Evaluation and Investigation of Risk Management in Iranian Construction Industry

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Abstract: This paper reports - on the basis of a questionnaire survey of the largest Iranian contractors - a perspective of construction risk, and the effective actions taken for the management of such risks, particularly those of time and finances. The study, the first inIran, focuses on the assessment, allocation and management of construction risks. The paper also presents two types of riskmanagement methods: preventive, which are effective at the early stages of the project life, and mitigative, which are remedialactions aimed at risk minimization during construction. The research found that contractors show more willingness to accept risksthat are contractual and legal-related rather than other types of risks. The research results also indicated that the application of theformal risk analysis techniques in the Iranian construction industry is limited.

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1. Introduction

Risk analysis and management are important parts of the decision making process in a construction company. The construction industry and its clients are widely associated with a high degree of risk due to the nature of construction business activities, processes, environment and organization.

Risk in construction has been the object of attention because of time and cost overruns associated with construction projects. Risk has been defined in various ways. Although Porter [17], Healy [10], Barrie and Paulson [2] and Perry and Hayes [16] have expressed risk as an exposure to economic loss or gain arising from involvement in the construction process; Moavenzadeh and Rosow [13] and Mason [12] have regarded this as an exposure to loss only. Bufaied [5] and Boothroyd and Emmett [4] describe risk in relation to construction as a consideration in the process of a construction project whose variation results in uncertainty in the final cost, duration and quality of the project. In order to emphasize the major objectives of survey on risk management actions, risk has been defined as the probability of occurrence of some uncertain, unpredictable and even undesirable event(s) that would change the prospects for the profitability on a given investment.

Recent economic conditions in Iran tend to force a certain attitude towards risks. As a result of economical recession, the number of business failures generally increases. Such situations can explain the desire to share the risks of financial failure. However, it should be recognized that all risks are rightfully the owner's, unless transferred or assumed by another party for fair compensation. The principal guideline in determining whether a risk should be transferred to another should be based upon whether the party assuming the risk has both the competence to assess the risk and the expertise necessary to control or minimize it.

Insofar as risk analysis and management is important to the activities of the construction industry, little is known regarding the industry's response and the techniques employed for risk analysis and management in the Iranian construction industry. This can be attributed to three main factors:

a) the Iranian economy depends largely on the oil revenues and the construction industry represents a small percentage of the GDP; specifically 2±3% of the total GDP and 5±6% of the non-oil sector in the 1990s [7];

b) very limited research has been undertaken in the area of construction; and

c) almost all the work force in this industry consists of mainly Iranian and some non-Iranian.

The objective of this paper is to present an attitude of a typically large Iranian contractor towards construction risk. The paper is concerned with the assessment and allocation of risk as well as the contribution of each risk type to project delay. The paper also investigates thebest contractual arrangements and the most effective approaches towards preventing or minimizing construction risks (i.e., mitigating losses).

2. Questionnaire design

This paper is based on a survey that comprised of three parts. The first part is intended to provide insight into the current attitudes of the Iranian contractors towards construction risk identification and allocation; the second part is concerned with the significance of different risk categories; and the third part is related to the practical actions for managing these risks. To ensure obtaining complete and meaningful response to the questionnaire, an interview was conducted with each respondent to explain the objective of the study and to get input towards the questionnaire design, especially towards identifying risk types and management actionsfor controlling these risks. Accordingly, all experts have participated in the questionnaire design and then, responded to the questionnaire. The questionnaire survey was designed in a concise and precise way in order to obtain all the necessary information in a multiple choice format.The investigation was undertaken by collecting the responses to a questionnaire through guided interviews with major contractors in the Iranian construction industry. All contractors in Iran depending on their contract size are divided into four major ranks, as per the Central Tendering Committee governmental classification [8] , where Rank 1 designates the largest contractors and Rank 4 represents the smallest contractors. To ensurethe respondents' sufficient professional qualifications based on their positions, work experience and educational background, only contractors belonging to Ranks 1 and 2were included in the survey. A total of 61 large contractors in Iran were surveyed; 15 of Rank 1 and 46 of Rank 2 [8]. This sample represents 94% of all contractors in Ranks 1 and 2.

The overall response to the survey comprised a total of 35 completed questionnaires, giving approximately 57% response rate. However, four of the returned questionnaires were incomplete and therefore only 31 returned questionnaires could be used for analysis. The effective response rate of 51% is considered acceptable and relatively high in the construction industry. In fact, this result has been achieved by guiding the whole questionnaire process through personal interviews with the respondents. The respondents are recognized experts in their respective organizations (mostly, directors and partners) with at least 10 years of construction experience.

3. Construction risk allocation

There are different types of risks associated with the construction activities. These are physical, environmental, design, logistics, financial, legal, political, construction and operation risks [16]. Table 1 illustrates 26 risk types included in the questionnaire without any particular order. These risk types were generated based on: a) an extensive literature review, especially the work of Perry and Hayes [16], Fisk [9], Akintola and Malcolm [1] and Thompson and Perry [19]; and b) consultation with the key local experts who participated in the survey.

