

Available online at [www.sciencedirect.com](http://www.sciencedirect.com)**ScienceDirect**

Procedia Engineering 123 (2015) 504 – 509

**Procedia  
Engineering**[www.elsevier.com/locate/procedia](http://www.elsevier.com/locate/procedia)

Creative Construction Conference 2015 (CCC2015)

## Safety improvement on building construction sites in Qatar

Ahmed Senouci<sup>a,\*</sup>, Ibrahim Al-Abbadi<sup>b</sup>, and Neil Eldin<sup>a</sup><sup>a</sup>*Department of Construction Management, University of Houston, Houston, Texas 77204*<sup>b</sup>*Urban Planning and Development Authority, West Bay, Doha, Qatar*

### Abstract

The construction industry is an essential national backbone, especially for developing countries. Poor project performance and lack of construction control could have long-reaching detrimental effects on slowing down the country's development pace and on impacting the prosperity of its citizens. The State of Qatar is currently experiencing an unprecedented rate of economic growth and urban development. As the host of the FIFA World Cup in 2022, Qatar plans to invest over \$40 billion in infrastructure projects in preparation of such a significant event. The plan includes a new airport, metro system, high-speed rail, and addition of 40,000 hotel rooms. Such an explosive boom has raised concerns about the construction industry, especially regarding its health and safety problems. Qatar National Provisional Safety Committee prepared a safety guide for construction work. The aim of the guide is to ensure worker safety and mandates that contractors, owners, and consultants abide by the established safety rules. The purpose of this study is to: 1) identify safety issues in Qatari jobsites, and 2) use risk management techniques to minimize the impacts of the risk factors. The risk management process consists of risk identification, risk assessment, risk response and risk control. In risk identification, 38 safety risk factors related to Qatari building construction sites were compiled based on an extensive literature review and recommendations of safety experts. The risk assessment was addressed through safety questionnaires to rank the risk factors in order to guide the application of risk management. Safety personnel were included in the data collection. After analyzing the questionnaires, the risk factors were ranked as low, moderate, and severe based on their degree potential impact. To address the risk response, interviews with safety experts were conducted to determine mitigation measures. These measures include: 1) developing comprehensive safety plans, 2) clearly defining the role of managers, supervisors, and employees in safety implementation and 3) teaming up managers and workers to accomplish the safety objectives.

© 2015 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Peer-review under responsibility of the organizing committee of the Creative Construction Conference 2015

*Keywords:* Construction Safety; Qatari Construction Projects; Risk Factors; Risk Management; Risk Mitigation.

\* Corresponding author. Tel.: +1- 713-743-6131; fax: +1- 713-743-0602..

E-mail address: [asenouci@uh.edu](mailto:asenouci@uh.edu)

## 1. Introduction

The construction industry is perceived as a pillar industry in national economies. Construction projects encounter significant risks and uncertainties in term of safety, cost, time, and quality. These risks threaten the successful completion of these projects, slow the pace of development, and could impact the whole society.

The construction industry, however, is recognized as the one of the most hazardous industries [1]. The construction industry is also well known for its safety challenges [2]. The harsh work environment and the high workforce turnover negatively impact jobsite safety [3]. The work environment features high intensity of physical work, constantly changing site conditions, and less formally defined construction processes [4]. Its labor-equipment intensive nature places workers in harm's way. It is common that multiple trades work in the same area and therefore creates congestion and possible lack of coordination that could affect the safety of individual workers. All these factors dramatically increase the work-related injuries and fatalities. Site injuries and fatalities do not only bring suffering to the workers and their families, but also cause project delays and additional costs due to loss of productivity, disrupted schedules, and accident investigation and reporting.

In preparation to host the 2022 FIFA World Cup in Qatar, more than \$40 billion in infrastructure projects are planned. This includes a new airport, a metro system, a high-speed rail network, and 40,000 more hotel rooms. It is estimated that 500,000 construction workers are currently in the country. Additional thousands of workers are likely to arrive as mega infrastructure projects are launched [5]. Such a huge construction boom raises concerns about workers safety. Similar to other developing countries, Qatar is experiencing high percentage of construction-related injuries and fatalities. Since 2012, almost 900 worker deaths were reported in Qatari infrastructure construction projects. The International Trade Union Confederation [6] stated that if the conditions did not get any better, at least 4,000 construction workers fatality are expected by the time the World Cup kicks off. This situation has recently raised many concerns about the construction industry health and safety problems. Several governmental agencies are currently monitoring and regulating work safety in their respective area of interest. The National Provisional Safety Committee prepared a safety guide for construction workers. The objective of the guide is to ensure worker safety by mandating that contractors, owners, and consultants abide by its safety rules. The purpose of this study is to identify the factors affecting safety in Qatari construction sites.

## 2. Objectives and Methodology

### 2.1. Objectives

The objectives of the paper are to: 1) investigate the factors affecting the safety in Qatari building construction sites and 2) apply risk management process to reduce risk factor and improve safety on Qatari building construction sites.

