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An Innovative Framework for Risk Management in Construction Projects in Developing Countries: Evidence from Pakistan

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Abstract: Risk management is a comparatively new field and there is no core system of risk management in the construction industries of developing countries. In Pakistan, construction is an extremely risk-seeking industry lacking a good reputation for handling risk. However, it is gradually giving it more importance as a result of increased competition and construction activities. For this purpose, a survey-based study has been conducted which aims to investigate the risk management practices used in construction projects in Pakistan. To achieve the objective, data was collected from 22 contractor firms working on 100 diverse projects. The analysis indicates that risk management has been implemented at a low level in the local environment. The results also disclose that there is a higher degree of correlation between effective risk management and project success. The findings reveal the importance of risk management techniques, their usage, implication, and the effect of these techniques on the success of construction projects from the contractor's perspective, thus convincing the key participants of projects about the use of risk management.

Keywords: risk management; construction projects; projects success; contractor's perspective

1. Introduction

Construction is a very risk-inclined industry with a relatively poor reputation for handling the risk (Shen et al. 2001). The construction industry and, moreover, construction project activities are risky (Wang et al. 2004). The accomplishment of project success in the construction industry mainly relies upon the level of risk (Kartam and Kartam 2001). With the increasing association of many contracting parties, such as contractors, subcontractors, suppliers, owners, and designers, the level of risk increases (Iqbal et al. 2015). This level of risk can be decreased by adopting risk management practices (Aleshin 2001; Iqbal et al. 2015).

Projects from the construction industry are different in size (small, large, medium) which involves risk of varying degrees of impact (Hwang et al. 2014). Frequently, the risk is not dealt with satisfactorily, and, as a result, the industry is facing poor performance (Iqbal et al. 2015). Many infrastructure projects, being massive in shape, involve huge budgets leading to huge monetary losses, and these losses are caused by the various risks linked with such megaprojects (Deviparasath 2007). These types of losses

needed to be identified and mitigated. The whole process of identification and mitigation is termed as risk management (PMI 2017).

Many risk management frameworks have been developed by various researchers. (Iqbal et al. 2015) developed a risk management framework to report the significance of different types of risks and the effectiveness of risk management techniques practiced in construction projects. Risks events were identified, classified, and assessed by Aleshin (2001) in his proposed framework for practical recommendations of risk management to joint projects in Russia. (Choudhry and Iqbal 2012), in their study, identified and prioritized common risks, management techniques to address those risks, the current status of the implementation of risk management systems in organizations, and their barriers to effective risk management in the construction industry. A risk management framework was proposed by Wang et al. (2004) who emphasize the risk identification process, the techniques, the risk evaluation process, and an effective way for mitigation measures. In addition, a risk model (named Alien Eyes' Model) was introduced, which shows hierarchical levels of risk and the affected relationship between the risks. Shen (1997) introduces a risk management model to identify critical risks and their mitigation plan from the contractor's perspective. In addition, there is a limited application of analytical techniques available to assess the critical risks in the Hong Kong construction industry. To identify and assess the risks in the joint venture project, Bing and Tiong (1999) proposed a comprehensive risk assessment model which is effective for the identification of critical risk factors and provides a way to assess the identified risk in a better way.

Management of projects is concerned with the utilization of skills, tools, techniques, and knowledge about the activities of projects, keeping in mind the core goal of the stakeholders' expectations in a project (Hwang et al. 2014). The construction sector is a standout amongst the most neglected sectors in Pakistan (Hameed and Woo 2007). Risk analysis and management is a critical part of project management. Risk is the quality of a system that relates to the possibility of different outcomes (Jaafari 2001). Risk is an event having an impact on the organization's objectives and may affect the performance of the organization in terms of low productivity, poor quality, and an increase in the budget (Akintoye and MacLeod 1997; Loosemore et al. 2012). Management of risk is considered to be the most important part of the execution in construction management (Tang et al. 2007). It is mostly concerned with the triple constraints (namely, time, cost, and quality) of the project, the integration of the project, communication, human resources (HR), and the procurement process. It also helps to develop the future vision of projects as it recognizes likelihoods and uncertainties (Borge 2001). It is characterized as a framework that expects to recognize and assess all risks to which the project is exposed with the goal that an alert judgment can be made how to deal with the risk (Zou et al. 2007; Flanagan and Norman 1993; Barber 2005). The above research highlights that many researchers have done research on risk management, but very little or no effort has been made from Pakistan's perspective. Due to inadequate risk management practices in the construction industry of Pakistan, many projects are not completed on time and within the allocated budget. There is still an immense need to train and educate employees about risk management practices in the construction industry. For this purpose, this research aims to develop a framework to investigate risk management practices and their implications to produce future benefits for construction projects in Pakistan.

