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Risk identification and assessment in sustainable construction projects in the UAE

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ABSTRACT

There is a big shift towards sustainable construction projects in the United Arab Emirates (UAE). Sustainable construction projects are riskier than traditional projects. The purpose of this paper is to identify and assess the risks in sustainable construction projects in the UAE. This will help project participants to properly manage these risks in their projects. A list of thirty risks was identified based on literature review. These risks were grouped into five categories: management, technical, green team, green materials and regulatory/economic. A survey was then developed and sent to professionals from the UAE. The respondents evaluated each risk in terms of its probability of occurrence and potential impact. Forty-four responses were collected. The thirty risks were ranked based on the risk severity (probability multiplied by impact). The top five risks are shortage of clients' funding, insufficient or incorrect sustainable design information, design changes, unreasonably tight schedule for sustainable construction and poor scope definition in sustainable construction. Risk identification and assessment are important part of project risk management. This allows for appropriate risk response planning and control.

KEYWORDS

Risk assessment; sustainable construction; UAE; project risk management

Introduction

Risk plays a significant role in the construction industry that is known of being borne to risks. Risks have negative impact on achieving project objectives. Risks may cause schedule delays, cost overruns and safety and quality problems. Risk management is defined as a formal and orderly process of systematically identifying, analyzing and responding to risks throughout the lifecycle of a project (Wang et al. 2004). There are several studies on risk management in various countries. El-Sayegh (2008) found that the most significant risk, in the UAE, is inflation and sudden changes in prices. Delay is a major risk in UAE's construction industry (Faridi and El-Sayegh 2006). Shen (1997) identified the top three risks in Hong Kong as insufficient or incorrect design information, variations in ground and weather conditions and subcontractors' labor shortage. Similarly, a study by Zou et al. (2007), conducted in China, identified the most significant risks to include variations by the client, price inflation of construction materials, project funding problems and tight project schedule. Perera et al. (2014) stressed on the necessity of handling risk factors as a prerequisite for project success.

Sustainability is the process of achieving our everyday needs while still preserving the fundamental resources of the Earth for future generations (Kates et al. 2001). Sustainable construction refers to the design, construction and operation of green building projects in which achieving sustainability is also one of the goals of the project (Kibert 2016). In the process of achieving these goals, projects must go through newly developed technologies and methods, since this is a relatively new branch of the construction industry (Hwang et al. 2017b). The construction industry has massive impacts on the society, environmentally, economically and socially (Zuo et al. 2012). Recently, sustainability has been a hot topic since the awareness of environmental issues has surfaced, waste being one of them. It is true that individuals produce solid waste each day in households, however, the construction industry is the biggest producer of waste. With the growing construction industry in the UAE, the country has become one of the largest producers of waste with 75% of its waste emerging from construction (Al-Hajj and Hamani 2011). Gulf Cooperation Council (GCC) countries have had the highest rates of carbon dioxide emission per capita (Al-Saleh and Taleb 2010).

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Sustainable construction projects are being encouraged recently throughout the world. The increase in traditional building material costs and energy prices are also other factors that lead people to think of sustainable construction, especially with the regulatory incentives by the governments (Robichaud and Anantatmula 2011). The UAE construction industry has experienced a boom over the past years, this boom started around 1996 and reached its peak in 2007, right before the major financial crisis in 2008 (El-Sayegh and Mansour 2015). The urge to shift to sustainability in our everyday life is being encouraged by environment activists on a small scale, and more recently, it is being enforced by government because this shift to sustainability will soon become a necessity. One example of this is the Estidama initiative in Abu Dhabi which has been launched by the Abu Dhabi Urban Planning Council. This initiative aims to create more sustainable societies by introducing their own Pearl Rating System, which rates construction projects according to how many credits they earned, and each of these credits represents satisfying a sustainable goal. They specified a minimum number of mandatory credits to be satisfied by all projects, and with that they are enforcing the shift towards sustainable construction (Estidama 2010). Likewise, in Dubai the municipality is also enforcing the concept of sustainable construction through introducing the green building initiative, where the regulation was drafted to fit the UAE's nature. This initiative has been in effect and enforced on all new buildings in Dubai since 2014 (Dubai Municipality 2017). Moreover, a study found that there's a growing interest and awareness about the green building initiative and the idea of shifting towards sustainability (Salama and Hana 2010).