The responses to each question were divided into two groups: risk allocation and risk significance. For risk allocation, the respondent must select the party actually taking the risk from one of the following three options: owner, contractor or shared by both the owner and contractor. The results of this part of the survey are summarized in terms of percentages of the total number of respondents who chose the appropriate selection, as given in Table 1. For example, the first row of Table 1 shows that the risk allocation due to permits and regulations is attributed to owner, contractor and shared categories, 74%, 12% and 14%, respectively.

To better understand the distribution of risk types between the owner and/or contractor, the author assumed a minimum response rate of 70%. Table 2 shows the risk allocation using such an assumption for all the risk types listed in Table 1.

According to the survey, a total of 13 construction risks were allocated to the contractor, ranging from availability of labor, material and equipment (response rate 97%) to inflation (response rate 70%). A total of four construction risks were allocated to the owner, rangingfrom delayed payment on contract (response rate 77%) to scope of work definition (response rate 71%). Responses in favor of sharing the risk ranged from change order negotiations (response rate 76%) to financial failure of any party (response rate 72%). Five risk questions pertaining to risk allocation have undecided results.

4. Significance of risk

The degree of impact for each risk type was included in the questionnaire under the heading “Significance." The questionnaire was designed to examine practitioners' observations and judgments in determining the relative significance of each risk category. Although the degree

of impact varies from project to project, the questionnaire is expected to elicit a general assessment of the significance of risk. Each respondent was required to rank each risk on a scale from 1 to 10 by considering its contributions to project delays. Rank 1 is assigned to arisk that would give the lowest contributions to delays while Rank 10 is allotted to a risk that would cause the highest contribution to delays. The rank range of 1 to 3 denotes risks that are not significant; 4 to 7 indicates significant risks and 8 to 10 shows very

high significant risks, as listed in the last columns of Table 1.

The findings of the survey concerning the relative significance of the risks in the local construction practice are summarized in Table 3. The figures within the table represent the number of respondents who gave the relative contribution rank to each risk. For example, there are three respondents who ranked the risk permits and regulations, with the highest rank value of 10.

In order to quantitatively demonstrate the relative significance of the risks to project delays, a weighting approach is adopted. The principle is that the risk with the highest contribution rank would be assigned the largest weight. The figures in brackets in Table 3 are weighted scores for each risk at different contribution rank. Each individual's weighted score is obtained by multiplying the number of respondents with the corresponding weight. The figures in the last column of the table give the total weighted scores for each risk.

Fig. 1 shows the relative significance of the 26 risks obtained from the survey results in the ascending order.

5. Risk management actions

Managing risks means minimizing, controlling, and sharing of risks, and not merely passing them o onto another party [9]. The methods of managing risks are retention, transfer, mitigation, and prevention of risks or any combination thereof.

In the survey, two kinds of management actions are presented to the respondents: preventive action and mitigative action. Preventive actions are used to avoid and reduce risks at the early stage of project construction, yet they may lead to submitting an excessive high bid for a project. Mitigative actions are remedial steps aimed at minimizing the effects of risks. The survey presents seven preventive and six mitigative actions.

These actions were generated based on:

(a) related research work on construction risk management, and

(b) input, revisions and modifications from local experts. The methodology was similar to the one adopted for generating the risk types described in the previous section.

5.1. Preventive actions

Thompson and Perry [19] conclude that risk management is most valuable at an early stage in a project, for example at the proposal stage, where there is still some flexibility available in design and planning to consider how the serious risk might be avoided. Table 4 represents the number of respondents who gave the different degrees of effectiveness for each of the seven preventive methods. The degree of effectiveness ranges from very high (5), to very low (1), or inapplicable (0). In order to quantitatively demonstrate the relative degree of effectiveness between the methods, a weighting approach is adopted. Based on the same procedures used in the previous section, each degree of effectiveness stands for the value of its relative weight between all the options. The figures in brackets within the table are weighted scores for each method and the last column shows the total weighted scores.

The first preventive method recommended by the respondents is produce a proper schedule by getting updated project information and the last recommended preventive method is transfer or share risk to/with other parties.

5.2. Mitigative actions

Whilst some project delay risks can be reduced through various preventive actions at early stages, the delay of progress still occurs in many projects during the construction process. A recent industry study has indicated that over 80% of projects exceed their scheduled time even with the employment of software techniques for project development [20]. When delay happens, contractors can adopt various mitigative actions to minimize the effects of the delay.

Table 5 represents the six mitigative methods being proposed to the respondents. The figures within the table represent the number of respondents who gave different degrees of effectiveness for each of the methods.In order to quantitatively demonstrate the relativedegree of effectiveness between the methods, a weightingapproach was adopted as shown previously in thispaper. The figures in brackets within the table areweighted scores for each method and the last columnshows the total weighted scores.

The first mitigative method recommended by therespondents is coordinate closely with subcontractors,and the last recommended mitigative method is changethe construction method.

6. Implications of findings

6.1. Risk allocation and significance

Table 2 demonstrates that half of the survey risks, i.e.,13risks, were allocated to the contractors. This shows that the contractors accepted or shared most of the risks identified in this paper. They held the owner responsible for only four risk types, i.e., only 15% of all construction risks.