This study focuses on risk management practices adopted by the contractor's firms in the construction industry of Pakistan. The principal objectives of the research are; (i) to study, identify, and prioritize the risk management techniques, (ii) to identify and prioritize the project success factor in the construction industry, (iii) to apply the effective knowledge of risk management in construction projects, (iv) to study and investigate the relationship between implementing effective risk management and the success of construction projects in Pakistan. The basic aim is to help contractor firms to take care of their upcoming and current projects by having a focus on implementing risk management practices and analyzing the effect of risk management on the success of construction projects.

This research is organized as follows: Section 1 describes the introduction of risk management, its definitions, and the practices previously accomplished. Section 2 states the research methodology for the current study, leading to a proposed framework for risk management in Section 3. Section 4

describes the risk management techniques for the current study. Results and a discussion are provided in Section 5, leading to the conclusion of the research in Section 6.

2. Research Methodology

This section presents the research methodology adopted for this study. It begins with understanding risk management. A literature survey was performed on risk management, its techniques, and current findings on risk management. Based on a literature review and a discussion with the top management of the construction industry, a questionnaire (5-point Likert scale) was developed. It consisted of three major sections, namely, (i) respondent's basic profile, (ii) questions related to aims of investigating risk management, and (iii) questions related to the success criteria (PSF, i.e., project success factors). The questionnaires were filled in by 270 respondents through field links (filled in by hand in a face-to-face meeting) from the target population. The target population consisted of the contractor companies listed with the Pakistan Engineering Council (PEC). These companies are categorized as CA, CB, C1, C2, C3, and C4 based on their tendering limit, as depicted in Table 1. The construction projects, including bridges, flyovers, buildings, infrastructures, roads, and dams, were the major focus of this research. In addition to this, the target population includes project managers, deputy project managers, senior site engineers, and planning engineers working in different construction companies.

Table 1. PEC (Pakistan Engineering Council) Category and Tendering Limit of Companies.

PEC Categories	CA	CB	C1	C2	C3	C4
Tendering Limit	No Limit	2000 M	1000 M	500 M	250 M	100 M

Note: M = Million of Rupees (PKR).

There are different respondents working on different projects belonging to different categories of registration under the PEC. According to Table 2, the largest number of samples were collected from the two companies with category CA and CB with 34.4% and 32.2%, respectively. Moreover, 58.5% of the people from whom data was collected were highly experienced (more than 20 years of experience). Based on their experience, it can be projected that the collected data is reliable and precise. The quality and reliability of the data can be affirmed by 35.6% and 21.5% of the responses were collected from deputy project managers and project managers, respectively. In addition, 41.1% of the samples were collected from infrastructure projects, and 47.1% of the projects cost more than 300 million rupees.

Table 2. Profile of Companies, Respondents, and Projects.

No of Samples (N = 270)			
Characteristics	**Category/Range**	**N**	**%**
Contractors	CA	93	34.4
	CB	87	32.2
	C1	66	24.4
	C2	5	1.9
	C3	14	5.2
	C4	5	1.9
Position in Job	Senior Engineer	37	13.7
	Planning Engineer	79	29.3
	Deputy Project Manager	96	35.6
	Project Manager	58	21.5
Type of Project	Buildings	83	30.7
	Infrastructure	111	41.1
	Motorways and Highways	66	24.4
	Dams and Bridges	10	3.7

Table 2. *Cont.*

No of Samples (N = 270)			
Characteristics	**Category/Range**	**N**	**%**
Experience	<5	4	1.5
	5–9	15	5.5
	10–20	93	34.4
	>20	158	58.5
Project Cost	≥5 M	9	3
	10 M ≤ · · · < 100 M	54	19.9
	100 M ≤ · · · < 300 M	79	29
	≥300 M	128	47.1

Note: M = Million of Rupees (PKR).

