Determining and assessing the risks of commercial and recreational complex building projects in developing countries: a survey of experts in Iran

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Abstract

Purpose – As construction of commercial and recreational complex building projects (CRCBPs) is one of the most important issues in many developing countries and requires a very high cost of implementation, it is important to identify and prioritize the risks of such projects. Therefore, the purpose of this study is to identify and rank the risks of CRCBPs by studying the case of the "Hamedanian Memorial," a CRCBP in Iran.

Design/methodology/approach – To pursue this aim, a descriptive-survey method was used. The statistical population of the study consists of 30 experienced experts (consultants, contractors and employers) of the "Hamedanian Memorial" project selected according to the Cochran formula and minimum population census. A questionnaire was used as the data collection tool, administered in all stages of risk identification and evaluation, and was devised by using library and field methods based on the literature and research background, as well as interviewing experts in the risk identification and evaluation stages. Kendall's coefficient of agreement was used to validate the experts' opinions in the risk identification stage. The ranking in qualitative evaluation was done based on the risk intensity and the cumulative risk index.

Findings – The results show that the risks are associated with exchange rate fluctuation, inflation fluctuation, access to skilled workers, contractors' claims and foreign threats from international relations.

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Originality/value – The results and findings of the present study can be of interest to the executives of large commercial, leisure, public and private projects in developing and developed countries; understanding risks can significantly improve the decision-making process of CRCBPs.

Keywords Iran, Developing countries, Risk management, Risk identification, Risk qualification, Complex building projects

Paper type Research paper

1. Introduction

What are the main risks concerning commercial and recreational complex building projects (CRCBPs)? Construction, like other industries, is influenced by risks from the beginning to the end of a project's life cycle (Siu *et al.*, 2018), mainly because of the inner uncertainty that is at the basis of the building process (Zavadskas *et al.*, 2010). Risk in a project is pervasive and affects all activities. In theory, risk is simple and understandable, but, in practice, it turns into a complex problem that is controversial to measure. However, risk is based on the logic of losses and threats, but uncertainty is used to express risk that indicates the likelihood of occurrence of an event (Al-Bahar and Crandall, 1990). Therefore, prior to any action, investors and project managers must have a (intentionally) rational prediction and accurate assessment of project risks (Liu and Yang, 2006) – despite knowing that their perception may depend on inner socio-demographic or other inner features (Cristofaro, 2019, 2020; Cristofaro *et al.*, 2020). Thus, identifying and evaluating risks in projects is necessary and can play a very important role in achieving project objectives.

In this regard, the risk management field offers some solutions for reducing risks associated with projects (Williams, 1995); basically involving a number of successive procedures that consist of implementing measures including time, cost and quality to achieve project goals. As a consequence, following a policy and recommendations within a given framework leads project risk management to better performance in different phases of the project (Rodrigues-da-Silva and Crispim, 2014) by maximizing positive outcomes (opportunities) and minimizing negative consequences (threats) (PMI, 2017). Project management literature identified several tools and procedures for identifying and evaluating the risks involved in the construction industry. For example, Ezeldin and Orabi (2006) stated that the main reference in risk identification is historical data, past experience and judgement. In addition, Hlaing *et al.* (2008) stated that there is no exact or standard procedure to identify risks in the construction industry; it relies strongly on the skills and judgement of the key project personnel. In this regard, various approaches can be used for risk identification. For example, Chapman (1998) believes that risk identification methods can be grouped into three general categories: identifying the risks by the risk analyst; risk identification by interviewing key members of the project team; and risk identification through brainstorming meetings. In this regard, research has shown that the questionnaire survey is the most frequently used technique for risk identification in the construction sector (Hlaing *et al.*, 2008; Goh *et al.*, 2013; Marcelino-Sádaba *et al.*, 2014).

A review of the research literature shows that, despite extensive studies to identify and evaluate the risks involved in the construction industry, few studies have been dedicated to the risks in CRCBPs. CRCBPs comprise a series of shops connected to each other with sidewalks that are designed and built alongside recreational, residential, office, hotel, restaurant and cinema spaces. Recently, new public investment has been in the development and construction of CRCBPs that has elements such as large investment, long-term return on investment as well as high risk and profit (Chen and Khumpaisal, 2009). In addition to meeting basic needs, these sectors have a positive impact on accelerating economic development (Kumaraswamy and Zhang, 2001). However, as with all projects, CRCBP projects may fail because of avoidable errors in the project phase, with the consequence of creating dramatic outcomes for the economics and society. The Jahan Nama amusement park in Isfahan, for example, has failed because of inadequate market studies as well as failure to comply with social norms and conditions (Ghaed and Daneshmandi, 2018). Therefore, identification, evaluation and ultimately prioritization of the risks affecting the project objectives can mitigate the consequences of such failures and guarantee the success of the project in terms of size, cost, time and quality.

From the above and as initially stated, the present study aims at identifying, classifying and evaluating the risks involved in CRCBPs projects. For this purpose, the "Hamedanian Memorial" project, a CRCBP in Isfahan (Iran), is studied. The research investigates the CRCBPs risks through conducting the Delphi method; the statistical population of the study consists of 30 experienced experts (consultants, contractors and employers) of the "Hamedanian Memorial" project selected according to the Cochran formula and minimum population census. A questionnaire acted as the data collection tool, administered in all stages of risk identification and evaluation and was devised by using library and field methods based on the literature and research background as well as interviewing experts in the risk identification and evaluation stages. Kendall's coefficient of agreement was used to validate the experts' opinions in the risk identification stage. The ranking in qualitative evaluation was done based on the risk intensity and the cumulative risk index. Findings of this research are an unprecedented contribution to the original body of CRCBPs and the construction industry. Such an outcome would enable decision-makers to make more explanatory decisions with regard to, for example, proper risk allocation, bid pricing, selection of the optimum procurement route and evaluation of different construction projects.

2. Literature review

The project life cycle of a facility usually consists of the following phases:

- market demands or perceived needs (outcome: definition of project and objectives and scope);
- conceptual planning and feasibility study (outcome: conceptual plan for preliminary design);
- design and engineering (outcome: construction plans for specifications);
- procurement and construction (outcome: completion of construction);
- startup for occupancy (outcome: acceptance of facility);
- operation and maintenance (outcome: fulfillment of useful life); and
- disposal of facility (outcome: disposal).