The risk, availability of labor, material and equipment, received 97%, the highest response rate in favor of the contractor. This might be attributed to the fact that subcontracting is a typical practice in the Iranian construction industry. However, the

conditions in the subcontracts normally do not include clauses stating the number of workers that subcontractors should provide at the site. Subcontractors normally allocate their manpower to different projects in a selective manner so as to achieve maximum profit for their own business. Thisleaves the main contractor less control over the number of workers at the site.

Labor disputes recorded 96%, the second highest allocation score in favor of the contractor. Yet, it was the least significant risk category between the survey risks (Fig. 1). This result is expected since the construction industry in Iran is not influenced by any power group, i.e., no labor unions exist. Thus, there is no fear from general labor strikes that would paralyze the Iranian construction industry.

Both coordination with subcontractors and productivity of labor and equipment risk categories gained 94% of allocation score in favor of the contractor. In fact, not only did contractors designate them as their responsibilities, but most researchers also support this position. [14]

The risks that accompany safety and accidents were overwhelmingly considered to be a part of the contractor's responsibility. Only three differing opinions were identified for this category. In fact, contractors are better able to control such risks by supervising the application of safety precautions inside the construction sites. Moreover, the existence of insurance premiums for accidents and injuries can mitigate some of these risk consequences.

Quality of work and accuracy of project program are the other two risk categories that were consistently allocated to the contractor, since the contractors are in a better position to control these risks.

Contractor competence is conceded industry-wide as a risk to be borne by the contractor. This risk was ranked as the seventh highest significant risk category that a contractor in Iran could face (Fig. 1). Actually, current sluggish economic growth and highly competitive market in Iran have forced contractors to reduce or even ignore their profit so as to remain competitive.

Defective materials risk category is one of the major dispute sources in Iran, since the quality of project finishing in Iran is normally high and the special material is commonly acquired from overseas.

Two risk categories which can ruin a contractor who is trying to perform under a lump sum contract were reported by the respondents as risks that Iranian contractors should bear. These two risks are differing site conditions and adverse weather conditions. This result reflects the fact that most owners of the construction projects in Iran are legally protected from liability of these risks by assigning some exculpatory clauses in their contracts. These risk categories increase the probability of uncertain, unpredictable and even undesirablefactors in the construction site. However, adverseweather conditions received the second least significantrisk category among the surveyed risks. It is well knownthat Iran weather is extremely hot during summer,causing significant delay to the progress of a project,especially in critical activities such as concreting. As aresult, Iranian contractors are expected to pay specialattention to the cost effects of weather conditions, e.g.,working in night shifts.

Allocating actual quantities of work to the contractorrepresents a trend in the attitudes of contractors toassume more risk for the quantities of work in the bidding process as well as in submission of the inprogresswork payment schedules. This attitude is important inthe performance of a lump sum contract, since the priceis based on a predefined amount of work.

The last risk category that was recorded in the contractor's side is inflation. Contractors considered thisrisk category as an oscillating risk category where itsthreat increases when inflation increases and viceversa.

Concerning the risks that were allocated to the owner,the highest response record was 77% for delayed payment on contract. This risk category is one of the mostdebated ones. Under the law, this item can be claimed aspart of loss and expense. [11]

Permits and regulations, changes in work and scope ofwork definition were allocated to the owners with 74%,72% and 71%, respectively. Allocating changes in workrisk category to the owner reflects a trend in whichcontractors are not very much concerned with obtainingpayment for a change in the work, since the cost impactof change orders can be claimed later.

Change order negotiations risk category joined theshared risks. This means that contractors in Iran feelconfident to engage in negotiations for such risk category, thus such risk is suitable to be shared.War threats risk category also joined the shared risks.Recently, the unstable political events in the PersianGulf region reflect the greatest unpredictable cost overburden that a contractor could face. As a matter of fact,the Iranian government is a major client for large contractors and government projects are large enough tokeep an awarded contractor busy for a number of years.Such matters could adjust the contractor's risk premiumtaken through long-term plans, and impose a trend ofsharing such an unpredictable risk with the owner.

Financial failure was awarded the highest significancerank of the survey risks (Fig. 1). Financial risks to contractors include whether the contractor has enough cashflow on time to enable him or her to progress with thework, or financial failure of the owner or subcontractors. [1]This

result might be attributed to the recessionaryperiod that Iran has been experiencing in the 1990s.
More contractors are currently failing. As a matter of fact, four of the biggest construction companies in Iran (representing 21% of Rank 1 total contractors(closed their operations or filed bankruptcies in 1998 and 1999. As the probability of financial failure increases contractors, understandably, prefer to share this uncontrollable risk. However, as the economy of the country improves, the significance of this risk is expected to decrease.
The survey results also show that contractors suffer from insufficient or incorrect design information. This result was obtained from ranking the defective design risk category as one of the five most significant risks to project delays. This risk joined the undecided risks, despite the fact that major allocation percent was heading towards owners who were in a better position to supply sufficient and accurate drawings on the design and services.
Delayed dispute resolution came in the undecided risks, despite the fact that allocation of percentages reflected that contractors were more willing to become involved in dispute resolution.
Table 6 presents a summary for the analysis of the risks allocation and significance results.