However, green construction still faces some barriers due to the increased risks they hold. These risks include but are not limited to; the inability to deliver the project within acceptable cost constraints and inefficient green project management (Robichaud and Anantatmula 2011). Green risk assessment has been established to acquire information about the uncertainty of different factors contributing to the goal of sustainable development of human beings. The goal is reducing the environment pollution, reducing the consumption of resources and reducing the consumption of energy (Xie et al. 2010). A recent study done in Singapore on green buildings shows that some risks remain the same in both traditional and sustainable projects such as inflation. However, there were some additional risks that are credited only to sustainable projects such as shortage of green materials and durability of materials. Results also showed that some risks are more critical than traditional projects such like design changes and poor construction quality (Hwang et al. 2017a). Now that the number of construction projects in the UAE is multiplying, and the introduced enforcement of sustainability in construction projects, it is necessary to identify the risks that are exclusive to sustainable construction projects in the UAE. This area of study has not been explored yet, or implemented in the UAE, and with the expected expansion in the field of sustainable construction, the assessment of risks affiliated with these specific projects will become a vital research area.

The construction industry is affiliated with various risks that may cause delays and/or cost overruns. Sustainability has become an essential element in the UAE construction projects. However, even with the advancement in sustainable construction, very minimal information is available regarding risks in sustainable construction projects in the UAE. The research described in this paper aims at identifying and assessing risk in sustainable construction projects. The first objective is to identify risks in sustainable construction projects. The second objective is assessing the identified risks based on their risk severity (impact and probability).

Research methodology

The first step was to identify the risks in sustainable construction projects through literature review. This included journals, articles and books that discuss risks in general and risks related to sustainable construction projects in particular. Initially, 67 risks were identified and then shortlisted to thirty based on the highest citations. Some of the green risks have fewer citations since there are limited number of papers that talk about these risks. Thirty risks were identified and used in the survey. The first part of the survey included general questions about the participants, such as their position of work and years of experience. The second part of the survey included two questions for each of the identified risks. The first question is related to the probability of occurrence. A Likert scale was used with numbers from one to five: one being very low probability and five being very high probability. The second question relates to the impact that the risks have on construction projects. A Likert scale was also used with numbers ranging from one to five: one indicates very low impact and five indicates very high impact

Table 1. Respondents' profile.

		Respondents	
Category		Number	%
Years of experience	>20 years	12	27.2
	10–20 years	16	36.4
	<10 years	16	36.4
Role	Owner	5	11.4
	Designer	20	45.5
	Contractor	13	29.5
	Construction manager	6	13.6
Average project size[a]	<50 (million AED)	3	06.8
	50–100 (million AED)	10	22.7
	100–500 (million AED)	16	36.4
	>500 (million AED)	15	34.1

[a]US$= 3.67 AED (2018 currency).

The surveys were sent to construction professionals in the UAE with experience in sustainable construction projects. The survey was sent either by e-mail or by personal interviews were conducted. The surveys were sent to 200 construction professionals with experience in sustainable construction projects. The professionals were selected based on available contact information and site visits to ongoing construction projects. Forty-four surveys were collected and used in the analysis. This corresponds to a response rate of 22%. The expected low response rate is due to the detailed and specialized nature of the survey. Most of the responses were collected through face-to-face interviews. The Relative Importance Index (RII), for each risk, was calculated using Equation (1). The RII is used to categorize the risks. Risks would have either a low, moderate or high level of importance (El-Sayegh 2008). The risks were then ranked based on the calculated RII. This was done for the probability, impact and severity. Risk severity is calculated by multiplying the probability and impact for each of the identified risks.

$$\text{Relative Importance Index, } RII = \frac{\sum_{i=1}^{5} WiXi}{\sum_{i=1}^{5} Xi} \quad (1)$$

where

Wi = weight assigned to i^{th} response; $Wi = 1, 2, 3, 4$ and 5 for $i = 1,2,3, 4$ and 5, respectively.