All of these phases are pervaded by uncertainty (Jordani, 2010; Eadie *et al.*, 2013; Wetzel and Thabet, 2015) – thus, there is not sufficient information for their understanding and/or developments (Toma *et al.*, 2012) – which forms an integral and inevitable part of them (Perminova *et al.*, 2008). Once more and more information on the project phases is collected, the decision-makers are in risky situations or events, thus meaning their occurrence or evolution can be forecasted (Toma *et al.*, 2012). Both uncertainty and risk result in deviation from the main objectives of projects and reduce their efficiency; therefore understanding and managing risks in projects is essential (Wideman, 1992). We, therefore, are opting for the "risk" aspect because of the fact projects require that decision-makers put effort into the understanding of project phases and their evolution. Uncertainties can be classified into four areas:

(1) uncertainty in a project's basics and estimates;
(2) uncertainty in a project's design and logistics;
(3) uncertainty in a project's objectives and priorities; and
(4) uncertainty in relationships between entities in the project (Marinho *et al.*, 2013).

The risks in these four categories must be managed; in this regard, the purpose of risk and uncertainty management is to provide guidelines for a well-defined framework (PMI, 2017) and to address risk issues in both project opportunities and threats, to achieve greater success in projects.

The first step is to identify and record the characteristics of the risks (PMI, 2017) of the risks that may affect the project. Risk identification is an iterative process, as new risks may be identified and discovered as the project progresses through its lifespan (Sarvari *et al.*, 2019b); in this vein, the definition of risk must be consistent throughout the project to facilitate comparison among the effects of risks in the project (PMI, 2017). Project management literature helped to build some risk identification tools and techniques, which include documentation review, brainstorming, the Delphi method, interviewing, checklists, hypothesis analysis and graphing techniques (Zavadskas *et al.*, 2010; Chan *et al.*, 2014; Siu *et al.*, 2018; Sarvari *et al.*, 2019b; Zhou *et al.*, 2020).

The second step is risk classification, considered as a key factor in risk management that greatly aids the process. Generally, classification includes cost, financing, demand and political risks (Irimia-Diéguez *et al.*, 2014), and should be managed to achieve the project objectives (Krane *et al.*, 2010). Risks can be classified in different ways based on different purposes, such as their hierarchy (Wang and Tong, 2007) or impact on project goals (Wideman, 1992). However, the Project Management Institute (PMI) (2017) declares that, to identify and respond to risks, the most appropriate approach is to identify the risk groups based on their origin (rather than their impact), that is: external risks, internal risks, technical risks and legal risks. This approach to the classification of risks is very close to the ones of Hillson *et al.* (2006) and Taroun (2014), who suggest an approach that identifies the groups and subgroups of risks that may occur in a typical project according to their origin – this is the so-called risk breakdown structure (RBS) (Hillson, 2003). One of the benefits of using this approach is that it highlights the many sources of risks and their relationships (PMI, 2017).

Some examples of the application of this approach are offered as follows. Sigmund and Radujković (2013) identified risks by designing an RBS composed of two categories, each with five sources: external (i.e. legal, political, economic, social and natural) and internal (i.e. management, design, human, delivery and contractual) (Sigmund and Radujković, 2013). In another study, Kolahan *et al.* (2015) identified different types of risks in electricity transmission projects in two major groups of postal and line projects. The results of this research led to the preparation of the RBS of these projects in four categories: legal, contractual, management and planning and resource limitation. Nazari and Jaberi (2015) also used the RBS approach to identify risks in a large project-oriented industrial organization. They first identified the uncertainties associated with the projects by analyzing the characteristics of the projects under investigation. Then, by analyzing the identified risks and focusing on the designed RBS, they categorized the risks into five groups including technical and technology, cost and finance, project organization, contracts and risks from outside the project's organization. Asgari *et al.* (2016) believed that, despite abundant software and hardware, risks in the upstream oil and gas industry have not been thoroughly investigated. They presented an RBS model, identifying risks at four different levels in six chapters, and the headings included political, economic, social, technological, technical and organizational risks.

2.1 Risk identification and classification in commercial and recreational complex building projects

CRCBPs comprise a series of shops connected to each other with sidewalks designed and built alongside recreational, residential, office, hotel, restaurant and cinema spaces. Walewski and Gibson (2003) pointed out that CRCBPs are always high-risk mainly because of the huge amount of resources and stakeholders involved. In such projects, owners and contractors face risks that have an impact on time, performance and cost targets, and risk management results in significant financial loss and prolongation of the project. Consequently, Walewski and Gibson (2003) highlighted the necessity to implement risk management approaches in CRCBPs. In this vein, over time, new tools for identifying risk in CRCBPs have been developed, as shown in the project management literature. Accordingly, Fuzzy methods have been extensively implemented – i.e. models that have the ability to recognize, represent, manipulate, interpret and use vagueness and imprecise information – in risk identification in project management (Bandemer and Gottwald, 1995); however, scholars also embraced other approaches. Chatterjee *et al.* (2018), for example, applied a hybrid Multi Criteria Decision Method (MCDM) technique – models that help to evaluate multiple conflicting criteria in decision-making – for risk identification in construction projects. In particular, these scholars identified risks and prioritized them based on a sensitivity analysis and a hybrid model – based on the analytic network process (ANP) method (i.e. a model that structures decision-making processes as a network) – that addressed the shortcomings of previous methods. In another study, Ezeldin and Ibrahim (2015) conducted risk analysis of a large CRCBP through a questionnaire distributed in Egypt and identified 30 risks, which were classified into six main categories. As a result, they found that the lack of financing, changes in design, incomplete specifications and the lack of owner liquidity were the most important risks.

3. Research methodology

To achieve the identified research aim, an empirical study of the CRCB "Hamedanian Memorial" project, set in Iran, has been undertaken (Obermeyer Planen and Beraten GMBH, 2016). In particular, it has been investigated the risk identification and classification for this project has been investigated, as pointed out in Figure 1. In particular, the implemented method has followed these steps:

- risk identification and categorization; and
- risk assessment.

As pointed out in Figure 1, the method of data collection in this study is based on a combination of field and library methods. Given the nature of risk management, identification and evaluation of risks by analyzing the data collected are deemed a systematic approach that provides a better understanding of the phenomena. For this reason, the field data collection method proves effective in the present research, but, in some cases, it is necessary to use other existing databases and resources to obtain information for developing new theories accordingly. Thus, the library method is also used in this study.