### 2.2. Methodology

A literature review was carried out to identify the safety risk factors on Qatari construction sites. Safety experts in Qatari building projects were consulted to refine these safety risk factors. A survey was also designed and distributed to safety experts in building construction projects. The purpose of the questionnaire was to acquire safety data from respondents actively involved in Qatari building construction. Data was collected and analyzed. Risk factors were assessed and then risk factors were classified according to severity.

## 3. Risk Factor Identification

The risk factors that affect the safety in Qatari construction projects were obtained from: 1) available reports and literature, and 2) interviews with safety experts in Qatari building construction. The risk factors identified by Farooqui [7], Yung [8], and Tabtabai [9] were used to select the risk factors affecting Qatari construction sites. Sixty two risk factors were identified at the onset. Similar risk factors were then merged based on the suggestions made by safety

experts in the Qatari construction industry. The modified list involved 38 safety risk factors. These factors were grouped under five classifications: project, management, personal, government, and site conditions.

#### 4. Risk Factors

##### 4.1. Survey

Many researchers in the construction industry have recently conducted large-scale surveys and interviews with experts in the construction industry. Questionnaires were also conducted herein to collect the required data and information about the risk factors affecting safety and the risk management practices. The feedback and comments made by the experts provided a comprehensive problem identification and advisement.

The questionnaire was designed to describe the current practice of risk management by contractors and A/E consulting firms in Qatar. It was also designed to investigate the probability of occurrence and the impact of risk factors affecting building construction safety.

The questionnaire consists of three parts. The first part collects the following information about the respondent: 1) affiliation, 2) position, 3) work experience, 4) work location, 5) number of projects involved in the last five years, and 6) safety training level achieved. The second part collects information about: 1) risk management awareness and application and 2) the benefits and importance of using risk management in building construction projects in Qatar. The third part identified the probability of occurrence and impacts of the risk factors using a scale of 1 to 5.

##### 4.2. Questionnaire Analysis

A total of 41 questionnaires were distributed among safety managers, safety engineers, and safety officers working in Qatari building construction projects, and 28 were received. Table 1 summarizes the 28 questionnaires.

Table 1. Questionnaire Respondent Characteristics.

Criteria	Respondent	Respondent Percentage (%)
Employer	Owner	50
	Contractor	43
	A/E Design Firm	7
Work Experience	Less than 6 years	7
	Between 6 and 15 years	57
	More than 15 years	36
Training	Safety Academic Degree	21
	Safety Supervisory Certificate	5
	Safety Officer Certificate	26
	Training Attendance Certificate	16
	Training Course Attendance Certificate	32

The above data indicates that the respondents had the required knowledge to answer the survey questions. All respondents stated that their organizations employ risk management techniques to mitigate construction safety. However, only 64% of the respondents explained correctly risk management implementation. The answers of the remaining 36% of the respondents show that their organizations did not adopt a comprehensive risk management strategy in their projects.

### 4.3. Risk Factor Assessment

A qualitative risk analysis was used to assess the risk factors. Table 2 summarizes the risk factor probability of occurrence and Table 3 summarizes the impact rating.

Table 2. Risk Factor Probability of Occurrence.

Scale	Rating	Description
1	Rare	Very low chance of occurrence
2	Low chance	Low chance of occurrence
3	Possible	Medium chance of occurrence
4	Likely	High chance of occurrence
5	Very High Chance	Very high chance of occurrence

Table 3. Risk Factor Impact Scale.

Scale	Impact Rating	Description
1	Negligible	Negligible or insignificant impact
2	Minor	Minor impact (i.e., slight project impact)
3	Moderate	Moderate impact (i.e., significant project impact)
4	Major	Major impact (i.e., major threat to project goals and objectives)
5	Severe	Severe impact (i.e., instantaneous disruption of project goals and objectives)

The probability of risk occurrence is calculated using the Mean Value Method as shown below.

$$OP = \frac{\sum_{j=1}^5 J * NRP[J]}{\sum_{j=1}^5 NRP[J]} \quad (1)$$

Where OP = probability of risk occurrence; J = probability of occurrence rating scale (integer values between 1 and 5), and NRP[J]= number of the respondents selecting the probability of occurrence equal to J.

The risk impact is also calculated using the Mean Value Method as shown below.

$$IP = \frac{\sum_{j=1}^5 J * NRI[J]}{\sum_{j=1}^5 NRI[J]} \quad (2)$$

Where IP = risk impact; J= impact rating scale (integer value between 1 and 5), and NRI[J]= number of the respondents selecting an impact equal to J.

The degree of risk R is computed using the following equation:

$$R=OP.IP \quad (3)$$

Table 4 summarizes the risk rating criteria used in the analysis.

Table 4. Risk Rating Criteria.

Risk Scale	Risk Impact Rating
1-4	Negligible
5-12	Tolerable
13-25	Intolerable

Table 5 summarizes the intolerable risk factors affecting the Qatari building construction projects.

