

## **AN INVESTIGATION INTO DESIGN-RELATED RISKS AFFECTING IRANIAN CONSTRUCTION PROJECTS**

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### **Abstract**

Managing risk effectively is central to the success of construction projects. In this context, the first step towards managing risks is to identify the most critical risks and allocate resources to deal with them accordingly. Evidence demonstrates that design-related risks and issues associated with the design stage play a crucial role in the failure of construction projects in the Iranian construction industry. Despite such a salience, to date no noteworthy effort has been made to investigate this area within the Iranian context. To address such a gap in the body of knowledge, this study intends to determine and rank the most crucial risks associated with design on construction projects in Iran. To this end, a survey questionnaire consisting of 14 design-related risks was administered to elucidate the perspectives of construction project managers in Iran, which resulted in 87 duly completed questionnaires. Statistical analysis of the data revealed the main design-related risks affecting Iranian construction projects. These were 1) design changes by the owner or other non-technical stakeholders during the construction; 2) errors in design documents; and 3) delays in updating and finalising design documents during construction. The findings of the present study contribute to the field through identifying the most critical design-related risks affecting Iranian construction projects. In practical terms, the findings will assist project managers and policy makers to allocate resources more effectively in dealing with potential design-related risks by targeting the risks with the most detrimental impact.

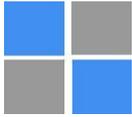
**Keywords:** *Construction Management, Risk Management, Risk Identification, Design-Related Risks, Iran*  
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### **Introduction**

The construction industry accounts for a high portion of the world's economy (Proverbs et al. 1999), it attracts enormous investments and is a major driver for evolution of other economically important industries such as mining (Assaf and Al-Hejji 2006). This contribution becomes even more critical (Altaf 1979) and flourishing (Sweis et al. 2008) in developing countries – such as Iran – compared with developed countries. Despite the vital input of the construction industry to the economy, due to its dynamic nature as well as involvement of a large numbers of stakeholders it is one of the riskiest and most fragile businesses (Mills 2001 and Ehsan et al. 2010). In essence, the construction industry is subject to more risks than any other industry. Therefore, appropriate action to manage all potential risks is central to success on construction projects. Despite the importance of managing risks in construction projects, Iranian construction firms have not been successful in managing risks. This has resulted in considerable economic loss and delays in completing projects (Samarghandi et al. 2016; Zadeh

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2010). A review of the literature highlights that previous inquiries on risk management within the Iranian construction context have been very rare and have paid scant attention to thorough examination of the nature of different influential risk factors.

To address this gap, the present study is aimed at providing a picture of the current state of risks in the Iranian construction context. Of particular interest is to determine and rank the most crucial risks associated with the design stage on construction projects in Iran. This is deemed necessary for promoting the risk management knowledge in the Iranian construction context. That is, the findings would support project managers and policy makers to assign resources more effectively in handling probable design-related risks by targeting risks with the most detrimental impact.

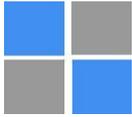
### Background

Risk management is defined as using a set of methods and actions to lessen the disturbances which may occur during the life cycle of the project and threaten achieving the objectives of the project (Skorupka 2003). In other words, risk management is a systematic approach in identifying and quantifying all possible risks and accordingly taking an appropriate approach to deal with the risks identified (Gohar et al., 2012). Risk management is one of the most important procedures in the context of project management (Tadayon et al. 2012) and is strongly associated with the success of the project (Voetsch, et al. 2004). Poor risk management delays completion dates, affects the quality of projects and causes cost overruns.

Despite all the advantages of managing the risk in construction projects, it seems Iranian construction firms have not been successful in implementing risk management on projects. As implied by Samarghandi et al. (2016) the average delay per year in Iranian construction projects is 5.9 months and the average cost overrun is 15.4%. Even in the face of such a significant detriment, to date limited effort has been made to identify and manage the risks within the Iranian construction context.