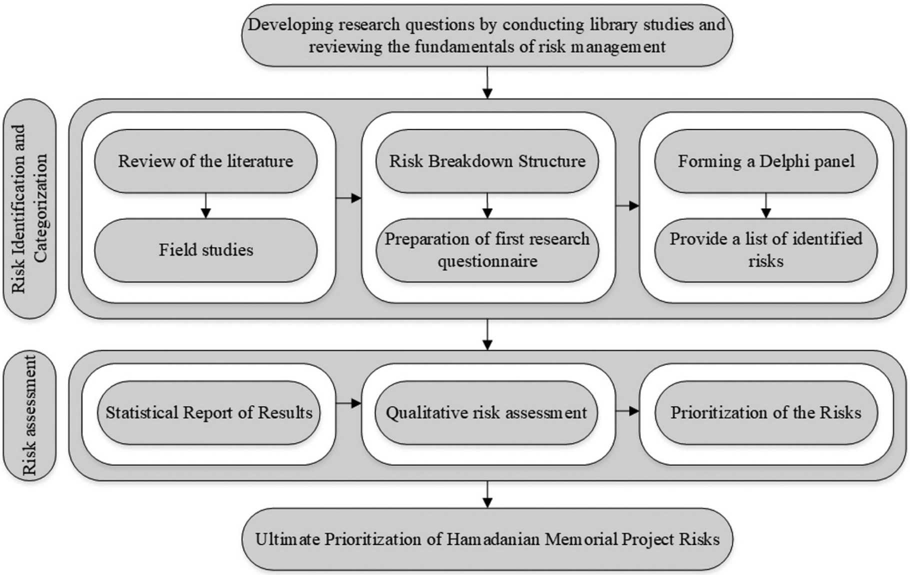

Figure 1.
Research methodology of the study

Many researchers have used this combined approach to identify the risks in construction projects, i.e. Siu *et al.* (2018) and Sarvari *et al.* (2019a).
The statistical population of this study consists of 30 experienced experts (detailed later) with specialized viewpoints from all groups involved in the project (consultants, employers and contractors). A questionnaire pointing out the main risks of CRCBPs has been prepared based on the results presented by existing risk management literature. Opinions were used from a group of experts to form a decision matrix both in the process of risk identification and in the qualitative assessment of risks.

3.1 Data collection

To reach the goal of this study, a Delphi research method (Yeung *et al.*, 2007; Olawumi and Chan, 2018) was implemented aimed at collecting the views of the experts of infrastructure projects about the challenges that developing countries have to face to attract private investments. In particular, the data collection method consisted of a questionnaire and semi-structured interviews administered to the following experts: contractors, consultants and employers (similar to Olawumi and Chan, 2019). The Delphi process is a perspective and systematic research method to obtain comments from a group of experts on a specific subject or question. In particular, the Delphi process has a structure to predict and help decision-making through a three-round survey that encompasses data gathering and concludes with group agreement. The Delphi includes survey or questionnaire rounds using a basic questionnaire, from which questionnaires are formed for the next rounds. Yet Delphi keeps the responders anonymous and hides each answer from other responders on the panel (Chan and Chan, 2012; Olawumi and Chan, 2019). Most of the time, sampling is based on a used target and agent samples are not important, but the quality, rather than the number, of panelists is more important (Chan and Chan, 2012; Olawumi and Chan, 2019). From that, participants of the Delphi are experts, critics and panelists who must have knowledge and experience in a same subject, time to participate, and effective communication skills (Yeung *et al.*, 2007). There is no explicit or firm rule on how to choose and how many experts to choose for the Delphi process. The number of the responders, indeed, depends on the factors of homogeneous and heterogeneous types of the sample, target of the Delphi, duration of data gathering, domain of the problem and acceptability of the answer (Chan *et al.*, 2007, 2010; Chan and Choi, 2015). The number of participants is usually less than 50 and most of the time is around 15 to 20 (Sarvari *et al.*, 2019b).

In the present study, all experts and experienced individuals with specialized opinions from all groups of the "Hamedanian Memorial" CRCBP (i.e. consultants, employers and contractors), based on a census of up to 30 people, were considered as sample size. It should be noted that the panel size used in this study is bigger than that of previous similar contributions, which had 19 (Choi *et al.*, 2010) and 12 (Salman *et al.*, 2007) respondents (Table 1).

Demographic findings of this study indicated the following:

- 90% of respondents are male;
- respondents aged 30-45 years accounted for 50% of the total statistical population;
- respondents with a bachelor's degree accounted for 46.7%;

Socio-demographic characteristics	No.	(%)
Gender		
Male	27	90
Female	3	10
Age (in years)		
<30	6	20
30-45	15	50
>45	9	30
Level of education		
Bachelor	14	46.7
Master	11	36.7
PhD	5	16.7
Construction industry experience (in years)		
< 10	9	30
10-20	8	26.7
> 20	13	43.3
Activity field		
Governmental	2	6.7
Private	21	70
Both	7	23.3
Responsibility		
Client	8	26.7
Consultant	16	53.3
Contractor	6	20
Specialty field (Position)		
Architect	5	16.7
Director	3	13.3
Engineer – civil, electrical and mechanical	7	23.3
General Manger – procurement and contracts	3	10
Project manager	3	10
Senior project manager	4	13.3
Technical director	4	13.3

Table 1. Details of interviewed experts

- respondents with over 20 years' work experience accounted for 43.3%;
- the majority of respondents (70%) work for private entities;
- 53.3% acted as consultants for the CRCBP; and
- the majority of respondents (23.3%) has an engineering specialization in terms of functional background.

It is worth noticing that the client, consultant, and contractor form the so-called "trilateral governance" of projects (Reve and Levitt, 1984; Dadzie *et al.*, 2012; Memon *et al.*, 2014).

3.2 Survey questionnaire

The type of data collection tool is subject to various factors including the nature and method of the research. Questionnaire was selected as the data collection tool in this research, similar to other studies (Chan *et al.*, 2014; Ezeldin and Ibrahim, 2015; Sarvari *et al.*, 2019a). The questionnaire was designed based on the initial RBS, which is mainly based on past research and library studies, and it was used to identify and document the risks of CRCBPs – using the Delphi technique as one of the most common methods of risk identification (Rostami, 2016; Sarvari *et al.*, 2019b; Siraj and Fayek, 2019).