6.2. Risk management actions

According to the survey results (Table 4), produce a proper program using subjective judgment and produce a proper schedule for resource procurement by getting updated project information are the two most effective risk preventive actions. Judgment or subjective probability uses the experience gained from similar projects undertaken in the past by the decision maker to decide on the likelihood of risk exposures and the outcome [18]. Judgment and experience gained from previous contracts may become the most valuable information source for the use when there is limited time for preparing the project program. Construction, however, is subjected to a dynamic environment, that is why risk managers must constantly strive to improve their estimates. Even with near perfect estimates, decision making about risk is a difficult task. Thus, depending only on experience and subjective judgment may not be enough, and updated project information should be obtained and applied. Consequently, a significant number of respondents, 90%, considered getting more updated project information at the project planning stage to be the most effective risk preventive method.
Make more accurate time estimation through quantitative risk analyses techniques such as Primavera Monte Carlo program [15] was not considered to be a very highly effective preventive method for reducing the effects of risks. This tends to support Birch and McEvoy [3], that the approach of risk analysis is largely based on the use of checklists by managers, who try to think of all possible risks. Insufficient knowledge and experience of analysis techniques, and the difficulty of finding the probability distribution for risk in practice could be the two main reasons for such a result.
Add risk premiums to time estimation were not recommended by the practitioners to be an effective preventive method. Risk premiums in construction projects take the form of contingencies or added margins to an estimate to cover unforeseen eventualities [6]. The amount of the premium varies between projects and is mostly dependent upon the attendant risk and decision makers risk attitude. Yet, this result was expected since taking into consideration such risks' premiums would increase the priced bid and would consequently decrease the probability of gaining the bid due to the highly competitive Iranian construction industry market.
The survey also indicated that the method of transfer or share risk is considered to be ineffective for preventing risks where it recorded the lowest weighted effectiveness score (Table 4). As a matter of fact, the development of the subcontracting system in the local construction industry brought a considerable increase in the number of subcontractors with multiple specializations in a construction project, where many of them have very limited technical and financial ability. However, most general contractors need to establish a long-term working relationship with a particular subcontractor and material vendor. Since thelong-term transaction relationship between the parties should prevail, a very few general contractors could exercise the practice of shifting risk to subcontractors.
On the other hand, the most effective risk mitigative method was coordinate closely with subcontractors (Table 5). Despite that this shall be recorded as a recommendation from general contractors; it may hold an explicit announcement that subcontractors bring additional risks to general contractors. These risks include uncertainties related to a subcontractor's technical qualifications, timeliness, reliability, and financial stability [3], causing a time and/or cost increase during construction. This mitigative method was recorded as one of the most five significant risks in the Iranian construction industry (Refer to Fig. 1).
Increase manpower and/or equipment were the second most effective mitigative method for minimizing the impacts of delay while change the construction method was rarely used as a mitigative method. This could mean that the number of workers on site is one of the mostimportant variables to project progress, since construction projects generally include many labor-intensive

operations. In fact, as pointed out before, shortage of manpower in subcontractors' firms is one of the most serious risks to project delays. Therefore, increasing the work force normally speeds up progress, subject to the availability of materials and supervisors, physical constraints of the site, and construction sequence.
Tables 7 and 8 summarize the findings of the survey on the effectiveness of preventive and mitigative methods.

7. Conclusions

This paper described the current views and practices of major contractors in Iran regarding allocation and significance of 26 risks presented in a questionnaire survey (Table 1). It also investigated the differing effectiveness of various preventive and mitigative riskmanagement actions being utilized in the local industry (Tables 4 and 5). The survey presented the experience of the largest Iranian contractors towards construction risk according to the CTC governmental classification.Although, it is generally recognized that the risk should be transferred to the party that is in the best position to deal with it, the survey indicated that Iranian local contractors are often responsible for most risk factors. Contractors considered themselves responsible to take care of the risks associated with physical and environmental problems. The risks of this type include differing site conditions and adverse weather conditions. The study also showed that the use of risk analysis techniques for managing and controlling construction risk is generally low among the largest Iranian contractors, with the exception of subjective judgment and practical experience.
The attitudes toward risks that are determined by economic conditions are also discussed. Financial failure has been considered to be the most significant risk category a contractor could suffer from in Iran. Actually, due to the reduction of oil revenues and the current unstable political situation, there are a few government projects left for bidding by large contractors. This may put some large contractors in a position where they barely recover the office overheads. It also forces the contractors to bid in a highly competitive construction industry market. Therefore, they should normally minimize their markups to maximize their chances of winning projects, and they may not take into consideration any risk premiums or contingency allowance in an estimate. Such situation might have been quite different if this survey had been conducted in the 1980s since responses are affected by the economic and political conditions of a country.The findings also indicate that coordination with subcontractors as well as increase of manpower and equipment are considered to be the most effective risk mitigative methods utilized in the Iranian construction industry market. This result has highlighted the fact that subcontracting work agreements hold the key to mitigate the losses of delay impacts that a general contractor has to bear in Iran.