3. Proposed Framework for Risk Management

This section presents the proposed framework for risk management. The proposed framework aims to investigate risk management by focusing on the risk management process (risk identification, risk assessment, and response) and problem-solving of the identified and assessed risks (risk treatment). In addition to achieving project success, there is a need to adopt the risk management cycle as projected in the study.

It is important to consider the following issues in terms of the risk management process, as shown in Figure 1.

- Identification of the risk event by using risk identification techniques (Tang et al. 2007; Hwang et al. 2014; PMI 2017).
- Analyzing the risk origin and risk impact (Westland 2006; Zou et al. 2007; Paek 2009).
- Risk assessment and risk response by using risk response techniques (Choudhry and Iqbal 2012; Loosemore et al. 2012; PMI 2017).
- Handling the threats and opportunities of the risk event by using the risk treatment techniques (Faber 1979; Choudhry et al. 2012; PMI 2017).
- Applying the risk management cycle to achieve project success in terms of contractor firms.

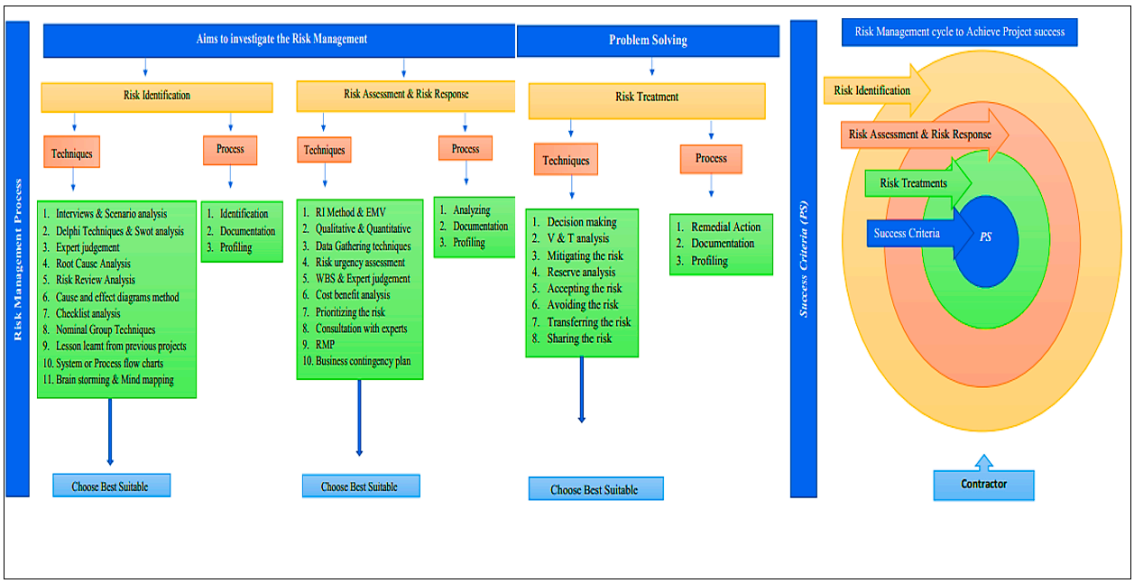

Figure 1. Proposed Risk Management Framework for the Construction industry.

In Pakistan, the contractor is a leading stakeholder in construction projects. Utilization of the maximum budget and scope depends upon the contractor. The contractor is also responsible for the command of the schedule of the project. The contractor, as an organization, is the only one among the stakeholders who needs to confront a number of risks during the life cycle of a construction project (Khan 2013; Choudhry et al. 2012).

4. Data Analysis Techniques

The Statistical Package for Social Sciences (SPSS) version 25.0 developed by IBM was the tool used by the researcher for the analysis of the data. The analysis involves: (i) estimation of sample population mean, (ii) ranking of technique based on their means, and (iii) correlation analysis (Spearman rank correlation). The results of the analysis were graded as significant at 0.05 level and highly significant at 0.01 level. In this study, the ranking was based on a population sample mean. Ranking of the risk management techniques and project success factors depended upon the mean values of the sample population. Means with a higher value were graded as rank one and means with the lowest value will be graded as last. The Spearman rank correlation test was used to check the nonparametric strength of association or direction between two variables based on the measurement scale and it is denoted by the symbol (r-Rho). The null hypothesis (H_0) for this test was justified if there was no relationship between the variables. It was rejected if the result was statistically significant at the level of 0.05 or highly significant at 0.01 level. The correlation between effective risk management and the success of construction projects (project success) was tested to determine whether the effectiveness of risk management has influence on making a project successful or not.