Risks in construction projects are classified into internal and external risks. Internal risks are those created within the project and external risks are those generated by the external environment of the project. Due to the nature of internal risks they are more manageable than that of external ones (Aleshin 2001). Smith and Bohn (1999) asserted that design related risks are internal risks, hence returning to the focus of this study, a deep understanding of design related risks and identifying all the underwriting causes will facilitate controlling the risk more effectively.

Design-related risks and issues associated with the design stage have been identified in a number of previous studies. For instance, Nguyen and Chileshe (2015) asserted 'poor design capacity and the frequent design changes' as the most cited factor in the literature and the third most critical factor causing failure in Vietnam's construction projects. In a similar study concocted by Le-Hoai et al. (2008) in Vietnam, 'design inefficiencies' ranked as the fourth risk factor that caused delay. Abdul-Kadir et al. (2005) identified and ranked the most important risk factors cause delay in Malaysian construction industry. They claimed that out of 50 delay factors, the 'late issuance of construction drawing by consultants' is the fourth risk factor. Similarly, Joshi and Khandekar (2015) asserted that a 'delay due to receiving permissions for design drawing from government authorities' is the fourth risk factor causing delay in construction projects in India. In another study, risk factors causing delay in construction projects in Saudi Arabia were examined by Assaf and Al-Hejji (2006). 73 different factors were



identified in the investigation by different stakeholders; the only factor which was cited by all groups of participants as a cause of delay was ‘changing design by owner during construction phase’. Likewise, in Denmark, the biggest risk factors affecting the budget and the quality of the project in construction were identified as ‘errors or omissions in consultant document’ (Larsen et al. 2015). Tang et al. (2007) consider ‘design related’ risks as one of the five most significant risks in construction industry in China. Perera et al. (2009) identified ‘design related’ risks including uncompleted drawings and design changes as the most critical risks in the construction industry of the Sri Lanka.

Referring to the aforementioned studies it appears that design-related factors play an important role in the success or failure of construction projects. However, taking into account the dynamic nature of the construction industry and its association to climate; social, cultural and economic context; and local laws, requirements and standards the results of the discussed studies cannot be extended to Iran. However, studies which have been completed in the context of risk management focusing on the Iranian construction industry also reveal that design-related risks play a crucial role in the accomplishment of projects. Ghahremanzade (2013) categorise the risks involved with construction management in Iran into 3 categories: critical, intermediate and not critical and categorises design-related risks as critical. Ghoddousi and Hosseini (2012) recognised design related issues as a main reason for re-work in Iranian construction; Pourrostan and Ismail (2011) asserted delays in producing design documents is one of seven most important factors causing delays in the construction industry. However, none of these studies thoroughly investigated the nature and importance of different factors shaping design-related risks. Consequently, there is a clear lack of research on design-related risks and the relevance in the Iranian construction context as the driving force behind conducting this study.

### Research methods

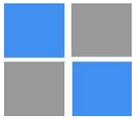
The methodology employed in this research study consisted of a comprehensive literature review, a questionnaire survey to calculate the severity index of identified risks. The questionnaire survey was designed using plain language and included closed-ended questions. The first section of the questionnaire consisted of the overarching aims of the research projects and covered questions that targeted demographics of respondents. The second section included fourteen design-related risk factors extracted through a review of literature. Respondents were asked to rate their perceptions of the likelihood and severity of these risks based on a five-point Likert scale. The five-point Likert-scale was used to elicit the respondents’ perceptions with regard to their level of agreement stated in five categories (1= strongly disagree, 2 = disagree, 3 =neutral, 4 = agree, and 5 = strongly agree).

### Data analysis

The severity index method was used to analyse the collected data. Equations (1) and (2) were implemented to rank the importance of the risk factors. This is the approach that has been widely used in previous studies on risk management e.g. (Perera et al. 2014; Zou et al. 2007; Sun et al. 2008).

$$S_j^i = \alpha_j^i \beta_j^i \quad (1)$$

$$RS^i = \frac{\sum_{j=1}^n S_j^i}{n} \quad (2)$$



The elements in Equations (1) and (2) represent the items below.