References

[1] Akintola SA, Malcolm JM. Risk analysis and management inconstruction, International Journal of Management in Engineering997:37-44.
[2] Barrie D, Paulson B. Professional construction management, New York: MacGraw-Hill, 1992.
[3] Birch DG, McEvoy MA. Risk analysis for information systems, Journal of Information Technology 1992;7:44-53.
[4] Boothroyd C, Emmett J. Risk management - a practical guidefor constructionprofessionals. London, UK: Witherby& Co Ltd,1998.
[5] Bufaied AS. Risks in construction industry: their causes and theireffects at the project level. Ph.D. thesis, University of Manchester, UMIST, 1987.
[6] Burcu A, Martin F. Factors affecting contractors risk of costoverburden. Journal of Management in Engineering 1998:67-76.
[7] CBK. Economic report. Central Bank of Iran, Iran, 1998
[8] CTC. Construction contractors' rank classification, Central Tendering Committee, Iran, 1999.
[9] Fisk Edward R. Construction project administration. Risk allocation and liability sharing, 4th ed. 1992, p. 217-233 [Chapter 10].
[10] Healy JR. Contingency funds evaluation. Transaction of American Association of Cost Engineers 1982:B3.1-B3.4.
[11] Kangari R. Risk perceptions and trends of US construction. J.Construction Engineering and Management, ASCE, December, 1995:422-9.
[12] Mason GE. Quantitative risk management approach to theselection of a construction contract provisions. Ph.D. thesis, Department of Civil Engineering, Stanford University, CA, 1973.
[13] Moavenzadeh F, Rosow J. Risks and risk analysis in construction management. Proceedings of the CIB W65, Symposium onOrganization and Management of Construction, US NationalAcademy of Science, Washington DC, USA, May:19-20.
[14] Oglesby C, Parker H, Howell G. Productivity improvement inconstruction. New York: McGraw-Hill, 1989.
[15] Paulson B. Computer applications in construction. New York:McGraw-Hill, 1995.
[16] Perry JG, Hayes RW. Risk and its management in constructionprojects, Proceedings of Institution of Civil Engineers1985; 78:499-521.
[17] Porter CE. Risk allowance in construction

contracts. M.Sc. Thesis, University of Manchester, UMIST, 1981.
[18] Shen LY. Project risk management in Hong Kong. InternationalJournal of Project Management 1997;15(2):101-5.
[19] Thompson Perry J. Engineering construction risks: a guide toproject risk analysis and assessment implications for project clients and project managers. Telford, UK, 1992.
[20] Weiler Chris. Risk-based scheduling and analysis, softwaredevelopment manager at Lexis-Nexis. PM Network Magazine, 1998:29-33.

Table1: Percentage of respondents towards risk allocation and significance

Types of risks	Risk allocation			Risk significance		
	Owner	Contractor	Shared	Not (1-3)	Significant (4-7)	Very (8-10)
Permits and regulations	74%	12%	14%	10%	61%	29%
Scope of work definition	71%	16%	13%	29%	32%	39%
Site access	52%	22%	26%	16%	65%	19%
Labor, material and equipment availability	0%	97%	3%	0%	19%	81%
Productivity of labor and equipment	0%	94%	6%	0%	32%	68%
Defective design	52%	16%	32%	0%	23%	77%
Changes in work	72%	10%	18%	13%	65%	22%
Differing site conditions	21%	73%	6%	6%	84%	10%
Adverse weather conditions	6%	71%	23%	32%	68%	0%
Acts of God	15%	10%	75%	55%	26%	19%
Defective materials	0%	74%	26%	16%	58%	26%
Government acts	23%	35%	42%	19%	65%	54%
Accuracy of project program	3%	84%	13%	3%	45%	52%
Labor disputes	0%	96%	4%	42%	52%	6%
Accidents/Safety	0%	90%	10%	29%	65%	6%
Inflation	7%	70%	23%	23%	55%	22%
Contractor competence	16%	75%	9%	6%	19%	75%
Change order negotiations	21%	3%	76%	3%	87%	10%
Third party delays	16%	58%	26%	3%	19%	78%
Coordination with subcontractors	0%	94%	6%	3%	19%	78%
Delayed dispute resolutions	29%	16%	55%	6%	65%	29%
Delayed payment on contract	77%	9%	14%	0%	16%	84%
Quality of work	0%	85%	15%	6%	39%	55%
Financial failure	7%%	21%	72%	0%	10%	90%
Actual quantities of work	18%	72%	10%	6%	39%	55%
War threats	26%	0%	74%	32%	26%	42%

Table 2: Results of risk allocation

Risk allocation	Risk description	Risk allocation	Risk description
Contractor	Labor, material and equipment availability Labor disputes Productivity of labor and equipment Coordination with subcontractors	Owner	Delayed payment on contract Permits and regulations Changes in work Scope of work definition
	Accidents/Safety Quality of work Accuracy of project program	Shared	Change order negotiations Acts of God War threats Financial failure
	Contractor competence Defective materials Differing site conditions Actual quantities of work Adverse weather conditions	Undecided	Site access Defective design Government acts Third party delays Delayed disputes resolution