Xi = frequency of the i^{th} response.

i = response category index =1, 2, 3, 4 and 5 for very low, low, moderate, high and very high respectively.

Table 1 shows the respondents' profile. Forty-four responses were collected from various types of construction parties. The team collected responses from owners, consultants, project managers and contractors who have experience in sustainable construction projects.

Risk identification

Several risks affect the success of construction projects. These risks were identified through extensive literature review. Some risks are unique to sustainable construction projects while others are applicable to both sustainable and traditional construction projects. Figure 1 shows the Risk Breakdown Structure (RBS) for sustainable construction projects. These risks are divided into five categories: management, technical, green team (stakeholders), green materials and technology and regulatory and economic.

Management risks

Management risks include those that would occur when managing the construction project. Tight schedule is a risk as owners sometimes enforce tight schedules that are unreasonable and impractical to achieve (El-Sayegh 2008). This risk might be more significant in sustainable construction projects since green construction requires more time than traditional ones (Hwang and Ng 2013). Project feasibility and planning has to be carefully organized by several educated employees. In the case when it is planned improperly, it would create a risk (Hwang et al. 2017b). Sustainable projects require careful attention to its feasibility since it is harder to deal with sustainable elements (Robichaud and Anantatmula 2011).

When clients have funding issues, this creates a risk for the contractor. Clients should have a clear plan regarding their funds, schedule and cost and control them accordingly; otherwise, it would result in shortage of clients funding (Zou et al. 2007). Another risk is difficulty in project budgeting which results from the contractor struggle to budget the project due to inexperience in green projects. Not all project managers have experience in sustainable construction and they often lack skills in implementing it. Even if they have a theoretical understanding of sustainability, lack of experience implementing it would create a major risk (Abidin 2010). Another management risk is the additional cost due to the green material and equipment used and this would lead to cost overruns (Hwang et al. 2017a). Finally, sustainable construction requires a high performance standard and would require a high quality of construction, therefore, the poor quality of sustainable construction is a risk.

Technical risks

Technical risks might occur during construction such as design changes, insufficient or incorrect sustainable design information, delay caused by frequent meetings