$n$  = number of respondents,

$S_j^i$  = evaluation of risk severity by the  $j^{\text{th}}$  respondent,

$\alpha_j^i$  = evaluation of frequency level of risk occurrence by the  $j^{\text{th}}$  respondent,

$\beta_j^i$  = evaluation of significance of risk occurrence from the  $i^{\text{th}}$  factor by  $j^{\text{th}}$  respondent, and

$RS_j^i$  = Risk Severity Index for the  $i^{\text{th}}$  risk factor.” (Perera et al. 2014, p. 7)

**Sample demographic attributes**

The list of certified companies was downloaded from the data bank of licensed Iranian construction companies. This list was merged and sorted alphabetically and then a random selection was conducted by using a non-replacement random selection technique. A total of 494 invitations to participate in the research study were sent by post to the list of companies with an invitation to distribute the questionnaire among their employees. Follow up calls were conducted which resulted in receiving 87 duly completed questionnaires.

Table 1

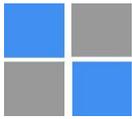
**Profile of the survey’s respondents**

Company’s role		Experience in the Iranian construction industry (years)				Total
		Fewer than 5	5-10 years	11-15 Years	More than 15	
Client	Count	5	9	5	8	27
Consultant	Count	11	10	6	4	31
Contractor	Count	11	7	8	2	29
Total	Count	27	26	19	14	87
	% of Total	31.4%	30.2%	22.1%	16.3%	100%

Source: Authors’ construction

As illustrated in Table 1, the proportion of respondents in terms of experience was: less than 5 years (31.4%); 5-10 years (30.2%); 11-15 years (22.1%); and more than 15 years (16.3%). The proportions of the respondents in terms of professional background (not shown in Table 1) were: 15.1 % (13) Project managers; 20.9% (18) design engineers; 33.7% (29) supervisors; 12.6% (11) site managers; and others 17.2% (15). The length of service and the position of respondents were regarded as evidence of the breadth of their knowledge regarding the strategic and operational levels in the Iranian construction industry. Thus, the sample was deemed adequately knowledgeable on the topic of the inquiry.

The breakdown of the final respondents according to their role in the construction industry (see Table 1) consisted of 31 consultants, 29 contractors and 27 clients. The contractor grouping also included 1 specialist sub-contractor and 1 operator, included in this ‘contractor’ grouping due to their limited numbers.



**Results and discussion**

As discussed, this study examined 14 design-related risk factors in the Iranian construction industry to determine the most influential factors. The result of statistical analysis of the data is summarized and presented in Table 2.

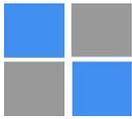
Table 2

<b>Ranking the design-related risk factors</b>		
<b>Risk factor</b>	<b>value</b>	<b>Rank</b>
Design changes by the owner or other non-technical stakeholders during the construction	24.31	1
Errors in design documents	23.88	2
Delays in updating and finalising design documents during construction	22.72	3
Changes in specifications and documentation	20.39	4
Occurrence of unpredictable problems due to adapting to new technology	15.60	5
Delays in the approval of planning permit	15.31	6
Design or documentation changes after completion of the construction	15.05	7
Informal and verbal orders for design changes	14.74	8
Technical problems in design drawings	13.85	9
Design changes by non-experts	13.21	10
Inaccuracy of predicting the amount of work in the initial contract because of inaccuracy of design drawings	12.88	11
Subjective decision making on site because of inaccuracy of design drawings	10.93	12
Re-work due to inaccuracy of design drawings	10.51	13
Disputes between project team due to inaccuracy of design drawings	8.33	14