Table 3: Contribution of risks to project delays (risk significance)

Types of Risks	Contribution rank to delays										Total weighted scores
	1	2	3	4	5	6	7	8	9	10	
Permits and regulations	1 (1)	2 (4)	0 (0)	14 (56)	1 (5)	1 (6)	3(21)	5 (40)	1 (9)	3 (30)	172
Scope of work definition	0 (0)	0 (0)	9 (27)	1 (4)	3 (15)	3 (18)	3(21)	5 (40)	0 (0)	7 (70)	195
Site access	2 (2)	0 (0)	3 (9)	5 (20)	8 (40)	3(18)	4(28)	4 (32)	0 (0)	2 (20)	169
Labor, material and equipment availability	0 (0)	0 (0)	0 (0)	0 (0)	3 (15)	0 (0)	3(21)	9 (72)	3 (27)	13 (130)	265
Productivity of labor and equipment	0 (0)	0 (0)	0 (0)	2 (8)	3 (15)	4 (24)	1 (7)	10 (80)	4 (36)	7 (70)	240
Defective design	0 (0)	0 (0)	0 (0)	0 (0)	2 (10)	4 (24)	1(7)	8 (64)	4 (36)	12 (120)	261
Changes in work	0 (0)	0 (0)	4 (12)	4 (16)	4 (20)	5 (30)	7(49)	6 (48)	0 (0)	1 (10)	185
Differing site conditions	0 (0)	0 (0)	2 (6)	8 (32)	6 (30)	7 (42)	5(35)	2 (16)	0 (0)	1 (10)	167
Adverse weather conditions	2 (2)	1 (2)	7 (21)	10 (40)	7 (35)	4 (24)	0(0)	0 (0)	0 (0)	0 (0)	125
Acts of God	3 (3)	2 (4)	12 (36)	0 (0)	4 (20)	4 (24)	0(0)	3 (24)	0 (0)	3 (30)	143
Defective materials	2 (2)	0 (0)	3 (9)	1 (4)	8 (40)	5 (30)	4(28)	4 (32)	2 (18)	2 (20)	183
Government acts	2 (2)	2 (4)	2 (6)	7 (28)	5 (25)	3 (18)	5(35)	1 (8)	3 (27)	1 (10)	163
Accuracy of project program	0 (0)	0 (0)	1 (3)	4 (16)	6 (30)	1 (6)	3(21)	6 (48)	4 (36)	6 (60)	220
Labor disputes	7 (7)	0 (0)	6 (18)	5 (20)	6 (30)	1 (6)	4(28)	2 (16)	0 (0)	0 (0)	125

Accidents/Safety	0 (0)	7 (14)	2 (6)	5 (20)	6 (30)	3 (18)	6(42)	0 (0)	2 (18)	0 (0)	148
Inflation	2 (2)	0 (0)	5 (15)	6 (24)	2 (10)	1 (6)	8(56/)	3 (24)	3 (27)	1 (10)	174
Contractor competence	1 (1)	0 (0)	1 (3)	2 (8)	1 (5)	0 (0)	3(2!)	14 (112)	3 (27)	6 (60)	237
Change order negotiations	0 (0)	0 (0)	1 (3)	7 (28)	6 (30)	7 (42)	7(49)	0 (0)	2 (18)	1 (10)	180
Third party delays	1 (1)	0 (0)	0 (0)	2 (8)	2 (10)	8 (48)	5(35)	6 (48)	4 (36)	3 (30)	216
Coordination with sub contractors	1 (1)	0 (0)	0 (0)	0 (0)	4 (20)	0 (0)	2(14)	12 (96)	8 (72)	4 (40)	243
Delayed dispute resolutions	0 (0)	1 (2)	1 (3)	2(8)	7 (35)	2 (12)	9(63)	4 (32)	2 (18)	3 (30)	203
Delayed payment on contract	0 (0)	0 (0)	0 (0)	2(8)	0 (0)	0 (0)	3(21)	4 (24)	9 (81)	14 (140)	274
Quality of work	0 (0)	1 (2)	1 (3)	2(8)	0 (0)	4 (24)	6(42)	13 (104)	2 (18)	2 (20)	221
Financial failure	0 (0)	0 (0)	0 (0)	1(4)	1 (5)	0 (0)	1(7)	6 (48)	2 (18)	20 (200)	282
Actual quantities of work	2 (2)	0 (0)	0 (0)	1(4)	1 (5)	1 (6)	9(63)	4 (32)	7 (63)	6 (60)	235
War threats	5 (5)	1 (2)	4 (12)	0(0)	3 (15)	1 (6)	4(28)	3 (24)	3 (27)	7 (70)	189