5. Results and Discussions

Risk Management technique implementation followed by understanding of project success provides an overview of successful analysis of applied techniques and furthermore provides a correlation analysis showing the relationship between applied technique and obtain benefits. Results for application of three phases has been discussed in this section.

5.1. Risk Management Techniques

Risk Management can be implemented by step application of its techniques following identification, assessment, response and treatment. Stepwise explanation has been given as:

5.1.1. Risk Identification Techniques

Risk identification techniques were calculated and organized from most frequently used to less frequently used, based on their means. In addition, respondents were asked to identify the frequency of usage on a scale of 1 to 5, on which 1 represented never used and 5 represented always used.

Table 3 shows the ranking of risk identification techniques based on their means to investigate the process of effective risk management. The risk identification technique named "lesson learn from the past project" (mean 2.54) was selected as most frequently used by respondents and ranked 1st based on its mean. Furthermore, "nominal group techniques" (mean 2.31) was selected as less important and ranked 12th in this group. The other techniques identified were "risk review meetings" (mean 2.51), "interview" (mean 2.50), "mind mapping" (mean 2.49), "cause and effect diagrams analysis" (mean 2.45), "checklist analysis" (mean 2.44), "expert judgement" (mean 2.43), "Delphi technique and SWOT analysis" (mean 2.40), "brainstorming" (mean 2.38), "root cause analysis" (mean 2.37), and "system or process flow charts" (mean 2.33)". Risk identification is the initial footstep of risk assessment (PMI 2017), which includes the identification and classification of potential risk factors is carried out concerning construction projects (Zou et al. 2007). Brainstorming, historical information, interviews, questionnaire surveys, and workshops are the widely used methods through which the risk can be identified (Tang et al. 2007).

Table 3. Ranking of Risk Identification Techniques.

Techniques	M	R
1. Interviews	2.50	3
2. Scenario analysis	2.33	11
3. Delphi technique	2.40	8
4. Expert judgment	2.43	7
5. Root cause analysis	2.37	10
6. Risk review meetings	2.51	2
7. Cause and effect diagrams analysis	2.45	5
8. Checklists analysis	2.44	6
9. Nominal group techniques	2.31	12
10. SWOT analysis	2.40	8
11. Lesson learned from the past project	2.54	1
12. System or process flow charts	2.33	11
13. Brainstorming	2.38	9
14. Mind mapping	2.49	4

Note: M = Mean, R = Rank.

5.1.2. Risk Assessment and Risk Response Techniques

Risk assessment and risk response techniques were calculated and organized from most frequently used to less frequently used, based on their means. In addition, respondents were asked to identify the frequency of usage on a scale of 1 to 5, on which 1 represented never used and 5 represented always used.

Table 4 shows the ranking of risk assessment and risk response techniques based on their mean to investigate the process of effective risk management. The risk assessment technique named "expert judgment and WBS" (work break down structure) (mean 2.44) was selected as most frequently used by the respondents and ranked 1st based on its mean. Furthermore, "data gathering and representation techniques" (mean 2.20) was selected as less important and ranked 9th in this group. The other techniques identified were "business contingency plan" (mean 2.39), "risk management plan" (mean 2.38), "risk urgency assessment" (mean 2.36), "cost–benefit analysis" (mean 2.34), "prioritizing the risk" (mean 2.29), and "risk index method and expected monetary value (EMV)" (mean 2.28).

Table 4. Ranking of Risk Assessment and Risk Response Techniques.

Techniques	M	R
1. Risk index method & expected monetary value	2.28	8
2. Qualitative & quantitative analysis	2.38	3
3. WBS & expert judgment	2.44	1
4. Data gathering and representation techniques	2.20	9
5. Risk urgency assessment	2.36	4
6. Cost–benefit analysis	2.34	5
7. Prioritizing the risk	2.29	7
8. Consultation with experts & meetings	2.33	6
9. Risk management plan (RMP)	2.38	3
10. Business contingency plan	2.39	2

Note: M = Mean R = Rank.