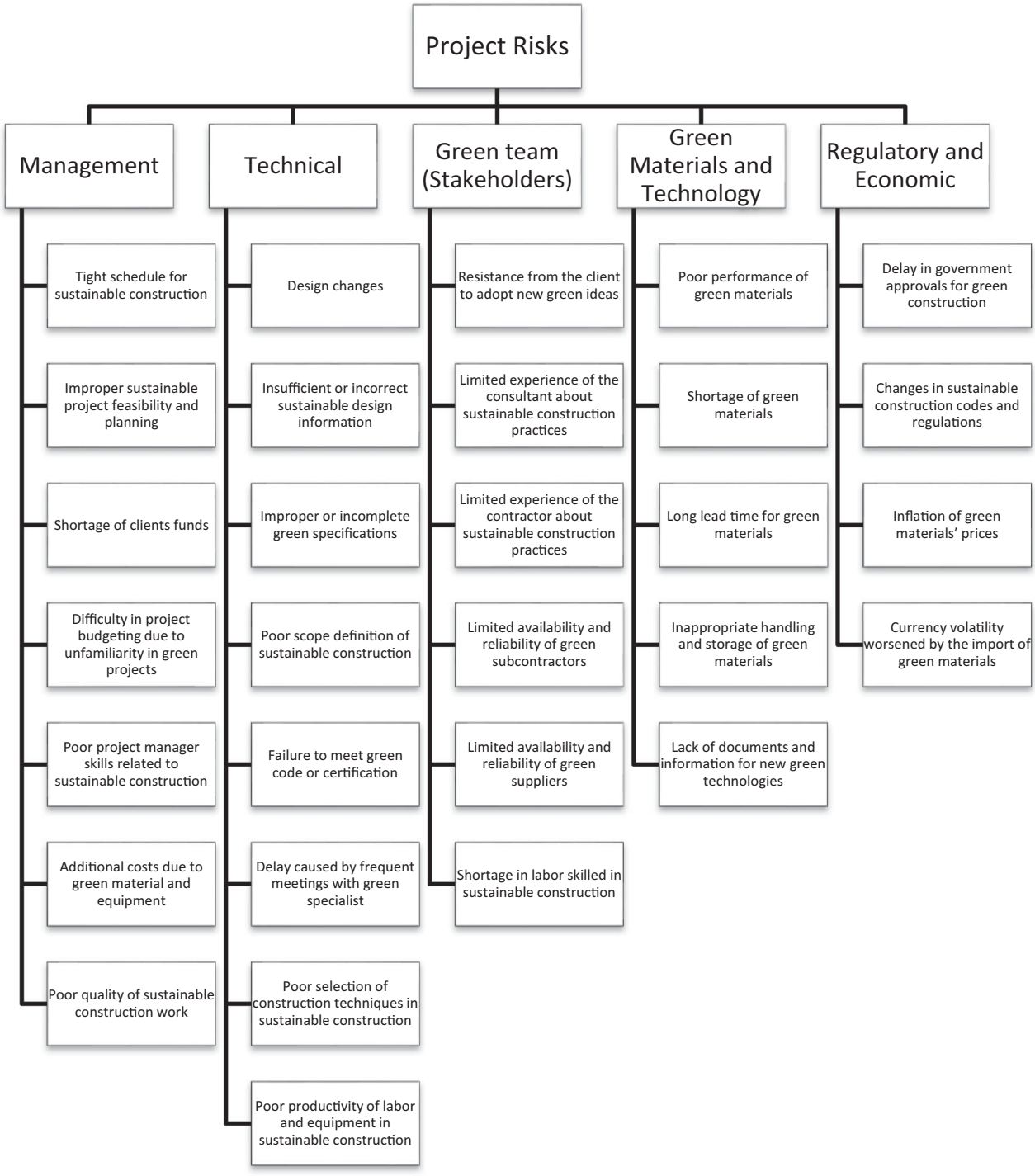

Figure 1. Risk breakdown structure (RBS) for sustainable construction projects.

with green specialist and a few others. Design changes can result from the owner changing his/her mind during construction. Insufficient or incorrect sustainable design information is another risk that might result from the designer being unaware about sustainable design and therefore creating complications in the design documents. The lack of research in green materials would result in the risk of improper or incomplete green specifications (Al-Hajj and Hamani 2011). The risk of poor scope definition might arise when the scope is not well defined. (El-Sayegh 2008). Failure to meet green code or certification is a result of construction companies trying to be sustainable but end up not satisfying the green code set by the government or municipality (Zurich 2017). Delay caused by frequent meeting with green specialist is

Table 2. Overall risk significance.

		Probability		Impact		Severity	
Factor	Description	RII	Rank	RII	Rank	Value	Rank
1	Unreasonably tight schedule for sustainable construction	3.75	2	3.52	24	14.41	4
2	Improper sustainable project feasibility and planning	3.25	23	3.41	27	12.05	23
3	Shortage of clients' funding	3.55	9	3.93	3	14.91	1
4	Inaccuracy in project budgeting due to unfamiliarity in green projects	3.57	6	3.7	16	14.18	8
5	Poor project manager skills related to sustainable construction	3.41	14	3.98	2	13.43	14
6	Additional costs due to green material and equipment	3.84	1	3.61	20	14.39	6
7	Poor quality of sustainable construction work	3.36	19	3.86	8	12.98	17
8	Design changes	3.64	3	3.93	4	14.43	3
9	Insufficient or incorrect sustainable design information	3.61	4	3.64	18	14.59	2
10	Improper or incomplete green specifications	3.57	7	3.61	21	14.3	7
11	Poor scope definition of sustainable construction	3.59	5	3.77	13	14.41	5
12	Failure to meet green code or certification	3.27	22	3.25	30	12.48	20
13	Delay caused by frequent meetings with green specialist	3.41	15	3.36	28	12.25	22
14	Poor selection of construction techniques in sustainable construction	3.39	18	3.77	12	13.09	15
15	Poor productivity of labor and equipment in sustainable construction	3.43	13	3.75	14	13.55	13
16	Resistance from the client to adopt new green ideas	3.18	24	3.7	17	11.14	25
17	Limited experience of the consultant about sustainable construction practices	3.45	11	3.86	6	13.59	11
18	Limited experience of the contractor about sustainable construction practices	3.45	12	3.59	22	14.11	9
19	Limited availability and reliability of green subcontractors	3.52	10	3.8	10	13.09	16
20	Limited availability and reliability of green suppliers	3.57	8	4.16	1	13.7	10
21	Shortage in labor skilled in sustainable construction	3.41	16	3.57	23	12.93	18
22	Poor performance of green materials	2.77	30	3.43	26	10.27	30
23	Shortage of green materials	3	28	3.52	25	10.77	28
24	Long lead time for green materials	3.36	20	3.86	7	12.36	21
25	Inappropriate handling and storage of green materials	3	29	3.64	19	11.39	24
26	Lack of documents and information for new green technologies	3.02	27	3.8	11	11.02	27
27	Delay in government approvals for green construction	3.41	17	3.84	9	13.57	12
28	Changes in sustainable construction codes and regulations	3.07	25	3.73	15	11.09	26
29	Inflation of green materials' prices	3.32	21	3.27	29	12.7	19
30	Currency volatility worsened by the import of green materials	3.05	26	3.89	5	10.36	29