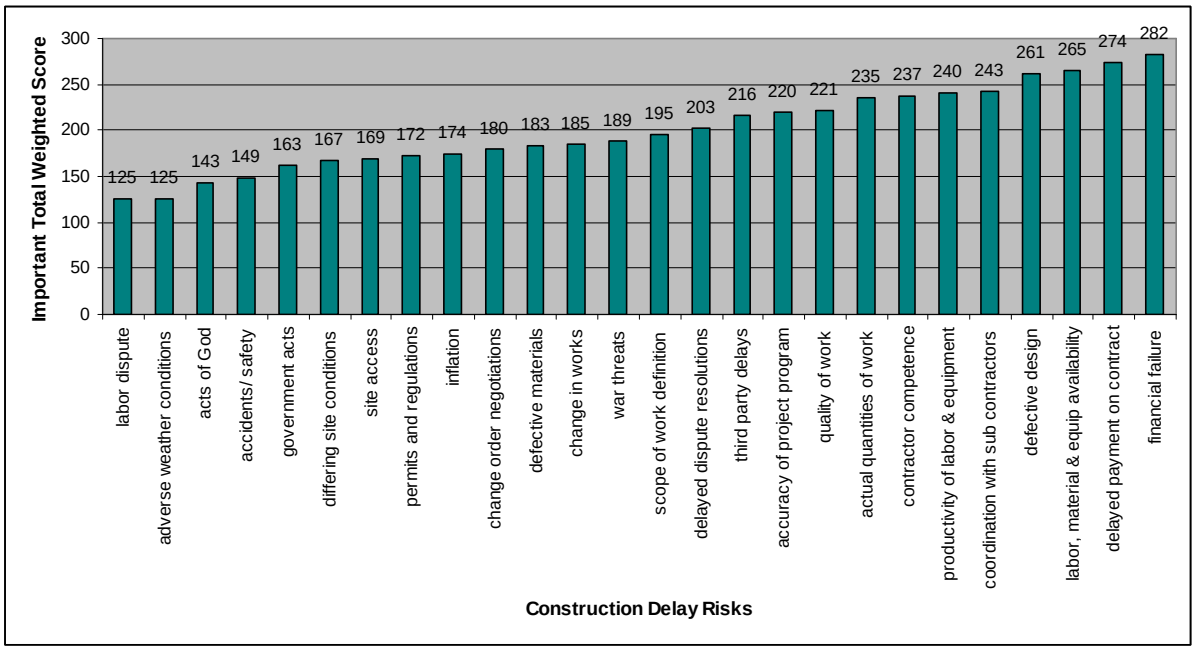

Fig. 1. Results of the survey on risk significance

Table 4: Relative effectiveness of preventive methods (survey results)

Preventive method	Effectiveness of preventive methods						Total weighted scores
	V.high 5	High 4	Moderat 3	Low 2	V.Low 1	In appl 0	
Utilize quantitative risk analyses techniques for accurate time estimation	6 (30)	10 (40)	8 (24)	3 (6)	3 (3)	1 (0)	104
Depend on subjective judgment to produce a proper program	15 (75)	11 (44)	5 (15)	0 (0)	0 (0)	0 (0)	134
Produce a proper schedule by getting updated project information	15 (75)	13 (52)	2 (6)	1 (2)	0 (0)	0 (0)	135
Plan alternative methods/options as stand-by	8 (40)	12 (48)	6 (18)	0 (0)	2 (2)	3 (0)	108
Consciously adjust for bias and add risk premium to time estimation	4 (20)	8 (32)	12 (36)	2 (4)	4 (4)	1 (0)	96
Transfer or share risk to/with other parties	1 (5)	11 (44)	7 (21)	4 (4)	5 (5)	2 (0)	85
Refer to previous and ongoing similar projects for accurate program	8 (40)	12 (48)	8 (24)	5 (5)	2 (2)	0 (0)	116

Table 5: Relative effectiveness of mitigative methods (survey results)

Preventive method	Effectiveness of preventive methods						Total weighted scores
	V.high 5	High 4	Moderat 3	Low 2	V.Low 1	In appl 0	
Increase manpower and/or equipment	15 (75)	8 (32)	6 (18)	2 (4)	0 (0)	0 (0)	129
Increase the working hours	6 (30)	16 (64)	9 (27)	0 (0)	0 (0)	0 (0)	121
Change the construction method	1 (5)	8 (32)	10 (30)	4 (8)	2 (2)	0 (0)	77
Change the sequence of work by overlapping activities	7 (35)	15 (60)	7 (21)	2 (4)	0 (0)	6 (0)	120
Coordinate closely with subcontractors	19 (95)	9 (36)	3 (9)	0 (0)	0 (0)	0 (0)	140
Close supervision to subordinates for minimizing abortive work	12 (60)	10 (40)	5 (15)	3 (6)	1 (1)	0 (0)	122

Table 6: Summary of the findings of the survey on risk allocation and significance