Table 5. Project Nature Risk Factor Assessment

Risk Factor Classification	Risk Factors	OP	IP	R
Project Nature	Project size and complexity	3.7	3.6	13.3
	Project schedule and cost requirements	3.4	3.5	12.1
Management	Lack of site safety inspection and supervision	3.3	4.0	13.4
	Lack of adequate resources to safety	3.3	3.9	12.9
	Lack of adequate in-house safety rules	3.3	3.9	12.9
	Lack of adequate safety training	3.4	3.8	12.8
	Lack of compliance to governmental safety regulations	3.1	4.0	12.2
	Lack of adequate safety plan	3.1	3.9	12.1
Personal	Lack of safety knowledge	3.5	4.1	14.3
	Lack of adequate job experience	3.4	3.9	13.3
	Failure to use personal protective equipment	3.3	4.0	13.2
	Working at improper speed	3.1	4.0	12.7
	Throwing or accidentally dropping objects from higher levels	3.0	4.1	12.5
	Smoking on the site	3.3	4.1	12.2
Government Regulations	Lack of rigorous enforcement of safety regulations	3.4	3.6	12.2
Unsafe Site Conditions	Lack of adequate house keeping	3.5	3.6	12.5
	Lack of adequate platform guardrails	3.1	3.9	12.3
	Lack of adequate fire warning systems	3.0	4.1	12.3

The personal and management risk categories had six intolerable risk factors. On the other hand, the project nature and unsafe site condition risk categories had two and three intolerable factor risks, respectively. Finally, the government regulation category had one intolerable factor risks.

#### 4.4. Risk Control

The risk factors rated as intolerable should be controlled and given more attention. The intolerable risk factors are mainly related to personal, management, and site conditions.

The personal risk factors could be controlled by allowing more supervision to the site activities. Increasing the number of site supervisors should help decrease the number of accidents.

The risk factors associated with management and site conditions should be controlled by maintaining an effective safety program that focuses on overall safety, equipment safety, and safety manuals/literature. The program needs

also to provide safety equipment provisions, provide safe environment, and appoint safety representatives on the construction site.

The risk responses should be reviewed periodically throughout the project life cycle to make sure the desirable results are achieved. The risk assessment should be repeated after implementing the necessary risk responses to insure that the probability of occurrence or the impact of the risk factors are reduced, if not more risk responses should be applied to reduce the risks.

## 5. Conclusions

The objectives of the study were to: 1) identify the major safety risk factors in Qatari building construction sites and 2) apply risk management technique to assess the impact of these risk factors. A questionnaire was designed based on a comprehensive literature review and feedback from safety engineers working in the Qatari construction industry. The questionnaires were distributed among practitioners with varied positions, duties, and work experiences to collect different opinions and views. The questionnaire included three main parts. The first part included general questions about the respondents' background. The second part addressed the extent of risk management application in Qatari construction projects and the major benefits of risk management. The third part addressed the likelihood and impact ratings of safety risk factors using a scale of 1 to 5.

The questionnaire responses showed a poor risk management practice in Qatar. The respondents agreed on the importance of applying risk management techniques to analyze safety problems in Qatari construction projects. The analysis of the questionnaire responses showed that 18 of the selected safety risk factors (out the total 38) were intolerable and needed special attention and care.

As a conclusion, the practice of safety risk management must be enhanced in the Qatari construction industry. More training, seminars, and workshops should be conducted by construction companies to familiarize employees about the concept of safety risk management.

## References

- [1] G. Suazo, E. Jaselskis, (1993). "Comparison of construction safety codes in United States and Honduras". *Journal of Construction Engineering and Management*, 119(3) (1993) 560-572.
- [2] S. Ahmed, J. Kwan, Site safety management in Hong Kong, *J. Manage. Eng.* 16(6) (2000) 34.
- [3] V. Davis, K. Tomasin, *Construction site safety*, Thomas Telford, London, Internal publication. (1990)
- [4] C. Reese, J. Eidson, *Handbook of OSHA Construction Safety and Health*, 2nd Ed., CRC Press, London, UK, 2006.
- [5] The Peninsula, New Safety Rules for Construction Workers Planned, The Peninsula. <http://thepeninsulaqatar.com/news/qatar/224775/new-safety-rules-for-construction-workers-planned> (Oct. 10, 2014).
- [6] International Trade Union Confederation (ITUC), Qatar 2022 World Cup risks 4000 lives, warns International Trade Union Confederation." <<http://www.ituc-csi.org/qatar-2022-world-cup-risks-4000?lang=en>> (Oct. 15, 2014)
- [7] R. Farooqui, F. Arif, S. Rafeeqi, Developing Safety Culture in Pakistani construction industry – An Assessment of Perceptions and Practices among Construction Contractors". *Proceedings of the Fourth International Conference on Construction in the 21st Century: Accelerating Innovation in Engineering, Management and Technology (CITC IV 2007)*, Gold Coast, Australia, pp. 420-437.
- [8] P. Yung, Institutional arrangements and construction safety in China: An empirical examination. *Construction Management and Economics*, 27(5) (2009) 439–450.
- [9] H. Tabtabai, Analyzing Construction Site Accidents in Kuwait. *Kuwait Journal of Science and Engineering*, 29 (2) (2002).