the risk that arises from the need to meet with green specialists to make sure the progress is successful. Another risk that might arise from inexperience of contractors is poor selection of construction techniques. The final technical risk is the poor productivity of labor and equipment in sustainable construction.

Green team (stakeholders) risks

The third category is the stakeholders or green team. The risks included in this category are only ones that affect sustainable construction and have no effect in traditional construction projects. Risks like resistance from client to adopt new green ideas and limited experience of consultants and contractors fall under this category. Resistance to adopt green ideas is a risk since clients tend to stick to what they know and tend to stick to more traditional and common projects (Hwang et al. 2017a). Limited experience of consultants and contractors may lead to the failure of sustainable projects. Additionally, lack of experience can result in problems while obtaining green certifications, delays and improper material specification (Zurich 2017). Another issue is the limited availability of green subcontractors. Even if a contractor has adopted sustainable practices efficiently, there is an issue with acquiring green subcontractors in the UAE since they are very limited and unreliable. Difficulties associated with the selection of subcontractors who provide green construction is a major challenge (Hwang and Ng 2013). Limited availability of green suppliers is also a risk. Construction companies would have difficulty finding green suppliers in the UAE that are reliable and efficient. There is an immaturity in the green supply market and a lack of trust in the suppliers (Lam et al. 2009). The UAE construction labor force is mainly skilled in traditional construction projects. They have many years' experience doing the same activity; therefore, there is a limited number of workers who can actually achieve the sustainability aspect of the construction process. One of the most critical challenges project managers face is the resistance of laborers to change their traditional practices (Hwang and Ng 2013).

Green materials and technology risks

The fourth category is green materials and technology. The risks that deal with the shortage, handling and quality of the materials lie in this category. Green construction tends to use advanced green materials to improve the sustainability performance, however these materials are not researched extensively and therefore create the risk of poor performance of green materials

Table 3. Ten most severe risks in green construction projects.

ID	Risk	RII	Rank	Category
3	Shortage of clients' funding	14.91	1	Management
9	Insufficient or incorrect sustainable design information	14.59	2	Technical
8	Design changes	14.43	3	Technical
1	Unreasonably tight schedule for sustainable construction	14.41	4	Management
11	Poor scope definition of sustainable construction	14.41	5	Technical
6	Additional costs due to green material and equipment	14.39	6	Management
10	Improper or incomplete green specifications	14.3	7	Technical
4	Inaccuracy in project budgeting due to unfamiliarity in green projects	14.18	8	Management
18	Limited experience of the contractor about sustainable construction practices	14.11	9	Stakeholders
20	Limited availability and reliability of green suppliers	13.7	10	Stakeholders

(Hwang et al. 2017a). Another risk is the shortage of green materials. This shortage might be caused by poor supply management and the development lag of green technologies (Hwang et al. 2017a). Long lead-time affects the attainment of green certification and may delay the related construction activities. Furthermore, the quality of the green materials would be affected by inappropriate handling and storage, producing more risk (Al-Hajj and Hamani 2011). Finally, lack of documentation of new green technologies creates a risk since the contractor would not know the specifications of the material and therefore would not know what should be done to produce the best results (Hwang et al. 2017a).