Table 2 outlines the risks affecting the objectives of CRCBPs and categorizes them into internal and external risks as well as grouping them into 14 clusters at the second level (i.e. social, economic, political, legal, natural, technical, work force, investment, management, safety, design, contract, market and environmental) and 53 risks at the third level. Because of different uses in previous studies and because the risks of each project vary widely depending on the environmental and social conditions, the present study uses past records and library studies as well as interviewing reporters to design a comprehensive RBS for CRCBPs.

Considering the 53 risks identified in CRCBPs, the experts expressed their opinions about them by using the Delphi technique. After statistical analysis, the results show that the majority of the 53 items were in collective agreement; however, based on the experts' opinions, the risks relate to the tactical group and two risk items of the market group – including growth and job competition and changes in demand for purchasing spaces – are eliminated. On the other hand, tax risks in the economic group, inappropriate financing in the investment group, inaccurate distribution of funds, unrealistic goals in the management group, accessibility of the site and traffic permits from the environmental group are added to the list. Finally, a questionnaire with 55 items was sent to the experts for evaluation.

At this stage, 49 out of the 55 items were validated: tax risks, political events, changes in government attitudes, inadequate geotechnical studies, failure to identify underground factors and workshop supervision were eliminated. In contrast, 33 new items were added to the list of the risks. For example, differences in cultural levels of people, regional and ethnic constraints, bank interest rate fluctuations, import regulations, government destabilization, inappropriate government relations, accidents caused by unexpected factors in the electricity distribution network, accidents of the unforeseen factors in the water and wastewater network, mismatch of the spaces for clients' needs, public lack of interest toward projects, increased competitiveness by other rival projects, change in demand for different user space, lack of proper organizational coordination, project staff crises in different units, assignment of responsibility of units to third parties, incompatibility of the design with a project site, inaccuracies in calculations and unrealistic estimates, incompatibility with design codes and neglecting maintenance periods. At the end of this process, 82 items were

No.	Chapter RBS Level 1	Group RBS Level 2	Risk RBS Level 3
1	External	Social	Dissatisfaction
2			Sabotage
3		Economical	Exchange rate fluctuation
4			Inflation
5			Government economic policies
6		Political	Government policies
7			Foreign threats
8			Political events
9		Legal	Changes in law
10			Standards and requirements
11			Regional standards
12			Changing point view of government organization
13		Natural	Earthquake
14			Storm
15			Flood
16			Fire
17		Technical	Lack of documentation on the changes in project
18			Lack of acceptance changes control
19	Internal	Work force	Availability of skilled worker
20			Salary amount
21			Work standards and behavior
22			Skill efficiency
23			Unrealistic primary estimation
24		Investment	Lack of finance
25			Bankruptcy
26			Mismatch between demand and available resources
27		Management	Client records and experience
28			Delay in land hand over
29			Poor coordination and management
30			Lack of using management methods
31		Safety	Building site safety
32			Hygiene
33			Environment
34		Design	Technical ability and authority of counselor
35			Inadequate geotechnical studies
36			Failure to identify underground factors
37			Workshop supervision
38			Incomplete plans
39			Poor technical characteristics
40		Contract	Contractor contract (listed, fixed)
41			Contractor policies to enter biddings
42			Incomplete duties, agreements, and contracts
43			Contractor claims
44			Legal claims
45		Market	Increasing work competition
46			Change in demand purchases
47			Facilitating sales and commercial marketing
48		Environmental	Adjacent building condition
49			Smoke, pollution, noise
50			Building workshop security
51			Historical condition
52			Historical buildings' privacy space
53			Geographic and climatic condition

Table 2. Identified risks affecting the objectives of RCPs based on the review of the literature

considered as risks and experts concluded that all 82 factors could be identified as a risk in CRCBPs.

On the one hand, the elimination and addition of items by the experts suggests that eliminated items are in conflict with the objectives of the project. On the other hand, the added items are in line with the project objectives, and these are evaluated by the experts in the next stage.

3.3 Validity and reliability of research tools

The validity and reliability of the Delphi method are not so easy to control and the method has been heavily criticized for lack of reliability (Skulmoski *et al.*, 2007). In other words, if the experts were given similar information or questions, it is highly possible to obtain different results. The validity of the technique has also been criticized because the researcher does not have any influence on the development and preparation of the questionnaire or tools, whereas he/she affects the formal validity. However, the validity of the content is guaranteed if the participants are representative of the target group. Therefore, in the present study the opinions of 30 experts have been collected including academic experts, project managers, senior project consultants, employers, contractors and project management experts. Content validity was evaluated by the Lavshh method and Kendall's coefficient of agreement was used to assess the degree of agreement:

$$CVR = \frac{\left(\mathrm{ne} - \frac{N}{2}\right)}{\frac{N}{2}} \tag{1}$$

where:

content validity ratio (CVR) = ratio of content validity;
ne = number of experts who approved the suitability of items included in the questionnaire; and
N = total number of participants.

As mentioned earlier, 30 experts were asked to give their opinions about the identified risks to determine whether the 53 factors identified could be considered as risks in CRCBPs or not. The frequency of each expert's agreement with the questionnaire items was determined and then content validity of the questionnaire was calculated.

The validity was compared with Table 3, which shows the minimum size and number of experts in content validity. The results indicated that most of the items were valid. However, according to the experts' opinions, it was necessary to remove a number of technical and market risks and add new questions, such as tax and toll risks, site access and traffic permits. Next, a new questionnaire with 55 items was sent to the experts. At this stage, the majority of the 55 items were valid, but again it was necessary to remove some of the disagreements and include new items that eventually led to the addition of new items to the questionnaire. Therefore, in the

Table 3. Expert numbers and minimum size in content validity

Expert number	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
Minimum size	0.99	0.99	0.99	0.85	0.78	0.62	0.59	0.56
Expert number	*13*	*14*	*15*	*20*	*25*	*30*	*35*	*40*
Minimum size	0.54	0.51	0.49	0.42	0.37	0.33	0.31	0.29