The identified risks are quantified in the risk assessment process using statistical analysis (qualitative or quantitative) (Smith 2008), WBS (work break down structure), and lesson learned which are considered the most effective tools for assessing the potential risk and to minimize the probability of neglecting the risk event (Hwang et al. 2014). In addition, WBS refers to identified

activities that determine what type of design is required to build a project and considers the resources through which work is carried out (Altoryman 2014).

5.1.3. Risk Treatment Techniques

Risk treatment techniques were calculated and organized from most frequently used to less frequently used, based on their means. In addition, respondents were asked to identify the frequency of usage on a scale of 1 to 5, on which 1 represented never used and 5 represented always used.

Table 5 shows the ranking of risk treatment techniques based on their mean to investigate the process of effective risk management considering to what extent any organization used the risk treatment option during projects. The risk treatment technique named "decision making and mitigating the negative risk" (mean 2.40) was selected as most frequently used by the respondents and ranked 1st based on its mean. Furthermore, "sharing the positive risk and variance and trend analysis" (mean 2.28) was selected as less important and ranked 7th in this group. Other techniques identified were "avoiding the negative risk" (mean 2.37), "exploiting the positive risk" (mean 2.35), "reserve analysis" (mean 2.32), "accepting the positive risk" (mean 2.31), and "transferring of the negative risk" (mean 2.29). The investigation of the treatment process shows that Pakistan's construction industry mostly believes to take the option of "avoiding the risk" (ranked 2nd) and "exploiting the risk" (ranked 3rd) rather than "transferring the risk" (ranked 6th).

Table 5. Ranking of Risk Treatments Techniques.

	Techniques	M	R
1.	Decision making	2.40	1
2.	Variance & trend) analysis	2.28	7
3.	Mitigating the negative risk	2.40	1
4.	Reserve analysis	2.32	4
5.	Accepting the positive risk	2.31	5
6.	Exploiting the positive risk	2.35	3
7.	Avoiding the negative risk	2.37	2
8.	Transferring the negative risk	2.29	6
9.	Sharing the positive risk	2.28	7

Note: M = Mean R = Rank.

The project can be protected from the impact of the risk by avoiding the risk (Tang et al. 2007). In addition, changing the management plan of a project can eliminate the threat of the risk completely. To exploit the responses directly means to select the best resources that need to be assigned to minimize the time of completion, or the risk can be reduced using technology to achieve project objectives (Loosemore et al. 2012; PMI 2017).

5.2. Project Success

Project success factors were calculated and organized by most frequently used to less frequently used, based on their means. In addition, respondents were asked to identify the frequency of usage on a scale of 1 to 5, on which 1 represented never used and 5 represented always used.

Table 6 shows the ranking of project success factors based on their means investigating the criteria of project success. The project success factor named "no complaints and claims" (mean 2.53) was selected as most important by the respondents and ranked 1st based on its mean. Furthermore, "completion of the project within schedule" (mean 2.33) is selected as less important and ranked 7th in this group. Other factors identified were "overall project quality objectives met based on baseline and targets" (mean 2.47), "confirm all technical specification" (mean 2.43), "fulfill all quality standards" (mean 2.41), and "fulfill scope/no changes in scope" (mean 2.37). The investigation of project success factors indicated the point at which most construction projects are considered successful is reached when the project baseline is achieved and targets reached and when all the technical specification are

confirmed (ranked 2nd and 3rd, respectively). Most of the project not complete on time, ultimately it affects the overall cost (ranked 6th). To achieve project objectives and targets project needs to be under schedule, within budget, obeying quality standards, and would be as per defined scope (PMI 2017).

Table 6. Ranking of Project Success Factors.

Project Success Factors	M	R
1. Fulfill scope/no changes in scope	2.37	5
2. The project is within the planned budget	2.33	6
3. Overall project quality objectives meet based on baseline and targets	2.47	2
4. Completion of project within schedule	2.29	7
5. Fulfill all quality standards	2.41	4
6. Confirm all technical specification	2.43	3
7. No complaints and claims	2.53	1

Note: M = Mean R = Rank.