Regulatory and economic risks

The fifth and last category is regulatory and economic risks. These involve any codes or regulations enforced by the government and any economic crisis that might arise. Delay in government approvals for green construction produces a delay in the project start date (Zayed et al. 2008). Moreover, changes in the sustainable construction codes and regulations are being developed at such a pace that makes it unreasonable for the project to be compatible and coherent with the new codes, this in turn would delay the project (Nutter 2012). Since sustainability is a new topic to the construction industry, some materials required for the success of the sustainable project might not be available in the UAE, therefore there is a need to import those materials and this would lead to volatility of currency that would lead to cost overruns (Hwang et al. 2017a). Finally yet importantly is the risk of inflation of green materials. Inflation refers to the 'increase in the price level of commodities and the decrease of the purchasing power of currencies' which, like currency volatility, would lead to cost overruns (Hwang et al. 2017a). Inflation is a risk in all construction project regardless of what type it is, therefore this would create a major risk in sustainable construction as well.

Risk assessment

The relative importance index (RII) was calculated for each risk based on probability, impact and severity. These factors were then ranked according to their RII values. The results are presented in Table 2.

The top 10 risks, based on severity, are presented in Table 3. These include four management risks, four technical risks and two green team (stakeholder) risks. Shortage of clients' funding is the most severe risk in sustainable construction projects in the UAE with an RII of 14.91. This might be due to poor planning for sustainable construction cost and schedule (Zou et al. 2007). The second risk is insufficient or incorrect sustainable design information (RII =14.59) and the third is design changes (RII =14.43). Both risks would result because of inexperience or lack of knowledge, with sustainable design in the UAE construction projects. Mishmish and El-Sayegh (2018) recommended to increase the time allowed for developing the design to minimize design errors and reduce the inconsistency in design documents. The fourth risk is unreasonably tight schedule for sustainable construction (RII =14.41). The UAE is known for its fast-paced construction industry.

Poor scope definition of sustainable construction is ranked fifth. The sixth risk is additional costs due to green material and equipment (RII =14.39). This risk would arise from the fact that green materials are more expensive compared to non-green materials. Research shows that there is a 10% green premium over traditional construction projects (Robichaud and Anantatmula 2011). Improper or incomplete green specifications, which came up to be number seven with a relative importance index of 14.30, is a risk that might occur from the lack of knowledge in green specifications since they need to be researched extensively in order for the specifications to be clearly defined (Hwang et al. 2017). Inaccuracy in project budgeting due to unfamiliarity in green projects (RII =14.18) is ranked eighth. The last two risks on the top 10 are from the green team (stakeholder)