No.	Group	Factors	Approval opinion	Opposite opinion	Without any opinion	Content validity rate
1	Social	General dissatisfaction with the project's location	30	0	0	1.14
2		Sabotage	27	2	1	0.93
3		Cultural difference between people	27	1	2	0.93
4		Regional and ethnic limitation	25	4	1	0.79
5	Economic	Exchange rate fluctuation	30	0	0	1.14
6		Inflation fluctuation	28	2	0	1
7		Bank interest fluctuation	28	1	1	1
8		Change in duties of imported equipment	27	2	1	0.93
9		Law changes and economic policies of materials	27	2	1	0.93
10	Political	Government internal policies contradiction	29	1	0	1.07
11		Foreign threats	22	4	4	0.57
12		Inappropriate work relation of government organizations	25	3	2	0.79
13		Government instability	26	2	2	0.86
14	Legal	Changes in law	26	1	3	0.86
15		Changes in binding legal obligations in contracts	24	5	1	0.71
16		Regional standard changes (firefighting-master plans, etc.)	22	5	3	0.57
17	Accidents	Natural disasters (flood –earthquake, etc.)	25	2	3	0.79
18		Sewage and water network unexpected accidents	25	1	4	0.79
19		Annual change in weather	26	2	2	0.86
20		Electrical distribution network unexpected accident	24	3	3	0.71
21	Market	Mismatching spaces with customer needs	30	0	0	1.14
22		Public lack of interest	28	1	1	1
23		Increased work competition around project area	29	1	0	1.07
24		Changes in demand for the purchase of spaces with different uses	29	1	0	1.07
25		Facilitate sales and marketing conditions for specific user spaces	30	0	0	1.14
26	Work force	Access to skilled worker	29	1	0	1.07
27		Salary	27	3	0	0.93
28		Behavior, standards, work commitment	27	2	1	0.93
29		Mismatch job referrals to personnel with related specialized skills	29	1	0	1.07
30	Investment	Unrealistic primary estimation	27	3	0	0.93
31		Inappropriate finance	30	0	0	1.14
32		Lack of on time finance	25	6	2	0.79
33		Bankruptcy	27	3	0	0.93
34		Mismatch between demand and available resources	29	1	0	1.07

(*continued*)

Table 4. Evaluating content validity of each risk factor of the questionnaire by Lavshh formula

No.	Group	Factors	Approval opinion	Opposite opinion	Without any opinion	Content validity rate
35	Management	Previous employer-related experience and background	30	0	0	1.14
36		Site unavailability and delay in delivery of land to the presenter	30	0	0	1.14
37		Unauthorized allocation of funds at various stages	29	1	0	1.07
38		Lack of realistic goals	29	1	0	1.07
39		Poor coordination and management	29	1	0	1.07
40		Lack of using appropriate methods in workshop management	27	2	1	0.93
41	Project communication	Lack of proper organizational coordination	27	3	0	0.93
42		Project staff crisis in different units	30	0	0	1.14
43		Assign responsibility of units to a third party	30	0	0	1.14
44	Design	Lack of qualified consultant	27	1	2	0.93
45		Incomplete plan	30	0	0	1.14
46		Poor technical specifications	30	0	0	1.14
47		Mismatch of layout with site location	29	0	1	1.07
48		Inaccuracies in realistic calculations and estimates	27	3	0	0.93
49		Non-compliance with design codes	30	0	0	1.14
50		Lack of maintenance period in designing process	30	0	0	1.14
51	Construction	Lack of a specific contract with contractors	30	0	0	1.14
52		Contractor's claim	30	0	0	1.14
53		Lack of coordination between the design process and manufacturing technology	30	0	0	1.14
54		Claims	27	3	0	0.93
55		Lack of timely completion of geotechnical studies and identification of underground factors	29	1	0	1.07
56		Delays in construction	29	1	0	1.07
57		Poor quality of workshop supervision	28	2	0	1
58		Incomplete description of tasks in contracts	26	1	3	0.86
59	Timetable	Failure to complete work items in anticipated times	28	0	2	1
60		Mismatching physical progress with the comprehensive project schedule	30	0	0	1.14
61		Delay in project duration because of lack of parallel work	28	1	1	1
62		Delay in completion of the project	27	3	1	0.93
63	Exploitation	Increase in exploitation costs	28	2	0	1
64		Increase in maintenance cost	27	1	2	0.93
65		Inappropriate pricing of saleable spaces	28	2	0	1
66		Lack of proper internal zoning of spaces in the business left	30	0	0	1.14

(*continued*)

Table 4.

No.	Group	Factors	Approval opinion	Opposite opinion	Without any opinion	Content validity rate
67		Luxury businesses in the vicinity of ordinary businesses	29	1	0	1.07
68		Poor wide advertising	29	1	0	1.07
69		Ignorance of security and safety protocol	28	2	0	1
70		Lack of crisis management in CRCBPs	29	1	0	1.07
71		Lack of specific instructions in case of unexpected events	29	1	0	1.07
72		Lack of maintenance team stationed in the CRCBPs	28	2	0	1
73	Environmental	Adjacent building condition	28	2	0	1
74		Historical conditions	29	1	0	1.07
75		Traffic permits	28	2	0	1
76		Privacy of monuments in the area	28	1	1	1
77		Workshop security in terms of side access	29	1	0	1.07
78	Logistics	Timely supply of materials	30	0	0	1.14
79		Supply of materials according to technical specifications	27	3	0	0.93
80		Predicting spare parts for emergency repairs and installations	28	1	1	1
81		Lack of instructions for ordering goods and services	26	4	0	0.86
82		Lack of instructions for ordering items in project warehouse	23	6	1	0.64

Table 4.

following step, the new questionnaire was sent back to the experts with 82 items (Table 4).

At this stage, all the experts concluded that the 82 items could be identified as risks in the CRCBPs. Content validity was estimated as equal to 0.99 at this stage. Because the obtained CVR was higher than the minimum value, it can be concluded that the items and questionnaire reached a high content validity. Table 3 shows the validity of each item of the questionnaire using the Lavshh formula.

3.4 Evaluation of consensus scale

Kendall's coefficient of agreement was used to investigate the coefficient of agreement with the Delphi method. Kendall's coefficient of agreement is a measure of coherence and agreement between several categories related to the N objects or individuals. In fact, by using this scale, one can find the rank correlation between the K sets. Such a measure is particularly useful in investigating the validity of judgments; indeed, Kendall's coefficient of agreement indicates that people who have prioritized categories according to their importance have essentially applied the same criteria to judge the importance of each category, and thus agree with one another in that regard. This scale is calculated using the following formula:

$$W = \frac{\mathrm{S}}{\frac{1}{12}\ \mathrm{k}^2(\mathrm{N}^3 - \mathrm{N})} \tag{2}$$

where:

$S = \Sigma\left[Rj - \left(\frac{\Sigma R_j}{N}\right)\right]^2$;

R_j = rank set for a given factor;
K = number of rank sets; and
N = number of ranked factors.