5.3. Correlation Analysis

The Pearson correlation was performed to check the relationship between effective risk management and project success by testing the hypothesis (see Table 7). The Pearson coefficient indicates that the values of PS (project success) were significantly correlated with risk identification, risk analysis, and risk response at a 0.05 level of significance, respectively. The PS values were positively associated with effective risk management and the hypothesis has been confirmed. In addition, the Pearson correlation result reveals that the aspects of effective risk management, i.e., risk identification, risk assessment, and risk analysis, were significantly correlated to each other, which confirms the findings of Tang et al. (2007). Hence, effective improvement in one risk management process also affects the other risk management processes positively.

Table 7. Pearson Correlation between Effective Risk Management and Project Success.

Indicators of Risk	Risk Identification	Risk Assessment	Risk Response	Project Successes
Risk Identification	1.000			
Risk Assessment	0.778 [a]	1.000		
Risk Response	0.809 [a]	0.730 [a]	1.000	
Project Successes	0.780 [a]	0.649 [a]	0.774 [a]	1.000

[a] Correlation is significant at the 0.05 level (2-tailed).

6. Conclusions and Recommendations

This research presents an innovative framework for risk management in the construction sector of Pakistan. For this purpose, a survey-based study was conducted which aimed to investigate the risk management practices used in construction projects in Pakistan.

This research study is an effort to evaluating the effect of risk management in the construction industry of Pakistan. It will help the contractor firms of the construction industry (CI) to find the weaknesses in terms of implementing effective risk management. A comparison of the risk factors of construction mega-projects will develop a sense of competition among the project stakeholders, i.e., contractors need to improve their risk management practices. This effort fuels the evolutionary process of changing the mindset of all contractors to invest in risk management practices for better productivity.

The major outcomes of the research are as follows:

- In Pakistan, the most widely used risk management techniques to identify risks are: (i) prospect of lesson learned from past projects (mean 2.54), (ii) risk review meetings (mean 2.51), and (iii) Delphi techniques (mean 2.40). The most widely used risk assessment and analysis techniques

in Pakistan are: (i) expert judgment (mean 2.44), (ii) WBS (mean 2.39), (iii) risk index method (mean 2.28), and (iv) data gathering and representation techniques (mean 2.20). The construction industry adopts the approach of (i) decision making and risk management plan with a mean of 2.40, i.e., it is frequently used for the process of risk response and treating the risks in an effective way. The industry seldom opts for (ii) cost–benefit analysis and sharing the risk (mean 2.28) and (iii) transferring the risk (mean 2.29).

- The results of the study disclose about project success factors that if (i) there is no complaint and regrets from clients (mean 2.53), (ii) the project achieved all objectives (mean 2.47), and (iii) it followed all technical specifications (mean 2.43) then project has achieved a milestone in term of achieving the success criteria. However, (iv) project completed within schedule (mean 2.29) and (v) no changes in scope (2.73) are rarely considered effective factors for the success of projects in the perception of Pakistan's largest contractors. The study also reveals the association of risk management practices and project success and that there is a higher degree of correlation between effective risk management and project success.

The study reveals many aspects of risk management practices by studying the perceptions of the largest Pakistani contractors in the construction industry. The results of the study provide an opportunity to project managers, assistant project managers, and senior key members of a project to take care of ongoing and upcoming projects of their contractor firms by following the proper risk management techniques highlighted in this study. Enlightening the results from a starting point in this study is that the level of "risk identification" processes used in the construction industry of Pakistan is low. Immediate mitigation measures are not in place if a risk event happens.

Future research can be conducted in other developed and non-developed countries to investigate the risk management practices and their implications in terms of usage and to investigate the relationship between effective risk management and project success. There is a major need to adopt and implicate the systematic approach of risk management in the local environment of Pakistan so that the threats of risk can be minimized individually and collectively. Finally, the standards of risk management in the construction industry need to be developed.

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References

Akintoye, Akintola S., and Malcolm J. MacLeod. 1997. Risk analysis and management in construction. *International Journal of Project Management* 15: 31–38. [CrossRef]

Aleshin, Artem. 2001. Risk management of international projects in Russia. *International Journal of Project Management* 19: 207–22. [CrossRef]

Altoryman, Anood. 2014. *Identification and Assessment of Risk Factors Affecting Construction Projects in the Gulf Region: Kuwait and Bahrain*. Manchester: The University of Manchester.