*Source: Authors' construction*

Results revealed that the most important design-related risk affecting Iranian construction projects is ‘design changes by the owner or other non-technical stakeholders during the construction’. This was consistent with the findings of studies on risk identification in Saudi Arabia by Assaf and Al-Hejji (2006) where ‘changing design by owner during construction phase’ was identified by all categories of participants as one of the risk factors causing delay. Changing different accepts of the project by the owner is not uncommon in the construction industry (Suprpto et al. 2015). However, because construction companies in Iran – similar to other developing countries – do not have any ‘change management system’, any ‘change’ could make a considerable discrepancy in the project (Gharaee Moghaddam 2013). This would be more significant in the occurrence of design changes as it would affect a wide range of other aspects of the project. Additionally, if changes in design occur during the construction phase causing re-work, considering the documented low productivity in Iranian construction industry (Zakeri et al. 1996; Ghoddousi and Hosseini 2012), the effect would be adverse.

The second highest ranked design related risk factor was ‘errors in design documents’. This resonates with observations made in Vietnam by other researchers (Nguyen and Chileshe Nafiseh Hamidi Monazam, Hamidreza Hamidimonazam, M. Reza Hosseini



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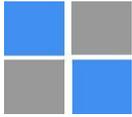
2015; Le-Hoai et al. 2008) denoting the crucial role of design-oriented risks in adversely affecting construction projects. Any errors in drawing or specification may cause re-work, which because of low labor productivity in the Iranian construction industry would result in serious delays. Such emphasize on design errors as risks could be attributed to two main factors adversely affecting the Iranian construction industry. First, similar to other developing countries Iran suffers from a lack of skilled personnel within the construction industry. This has been well-documented in the literature as issues negatively affecting major aspects of success on construction projects (Tabassi et al., 2009). Second, the construction industry in Iran particulate contractors is under continuous pressure to start the construction phase. This ends up in contractors starting construction activities while drawings being far from complete (Ghoddousi et al., 2015).

‘Delays in updating and finalizing design documents during construction’ was ranked as the third risk factor. This finding echoes the observations by Abdul-Kadir et al. (2005) in Malaysia and Joshi and Khandekar (2015) in India implying the adverse impacts of delays in receiving or updating drawings on the success of projects. One of the main reasons behind delays in receiving updated drawings in an Iranian context is that the construction industry is dominated by traditional methods of project delivery (Ghoddousi and Hosseini, 2012). The industry has been resistant to adopting innovative methodologies and collaborative procurement methods such as building information modelling (BIM) (Hosseini et al., 2015). As such, the exchange of information is still linear and fragmented, thus culminating in delayed information and lack of collaboration among designers with other parties involved on construction projects. Risks ranked as the 4<sup>th</sup> to 10<sup>th</sup> all were associated with the traditional nature of delivering construction projects in Iran and lack of attention to implementing a systematic project delivery system in projects as observed in the recent study by Hosseini et al. (2016) in Iran. In such a delivery method, roles and responsibilities associated with design are not clearly defined, which result in frequent changes enforced by influential non-technical stakeholders on construction projects as a major risk.

### Conclusion

As the first study in its kind, this paper targets the risks associated with design aspects of construction projects within the Iranian construction industry. As indicated by the findings, the serious risks identified were almost entirely stemmed from the traditional delivery method of projects in Iran, which follows a linear and fragmented structure for design and subsequent delivery of construction projects. Moreover, low levels of adoption of innovative collaborative methodologies such as BIM were another cause for the design-oriented risks as identified in the present study. The findings also revealed another major issue prevalent in Iran namely lack of attention to strategic and systematic delivery of projects and vagueness of roles and responsibilities on projects as another reason for frequent changes and influences on the design procedure of projects.

The findings bring to light the main risks associated with design stage of construction projects in Iran. This contributes to the field by highlighting the main areas to focus on by future investigators and pointing to fertile grounds for research in the Iranian construction industry. Yet, the findings should be considered in view of the relatively small sample size of the study. This also defines another area for research through conducting broader studies in the Iranian context targeting the root causes of the risks identified in the present study.



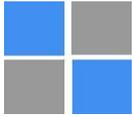
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