The scale ranges from zero to one, indicating the degree of consensus reached by the Delphi panel (very strong consensus: $W < 0.9$, strong consensus: $W = 0.7$, moderate consensus: $W = 0.5$, poor consensus: $W = 0.3$ and very poor consensus: $W = 0.1$). It is worth noting that the W coefficient is not significant enough to stop the Delphi process. For panels consisting of more than 10 members, even very small values of W are considered significant. Kendall's coefficient in the present study was calculated equal to 0.91, which indicates a very strong consensus and favorable agreement among the respondents.

3.5 Qualitative evaluation of risks

To prioritize the risks in a qualitative way, the severity of the impact of each risk has been taken into account – which is calculated by multiplying the probability of occurrence of each risk by its impact on the project objectives. For this purpose, a Primary Risk Index (*PRI*) is defined based on the criteria for the probability of occurrence of the risk and the extent to which the risk affects the objectives of the "Hamedanian Memorial" project. These objectives include the time, cost and quality of the project.

$$PRI = \sum (P \times I_t) + (P \times I_c) + \left(P \times I_q\right) \quad (3)$$

In which P is the probability of occurrence of risk and I_t, I_c and I_p is the intensity of impact of the risk on the project time, cost and quality, respectively.

These indices were analyzed separately based on the opinions of each expert, and later, the PRI_1 to PRI_{30} indices are determined for each of the 82 identified risks. The indices are calculated using the arithmetic mean method and the cumulative risk index for each of the risks using the following relationship:

$$\mathrm{A}PRI = \frac{\sum_{\mathrm{i}=1}^{30} (PRI_{\mathrm{i}})}{\mathrm{N}} \quad (4)$$

where:

$APRI$ = cumulative risk index for each of the 82 identified risks;
PRI_{i} = primary index risk for each individual; and
N = total number of experts who participated in this research.

It is then possible to rank the risks using this index. It is evident that a simple and primitive definition of risk, i.e. the probability of occurrence multiplied by the risk impact, is included in the *PRI* index and, thus, in the *APRI* index. However, the scope of impact is expanded to cost, time and quality criteria with equal weight.

4. Discussion of survey results

4.1 Risk identification

The purpose of risk identification is to identify and record the details of the largest number of uncertain events before they occur. This facilitates proper management of risks at the time of their occurrence. However, it is not always possible to identify all risks for reasons such as lack of knowledge, emerging risks, future risks, hidden risks, and so on. In the present study, the Delphi method was used to reach consensus among respondents regarding the proposed risk items of CBCRPs through the RBS. Finally, with the consensus of the experts, the 82 risks were identified and recorded.

Kendall's coefficient of agreement was used to evaluate the experts' agreement in the Delphi method. Kendall's coefficient of agreement indicates that experts who have prioritized categories according to their importance, have essentially used the same criteria to judge the importance of each category, and thus agree with each other. Based on the calculations, Kendall's coefficient of agreement was determined as equal to 0.91, implying a very strong consensus among experts who participated in the risk identification process.

4.2 Results of evaluation and qualitative prioritization of risks

As stated in the literature review (Liu and Yang, 2006; Siu *et al.*, 2018), risk is a non-deterministic phenomenon that may affect the project objectives upon its occurrence. This can be interpreted in two ways: the first is the influence on the objectives of the project and the second is the uncertainty and probability of the event. The magnitude and significance of each risk depends entirely on the two factors mentioned, and these two factors must be fully evaluated to obtain a clear understanding of the impact of each risk. Therefore, qualitative evaluation was based on both probability of occurrence and impact of each risk.

Comprehensive qualitative prioritization methods based on the source of risk were performed using the RBS (Al-Bahar and Crandall, 1990). By determining the probability of occurrence of each risk and its impact on the project objectives, it is possible to calculate the *PI* score. After calculating the *PI*, the score of each area of RBS is calculated in terms of the sum of *PI* scores. To achieve the desired outcome, after determining the probability of occurrence of each risk and its impact on the project time, cost and quality, the *PRI* was calculated according to the explained equation (3) already described. It is worth noting that the index was calculated on a case-by-case basis according to each expert's opinion.

Then, PRI_1 to PRI_{30} were determined for each of the 82 risks, and the cumulative risk index for each of the risks was calculated by:

Table 5. Expert opinions on probability and impact of risks

	Expert opinions			
Risk	Probability of occurrence (P)	Impact on project time (I_t)	Impact on project cost (I_C)	Impact on project quality (I_q)

Table 6. Calculation of Primary Risk Index based on the probability and impact of risks

Probability and Impact			
RiskProbability + impact on project time (PI_t)	Probability + impact on project cost (PI_c)	Probability + impact on project quality (PIq)	primary risk index (PRI)

No.	Chapter	Group	Risks	∑*PRI*	Sample size	*APRI*	Risk ranking
1	Internal	Social	General dissatisfaction with the project's location	6.3	28	0.225	67
2			Sabotage	8.26	28	0.295	58
3			Cultural difference between people	3.48	28	0.124	81
4			Regional and ethnic limitation	4.18	28	0.149	79
5		Economic	Exchange rate fluctuation	46.36	28	1.655	1
6			Inflation fluctuation	25.23	28	1.615	2
7			Bank interest fluctuation	14.44	28	0.872	6
8			Change in duties of imported equipment	18.92	28	0.675	18
9			Law changes and economic policies of materials	17.76	28	0.634	21
10		Political	Government internal policies contradiction	13.67	28	0.488	35
11			Foreign threats	24.49	28	0.874	5
12			Inappropriate work relation of government organizations	11.68	28	0.417	46
13			Government instability	10.20	28	0.346	50
14		Legal	Changes in law	12.38	28	0.442	43
15			Changes in binding legal obligations in contracts	8.28	28	0.295	57
16			Regional standard changes (firefighting-master plans, etc.)	19.58	28	0.699	14
17		Accidents	Natural disasters (flood – earthquake, etc.)	13.50	28	0.482	36
18			Sewage and water network unexpected accidents	2.28	28	0.0814	82
19			Annual change in weather	7.860	28	0.280	59
20			Electrical distribution network unexpected accident	3.80	28	0.135	80
21		Market	Mismatching spaces with customer needs	6.74	28	0.240	65
22			Public lack of interest	6.57	28	0.234	66
23			Increased work competition around project area	7.42	28	0.265	62
24			Changes in demand for the purchase of spaces with different uses	4.52	28	0.161	77
25			Facilitate sales and marketing conditions for specific user spaces	4.56	28	0.162	76
26		Work force	Access to skilled worker	25.02	28	0.893	3
27			Salary	19.54	28	0.697	15
28			Behavior, standards, work commitment	14.01	28	0.500	33
29			Mismatch job referrals to personnel with related specialized skills	20.72	28	0.74	11
30		Investment	Unrealistic primary estimation	22.66	28	0.809	9
31			Inappropriate finance	18.21	28	0.647	20
32			Lack of on time finance	18.72	28	0.668	19
33			Bankruptcy	17.360	28	0.62	22
34			Mismatch between demand and available resources	19.440	28	0.694	16