Barber, Richard B. 2005. Undserstanding Internally Generated Risks in Projects. *International Journal of Project Management* 23: 584–90. [CrossRef]

Bing, Li, and Robert L. Tiong. 1999. Risk management model for international construction joint ventures. *Journal of Construction Engineering and Management* 125: 377–84. [CrossRef]

Borge, Dan. 2001. *The Book of Risk*. New York: John Wiley & Sons Inc.

Choudhry, Rafiq Muhammad, Jimmie Wayne Hinze, Muhammad Arshad, and Hamza Farooq Gabriel. 2012. Subcontracting practices in the construction industry of Pakistan. *Journal of Construction Engineering and Management* 138: 1353–59. [CrossRef]

Choudhry, Rafiq Muhammad, and Khurram Iqbal. 2012. Identification of risk management system in construction industry in Pakistan. *Journal of Management in Engineering* 29: 42–49. [CrossRef]

Deviparasath. 2007. *Risk Assesement and Analysis in Construction Projects*. Chennai: Anna University.

Faber, Willis. 1979. *Protecting Giant Projects: A Study of Problems and Solutions in the Area of Risk and Insurance*. Ipswich: Willis Faber.

Flanagan, Roger, and George Norman. 1993. *Risk Management and Construction*. Hoboken: Wiley.

Hameed, Asif, and Sungkwon Woo. 2007. Risk importance and allocation in the Pakistan Construction Industry: A contractors' perspective. *KSCE Journal of Civil Engineering* 11: 73–80. [CrossRef]

Hwang, Bon-Gang, Xianbo Zhao, and Li Ping Toh. 2014. Risk management in small construction projects in Singapore: Status, barriers and impact. *International Journal of Project Management* 32: 116–24. [CrossRef]

Iqbal, Shahid, Rafiq Muhammad Choudhry, Klaus Holschemacher, Ahsan Ali, and Jolanta Tamošaitienė. 2015. Risk management in construction projects. *Technological and Economic Development of Economy* 21: 65–78. [CrossRef]

Jaafari, Ali. 2001. Management of risks, uncertainties and opportunities on projects: Time for a fundamental shift. *International Journal of Project Management* 19: 89–101. [CrossRef]

Kartam, Nabil A., and Saied A. Kartam. 2001. Risk and its management in the Kuwaiti construction industry: A contractors' perspective. *International Journal of Project Management* 19: 325–35. [CrossRef]

Khan, Ahmad Hassan. 2013. The Contractors Perception of Risk Management in Pakistan. *Pakistan Acedmy of Sciences* 50: 189–200.

Loosemore, Martin, John Raftery, Charles Reilly, and David Higgon. 2012. *Risk Management in Projects*. London: Routledge.

Paek, Fang Guang Xiu Joon H. 2009. A study on the risk management based on the procedure for high-rise multi-purpose building projects in Korea. *China Civil Engineering Journal* 12: 028.

PMI. 2017. *A Guide tp Project Managemnet Body of Knowledge*. Newtown Square: PMI.

Shen, Li Yin. 1997. Project risk management in Hong Kong. *International Journal of Project Management* 15: 101–5. [CrossRef]

Shen, Li Yin, George W. Wu, and Catherine S. Ng. 2001. Risk assessment for construction joint ventures in China. *Journal of Construction Engineering and Management* 127: 76–81. [CrossRef]

Smith, Nigel J. 2008. *Engineering Project Management*. Oxford: Blackwell.

Tang, Wenzhe, Maoshan Qiang, Colin F. Duffield, David M. Young, and Youmei Lu. 2007. Risk management in the Chinese construction industry. *Journal of Construction Engineering and Management* 133: 944–56.

Wang, Shou Qing, Mohammed Fadhil Dulaimi, and Muhammad Yousuf Aguria. 2004. Risk management framework for construction projects in developing countries. *Construction Management and Economics* 22: 237–52. [CrossRef]

Westland, Jason. 2006. *The Project Management Life Cycle*. London: Kogan Page.

Zou, Patrick XW, Guomin Zhang, and Jiayuan Wang. 2007. Understanding the key risks in construction projects in China. *International Journal of Project Management* 25: 601–14. [CrossRef]