and consultant and none of them were considered by contractor as shown in Table 11.

Risk Factor	Risk Description	Significance index scores	Owner	Consultant	Contractor
CR2	Price inflation of construction materials	0.712		✓	
SR5	Inadequate safety measures or unsafe operations	0.702		✓	
QR12	Low management competency of subcontractors	0.689	✓		
CR2	Price inflation of construction materials	0.68	✓		
TR2	Price inflation of construction materials	0.672		✓	
CR8	Contractors' poor management ability	0.671	✓		
CR13	Unavailability of sufficient amount of skilled labor	0.671	✓		
TR10	Bureaucracy of government	0.659		✓	

Table 11 Large significance risk index for owner, contractor, consultant

13. CONCLUSION

This paper investigates potential risk sources for projects in Saudi Arabia through different perspective of owners, and contractors, as well as consultants in order to understand the risk contributors and be able to manage such risk. Therefore, we identify risk sources through literature review, preparing survey questionnaire, collecting and analyzing data, and finally draw a clear picture of risk priorities in projects for Saudi Arabia.

Responses from 269 participants were received, among which 23 discarded due to not complete information and the rest of 246 participants were analyzed, summarized and reported for each type of projects objectives in terms of cost, time, quality, and environment, as well as safety. In order to understand different perspectives of projects owners, contractors, and consultants we reanalyzed responses to measure the significance score index for each risk sources. 25 participants were for owners, 87 for contractors, 29 for consultants, and 33 for participants without specifying their roles in projects.

All participants' roles (owner, contractor, and consultant) ranked environmental risk sources as the least important. As for owner, risk significance in order was: Safety, cost, time, quality, and environment. On the other hand, contractors ranked risk sources as the following: Safety, quality, time, cost, and environment. Finally, consultant ranked them: Time, safety, quality, and cost, as well as environment.

It is clear that there are differences in risk significance index for each risk sources for different project stakeholders. Such differences might shift available resources to mitigate their consequences. Therefore, a consensus between stakeholders should be established early in project planning process through having quick survey to realize the most important risk contributors and be able to manage them accordingly with minimal impact on cost, time, quality, and safety, as well as environment.

14. RECOMMENDATIONS

This paper identified risk management priorities for projects in Saudi Arabia. Therefore, we investigated different risk sources and classified them after estimating risk index for each risk sources from different perspectives or owners, consultants, and contractors. However, the research has some limitations, such as:

We recommend to study different perspectives for different types of projects such as infrastructure, housing, public assets and commercial buildings.

Also, this research did not analyze different perspective within the same role classification. I.e., within contractors the study did not analyze the results based on company size or classification. Therefore, we recommend analyzing different perspectives within the same role classification to see if there is consensus among project management team such as executives, project directors, program managers, and team leaders.

Since project ownership is critical aspect of project risk management. Therefore, public owned projects might be relaxed with accepting risk taking while private owned projects might be more conservative especially in cost part of projects.

We found a lack of interest in environmental issues and that is why significance risk indexes were ranked the lowest among stakeholders (owner, contractor, consultant).

Therefore, we should emphasis environmental protection measures to prevent future environmental degradation due to current or future projects.

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