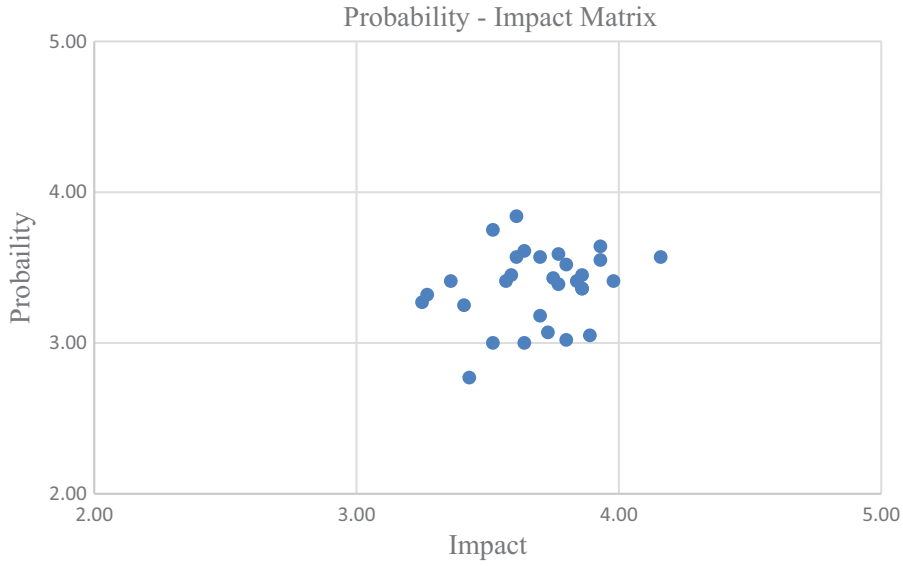

Figure 2. Probability – impact matrix.

category. They are limited experience of the contractor about sustainable construction practices (RII =14.11) and limited availability and reliability of green suppliers (RII =13.7) which are the ninth and tenth risks, respectively. An inexperienced contractor creates a major risk to the success of the project. The inexperience of consultant was on the list and was ranked as the eleventh risk which brings to our attention that limited experience of contractor and consultant are not far off from each other and they have a great effect on the project. The availability and reliability of green suppliers creates a risk and that might be due to the fact that sustainable construction is a growing industry and is in need of more suppliers.

As seen in Table 3, six out of the top 10 risks are exclusive to sustainable construction projects. This confirms that the risks in sustainable projects are unique and are not similar to those in traditional projects.

The least five significant risks according to the survey results are related to regulatory and economic factors, as well as green materials and technology factors. The lowest ranked risk according to severity is poor performance of green materials (RII =10.27), while shortage of green materials (RII =10.36) and currency volatility worsened by the import of green materials (RII =10.77) were ranked 29th and 28th, respectively. The UAE is considered politically and economically stable, which explains why the least significant risks are related to regulatory and economic factors. The performance of green materials is the least significant risk in the UAE due to the growing technological advancement in the country. These results are different than the study done in Singapore by Hwang et al. (2017a). In Singapore, currency volatility worsened by the import of green materials and durability of green materials are in the top three critical risks. The variation in the results of our study and the one done in Singapore proves the importance of this research, showing that the UAE has different critical risks than other countries like Singapore.

The severity list was based on the RII value of each risk, however the probability and impact are ranked out of five. The number one probable risk shown is additional cost due to green material and equipment and the least probable risk is poor performance of green material. Even though green materials have additional cost, this cost is accounted for. Similarly, the impact of risks was evaluated and the most impactful risk was determined to be shortage of clients' funding. This risk was also the number one risk based on severity, concluding that it being in this position is due to its high impact, having a RII of 4.16. On the other hand, the risk with the least impact came out to be the same as the least probable which was poor performance of green material.

To further analyze the results of the survey, the probability–impact matrix, shown in Figure 2, is used. This is developed by plotting the probability values against the impact values of the risks. Then, using a scale from 1 to 5 (1 being the lowest and 5 being the highest), the severity of each risk according to its position on the graph is identified. It can be seen from the matrix that most of the risks are high (probability >3 and impact >3) as well as one risk that has an impact greater than 4. The matrix also shows that there is only one moderate risk that has an impact greater than 3 and probability value between 2 and 3. There are no risks with a probability and impact less than 3.

Table 4. Top five risks in Singapore and their ranking in UAE.

Risk	Rank in Singapore	Rank in UAE
Inflation	1	19
Currency and interest rate volatility worsened by the import of green materials	2	29
Durability of green materials	3	30
Damages caused by human error	4	N/A
Material suitability and accessibility and shortage of green materials	5	28

Table 5. Top five risks in UAE and their ranking in Singapore.