(*continued*)

Table 7.
Primary Risk Index and Cumulative Risk Index Results of qualitative risk evaluation

No.	Chapter	Group	Risks	∑*PRI*	Sample size	*APRI*	Risk ranking
35	External	Management	Previous employer-related experience and background	20.72	28	0.694	16
36			Site unavailability and delay in delivery of land to the presenter	13.72	28	0.49	34
37			Unauthorized allocation of funds at various stages	11.04	28	0.39	47
38			Lack of realistic goals	7.47	28	0.266	61
39			Poor coordination and management	14.10	28	0.503	32
40			Lack of using appropriate methods in workshop management	19.08	28	0.681	17
41		Project communication	Lack of proper organizational coordination	12.62	28	0.450	40
42			Project staff crisis in different units	10.22	28	0.365	49
43			Assign responsibility of units to a third party	8.32	28	0.297	55
44		Design	Lack of qualified consultant	23.44	28	0.837	7
45			Incomplete plan	17.22	28	0.611	23
46			Poor technical specifications	17.04	28	0.608	24
47			Mismatch of layout with site location	12.62	28	0.455	39
48			Inaccuracies in realistic calculations and estimates	14.90	28	0.532	30
49			Non-compliance with design codes	7.84	28	0.28	60
50			Lack of maintenance period in designing process	8.64	28	0.308	53
51		Construction	Lack of a specific contract with contractors	15.14	28	0.540	29
52			Contractor's claim	24.98	28	0.892	4
53			Lack of coordination between the design process and manufacturing technology	13.44	28	0.48	37
54			Claims	12.50	28	0.446	42
55			Lack of timely completion of geotechnical studies and identification underground factors	11.02	28	0.393	48
56			Delays in construction	20.26	28	0.723	13
57			Poor quality of workshop supervision	16.36	28	0.58	26
58			Incomplete description of tasks in contracts	9.10	28	0.325	52
59		Timetable	Failure to complete work items in anticipated times	16.90	28	0.603	25
60			Mismatching physical progress with the comprehensive project schedule	13.14	28	0.469	38
61			Delay in project duration because of lack of parallel work	13.54	28	0.447	41
62			Delay in completion of the project	16.24	28	0.58	27
63		Exploitation	Increase in exploitation costs	4.58	28	0.163	75
64			Increase in maintenance cost	5.42	28	0.193	71
65			Inappropriate pricing of saleable spaces	5.34	28	0.190	72
66			Lack of proper internal zoning of spaces in the business center	5.610	28	0.200	70

(*continued*)

Table 7.

No.	Chapter	Group	Risks	$\sum PRI$	Sample size	*APRI*	Risk ranking
67			Luxury businesses in the vicinity of ordinary businesses	4.58	28	0.163	75
68			Poor wide advertising	4.24	28	0.151	78
69			Ignorance of security and safety protocol	5.24	28	0.187	73
70			Lack of crisis management in CRCBPs	5.98	28	0.213	68
71			Lack of specific instructions in case of unexpected events	7.0	28	0.253	63
72			Lack of maintenance team stationed in the CRCBs	7.02	28	0.250	64
73		Environmental	Adjacent building condition	21.84	28	0.78	10
74			Historical conditions	8.52	28	0.304	54
75			Traffic permits	22.82	28	0.815	8
76			Privacy of monuments in the area	5.80	28	0.207	69
77			Workshop security in terms of side access	12.80	28	0.431	45
78		Logistics	Timely supply of materials	15.36	28	0.548	28
79			Supply of materials according to technical specifications	12.34	28	0.440	44
80			Predicting spare parts for emergency repairs and installations	8.32	28	0.297	56
81			Lack of instructions for ordering goods and services	9.47	28	0.338	51
82			Lack of instructions for ordering items in project warehouse	14.20	28	0.507	31

Table 7.

$$PRI = \sum (P \times I_t) + (P \times I_c) + \left(P \times I_q\right)$$

$$APRI = \frac{\sum_{\mathrm{i}=1}^{30} (PRI_{\mathrm{i}})}{\mathrm{N}} \tag{5}$$

Expert opinions were obtained in accordance with Table 5.

According to Table 6, the *PRI* value was calculated for each risk. By calculating the *PRI* of all risks and based on the experts' opinions, the *APRI* value was calculated and prioritization was carried out.

Table 7 summarizes the results of *PRI* and *APRI* risks and the rank grade of each risk. As is evident, by performing the qualitative assessment and taking into account the timing condition of data collection, currency rate fluctuations and inflation rate fluctuations from the economic risks group were ranked first and second, respectively. According to the experts' opinions, availability of skilled workers from the work force group ranked third, construction contractor claims from the construction risks group ranked fourth, and foreign threats because of international relations from the political risks group ranked fifth. Finally, accidents because of unpredicted factors in the water and wastewater network from the accidents risks group was the least important risk.