Type of risk	Summary of results
Permits and regulations	Its owner should be responsible for this risk. Contractors do not think of this risk as animportant one. The relative significance placed it as the eighth one from the last
Scope of work def.	This risk belongs to the owner and is expected to stay that way. This was a risk with amid-level significance
Site access/right of way	This risk should be either a shared or owner responsibility. This risk was considered tohave low importance, as it ranked seventh in relative significance
Availability of labor, material and equipment	This risk scored the highest in allocation to the contractor. The significance of this riskplaces it within the top five most important risks in the Iranian construction industry
Productivity of labor and equipment	The results overwhelmingly assigned the contractor to be responsible for this risk
Defective design	Contractors assigned high significance for this risk This risk should be either owner's responsibility or shared. Its significance was highespecially for contractors working for a lump sum contract
Changes in work Differing site conditions	The owner is responsible for this risk. Its significance was ranked in the lower-mid range Surprisingly, this risk was allocated to contractors. This means that contractors inIran are acting as the insurers of the owners. However, its importance was low as therelative significance placed it as the sixth from the last
Adverse weather conditions	The survey indicated that the contractor must assume this risk. This risk was determinedto be the second lowest significant risk of the survey
Acts of God	The view of contractors is that this risk should be shared. It was determined to be of little significance
Defective materials	This risk was found to be the responsibility of contractors since they are most certainly inthe best position to handle it. This risk ranked in the lower-mid range of significance
Government acts	This risk should be either shared or contractor responsibility. It was found to have lowsignificance
Accuracy of program	Contractors assign this risk to themselves. They ranked it in eighth position of significance
Labor disputes	Contractors are responsible for this risk, and it is expected to continue as such. However,its significance was the least among the surveyed risks
Accidents/Safety	Contractors believe that they have sole responsibility for this risk. Yet, its relative significance placed it in the least five significant risk categories
Inflation	The survey showed that this risk depends on the economic condition of the country. Currently, the inflation rate is low, so contractors are more willing to accept this risk
Contractor competence	Contractors assumed responsibility for their competence and ranked this risk as having high significance
Change order negotiations	This risk is usually shared and is expected to remain that way. The level of significance was in the lower-

	mid range
Third party delays	This risk should be either a shared or contractor responsibility. This risk is considered to be important, as it was assigned in the upper mid-range
Coordination with subcontractors	The survey results overwhelmingly assigned the contractor responsibility for this risk, and it is expected to continue this way. This risk was considered as one of the top five most significant risk categories
Delayed dispute resolution	The results of this survey indicated that this risk should be either owner or shared responsibility. Contractors assigned a relatively high significance level to this risk
Delayed payment on contract	The results indicated that owners should assume this risk, and that they will continue to do so. This risk is considered to be extremely important by contractors as it was ranked second in relative significance
Quality of work	Contractors consistently assign this risk to themselves as they only can handle this task. They also ranked it as a significant one
Financial failure	The survey showed that contractors must assume this critically important risk, assigning it the highest significance rating. Yet, this risk is a result of economic conditions. While in a recessionary period, the significance increases and the contractor desires a risk sharing approach
Actual quantities of work	Contractors seem to remain in favor of assuming this risk. This risk was considered important as it was ranked eighth in relative significance
War threats	This risk just came in the middle range of relative significance of surveyed risks. Its significance may decrease as the political circumstances in the Persian Gulf region become more stable. A shared responsibility was the best approach

Table 7: Summary of the findings of the survey on risk preventive methods

Preventive method	Summary of results
Application of risk analysis techniques	This method was not considered one with very high efficiency in preventing risks. It wasranked as the third recommended method to be employed by practitioners
Depend on subjective judgment	This method was considered the second highest effective method for preventing risk. Yet,it cannot be regarded as a formal technique
Utilize updated project information	This method was the best recommended preventive method to be utilized at the early stages
Plan alternative methods as stand-by	This method was rarely used as it was assigned the fifth recommended preventive methodfrom the contractor's point of view
Add risk premium to time estimation	This method is of moderate effectiveness as a preventive method and is rarely taken intoaccount by Iranian local contractors
Transfer or share risk	General contractors did not consider this approach as an effective method as it was rankedas the last recommended preventive method
Refer to similar projects	The survey revealed that this method was considered of moderate effectiveness as it wasranked in the fourth place among the surveyed preventive methods

Table 8: Summary of the findings of the survey on risk mitigative methods

Mitigative method	Summary of results
Increase manpower and equipment	This method was considered as the second effective method for mitigating losses. It reflects the fact that shortage of manpower is one of the most serious risks to project delays in Iran
Increase the working hours	Productivity is the main item adversely affected by this approach. The survey showed that contractors consider this method as a relatively effective mitigative method
Change the construction method	The practitioners have considered this method as the lowest effective remedial method to be employed for mitigating risk impacts
Change sequence of work by overlapping activities	The survey results indicated that this method was moderate in its effectiveness as a mitigative method. However non of the respondents gave it the very low effectiveness category
Coordinate closely with subcontractors	The contractors have considered this method to be the highest effective remedial method for mitigating the losses encountered in a construction project. Thus, local subcontractors could be holding the key to projects delays
Apply close supervision of abortive works	This approach was ranked as the third effective mitigative method to be followed for minimizing losses. However, it unfolds the fact that most local subcontractors have lack of technical ability to fulfill contracted works

10/30/2012