Risk	Rank in UAE	Rank in Singapore
Shortage of clients' funding	1	21
Insufficient or incorrect sustainable design information	2	29
Design changes	3	17
Unreasonably tight schedule for sustainable construction	4	N/A
Poor scope definition of sustainable construction	5	31

Discussion and comparison with previous studies

There are some similarities between the significant risks in traditional construction projects (previous studies) and sustainable construction projects (this study). The two most significant risks in China were tight project schedule and project funding problems (Zou et al. 2007). These results are similar to the ones in this research with funding problems as the number one risk and tight project schedule was placed fourth. Tight schedule was also a significant risk in a research conducted in the UAE construction industry where it was placed second having an RII of 13.32 (El-Sayegh 2008). On the other hand, there were some differences between traditional and sustainable risks. There are, of course, new risks that arise from the project being sustainable. Some examples are additional cost due to green material and equipment and limited availability and reliability of green suppliers. Other differences lie in the severity of the risk from one type of project to the other. Lack of scope definition is one example where it was ranked eleventh (RII =11.38) in El-Sayegh's (2008) research, while in this research it is ranked fifth (RII =14.41). Another example showing a major change is inflation. In El-Sayegh (2008) research, inflation was the number one risk in UAE construction industry at that time whereas inflation on green material prices was ranked 19th. This might be due to the time at which the survey was done, as there was a construction boom during the period of the older survey.

The research done by Hwang et al. (2017a) in Singapore shows that the top five most critical risks were inflation, currency and interest rate volatility worsened by the import of green materials, durability of green materials, damages caused by human error and material suitability and accessibility and shortage of green materials. Table 4 shows the top risks found in Singapore with their corresponding rank in the current research.

Table 4 shows that the risks are placed on opposite ends. The reason for this might be because Singapore has limited green materials and they require these materials to be imported (Hwang et al. 2017a). Whereas on the other hand, the UAE seems to not have a problem with these issue. Similarly, the top five risks found in the UAE were compared with results from the Singapore project. Table 5 shows the risks with their ranking.

Table 5 shows that there is a difference between the rankings. This might be majorly due to the location of the project. It would seem that Singapore has more experienced professionals in the sustainable construction industry since poor scope definition and insufficient or incorrect sustainable design information had much lower ranking that the ranking in the UAE. This discrepancy proves that risks are unique to each country. There is a need for international contractors to be aware of the major risks in the countries they operate.

Summary and conclusion

The UAE construction industry is experiencing a rapid growth in the size and complexity of its projects. These are responsible for a great deal of greenhouse gases emissions and pollution. This led the UAE officials to start the shift towards more environmentally friendly approaches to construction that satisfy the three pillars of sustainability. This was implemented through the enforcement of sustainable construction methods in construction projects in the UAE. With the introduction of green construction, and the rapid growth of the size of the industry, the risks affiliated with these construction projects are also increasing and becoming more complex.

Risk identification and assessment are important part of project risk management. There is a need to identify and assess potential risks in sustainable construction projects. This allows for appropriate risk response planning and control. Thirty risks were identified through literature review and used in a survey designed to measure the probability and impact of each of the identified risks. The top five risks, according to severity, are shortage of client's funding, insufficient or incorrect design information, design changes, unreasonably tight schedule for sustainable construction and poor scope definition of sustainable construction. These results are different from earlier

studies. These differences highlight the importance of this research showing that the UAE has different critical risks than other countries. Risks are unique in different countries and different project types.

Four, out of the top 10 risks, are in the management category and related to funding, scheduling, budgeting and cost. To address these management risks, there is a need for proper implementation of project management techniques with a particular focus on sustainable construction projects. Contractors should take extra care when dealing with specific clients that may have funding problems. The other four, in the top 10, are in the technical risks category. These are mainly due to the lack of design experience in sustainable construction projects. Owners should select appropriate designers who have experience in sustainable construction projects. Those would be able to produce a sound design with minimal changes during the project execution.

It is very important that the responsible authorities come up with innovative approaches to overcome such risks in sustainable construction projects. Moreover, educational sessions can be held for project managers and consultants that will enable them to foresee possible and potential problems that might occur in the sustainable construction projects. This will help them overcome risks and think about professional solutions before starting the project. Employing experienced labor and engineers and trained managers can hugely affect the project success. Such engineers can help inexperienced individuals as well as help with their comments during the construction phase. Finally, a panel of highly qualified engineers employed by the government can go to sites, give their advice and provide project engineers with feedback that can help improve the sustainability level and implementation of sustainable practices across the UAE.

Disclosure statement

No potential conflict of interest was reported by the authors.

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