5. Conclusions and implications

This study aimed to identify and prioritize risks in CRCBPs. The statistical population of the study consisted of 30 experts from all groups involved in the "Hamedanian memorial" project (consultants, employers and contractors), who were selected carefully to very accurately represent all of the participants to the project. The initial identification of risks was carried out by surveying the previous research with scrutiny. In the next step, for the purpose of identification and qualitative prioritization of risks in CRCBPs, a semi-structured questionnaire was prepared to collect experts' opinions. By reviewing and summarizing past research and doing further research using library studies, the RBS was formulated in three levels. By using the Delphi technique as an effective and useful method of identifying risks, the proposed risks in one CRCBP were reviewed by experts. Finally, the degree of agreement of the experts' opinions was evaluated using Kendall's coefficient of agreement, and based on the analysis, 82 risks were identified. These were then categorized into internal and external risks in 16 groups: social, economic, political, legal, accidents, market, workforce, investment, management, project communication, design, construction, timetable, exploitation, environmental and logistics. The risks were prioritized based on their probability of occurrence and impact on the project's objectives. Finally, the score of each RBS area was calculated based on the sum of *PRI* scores, and the prioritization of risks was done based on the cumulative primary risk index *APRI*.

The qualitative prioritization results showed that the top 10 risks in CRCBPs are currency exchange rate fluctuations, inflation rate fluctuations, access to skilled labor, contractor claims, foreign threats from international relations, bank interest rate fluctuations, lack of qualified consultants, traffic permits, unrealistic primary estimation and the condition of adjacent buildings. Among these ten risks, some are external and some other internal to the CRCBP, but all of them can significantly influence its development according to the setting (e.g. being implemented in a developed or developing country). Some external risks, i.e. currency exchange rate fluctuations, inflation rate fluctuations, foreign threats from international relations and bank interest rate fluctuations, cannot be managed by those responsible for CRCBPs, and also they can have a great impact (especially) on the life cycle phase of a project's conceptual planning and feasibility study. Indeed, if these economic and financial risks have a manifestation in the early phases of the project, CRCBP decision-makers can decide to abandon it with the hope of not having already invested too much. Alternatively, decision-makers can try avoiding these risks by reverting to an insurance against CRCBPs' economic and financial risks. This insurance would be even more acceptable financially if those responsible for the CRCBP had also already invested in other projects. The increase in a project's volume allows those in authority to control investments with different degrees of risk manifestation and, in practice, reduce the risk of overall failure. The insurance protection, however, cannot work for the risks with traffic permits and the condition of adjacent buildings – which are always outside the control of the projects' management team. These risks, if verified, can respectively delay the CRCBP (or undermine its fruition) and decrease the value of the CRCBP. In these cases, CRCBP decision-makers can choose between continuing the project while trying to maintain the economic and financial equilibrium or liquidating it if these risks heavily affect the possibility of reaching the planned return on investments. Finally, the risks of lack of access to skilled labor, lack of qualified consultants and unrealistic primary estimation can have as great an impact as the previous ones – by delaying the execution of the CRCBP as well as undermining its management and coordination. However, at the same time, because they are related to processes activated by CRCBP management, they can be directly controlled. Indeed, the lack of access to resources or qualified consultants can be usually solved by relying on human resource agencies, headhunters or other qualified players that are able to identify suitable employees or consultants for the CRCBP. The same solution applies for the unrealistic primary estimation, which can compromise the feasibility study of the CRCBP; indeed, using skilled labor and qualified consultants should minimize forecasting mistakes by the management team.

The findings of this study are consistent with previous research. Indeed, the results presented are similar to the ones of Zavadskas *et al.* (2010), who found that risk indicators in construction projects are mainly related to the domestic and international changes, a country's economic efficiency, workforce, construction characteristics, and consultative and contractual services, as the top priorities in dealing with project risks. In another study, Chen and Khumpaisal (2009) used the ANP method to prioritize a group of risk assessment criteria against social, economic, environmental and technological requirements directly related to commercial real estate development. The results of their research are consistent with the present study.

The results of the research are useful for the beneficiaries of the project by giving special attention to risks with the highest contribution to the performance of the project during its life cycle to ensure that the main objectives of the project are met. In this regard, among the risks identified in this study, the risk of exchange rate fluctuations has a significant impact on all project objectives; therefore, implementing projects in countries and/or periods where the exchange rate is stable facilitates the achievement of project objectives. However, it is also true that project risks vary from time to time depending on the project progress (Jaafari, 2001; Perroni *et al.*, 2015), and this is even more true for financial risks, such as the instability of exchange rate, that can suddenly vary because of unforeseen phenomena (Froot, 2008) – especially external ones. From that, by considering the project life cycle of a facility (Jordani, 2010; Eadie *et al.*, 2013; Wetzel and Thabet, 2015), the influence of identified groups of risks cannot be exclusively studied in some phases of the CRCBP. Indeed, if looking at, for example, the 'Management' category of risks, the individual risks that compose it can be important for different or for multiple phases of the CRCBP's life cycle. This is the case of the 'Site unavailability and delay in delivery of land to the presenter', that surely appears more within the first phases of the CRCBP rather than in the concluding ones, or the case of the 'Poor coordination and management', which is an important risk in all CRCBP phases (e.g. design and engineering, and procurement and construction). From the foregoing, practitioners should: mitigate single risks that are more likely (but not exclusively) to occur in each phase of the CRCBP's life cycle, control the evolution of risks and effects on project performance, even if the project passed the phase in which they were expected to have a manifestation, by using, for example, the real options method or a scenario-based approach (Chen *et al.*, 2009; Bañuls *et al.*, 2017). In sum, external and internal conditions of a CRCBP may vary and risks that were thought as not very likely to occur can suddenly appear; because of that, practitioners should maintain a high level of attention on risks and changes in the internal and external environment and be prepared for their manifestation (Cristofaro, 2017).

The main limitation of this study lies in the small sample of experts interviewed, even though they can surely be considered as suitable, in line with the aim of the study. Future studies should enhance the validity of the proposed results, either through increasing number of experts to be interviewed and through the replication of the presented study in other developing countries. In addition, it would be interesting to compare the results emerging from developing countries with those of developed ones to identify similarities and differences. Moreover, the socio-demographic characteristics of experts who determined and assessed risks of CRCBPs may have a role in directing their own attention to the identification of particular risks rather than others and in assigning a greater importance to them. In this regard, it would be interesting to investigate, in a quantitative manner and building on the Upper Echelons Theory literature (Abatecola and Cristofaro, 2015, 2020), whether socio-demographic characteristics and/or other psychological variables are significant in the definition and evaluation of CRCBP risks at the individual and group level.

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