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## Implementation of environmentally sustainable practices and their association with ISO 14001 certification in the construction industry of the United Arab Emirates

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### ABSTRACT

Despite significant worldwide growth in ISO 14001 standard adoption by construction firms, limited research exists on issues related to the implementation of environmentally sustainable practices and their associations with ISO 14001 certification. This article reports the results of an empirical study examining the implementation of environmentally sustainable practices, the link between their usage frequencies and ISO 14001 standard adoption, and the association between having this standard and firm size. The methodological approach involved interviews followed by a structured questionnaire to collect data from 259 construction firms in the United Arab Emirates. The results indicate that (1) environmentally sustainable practices have not been used extensively and those that have been implemented have varying usage frequencies, (2) adoption of the standard has been accompanied by partial improvement in the usage frequencies of the practices, and (3) there is no association between firm size and adoption of the standard. These findings can serve as a guide for policymakers as well as project managers in construction firms that are interested in implementing environmentally sustainable practices and those that are planning to invest in ISO 14001 certification.

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### KEYWORDS



Construction; project execution; environmentally sustainable practices; ISO 14001 standard

### Introduction

Construction is an important industry that contributes to the economic growth of developed and developing countries apart from providing infrastructure and superstructures for civilization needs. However, the damage caused to the environment due to construction activities is indisputable. For instance, approximately 25–50% of the carbon dioxide (CO<sub>2</sub>) released into the atmosphere worldwide is the result of construction activities (Gharzeldeen and Beheiry 2015; Arocho et al. 2016; Afabe 2019; Liu, Yang, et al. 2020). Furthermore, such activities consume between 20 and 50% of natural resources and are responsible for approximately 50% of solid-waste generation (Bimhow 2015; Benachio, Freitas, and Tavares 2020; Sáez and Osmani 2019). This situation has prompted governments at various levels to launch programs and to establish regulations aimed at protecting the environment by increasing the use of eco-friendly practices during project execution. Firms need to implement environmentally

sustainable practices to comply with governmental initiatives and regulations (Yusof, Iranmanesh, and Awang 2015; Bamgbade et al. 2019; Willar et al. 2020). These practices include, for example, sourcing materials that are reusable and recyclable, reducing energy consumption during construction, and using renewable energy (Yates 2014; Chen et al. 2019; Hossain et al. 2020; Kabirifar et al. 2020).

The implementation of environmentally sustainable practices by firms, including those in construction, started in most industrialized countries in the early 1970s as a means of fulfilling the requirements stipulated by government agencies. However, the primary focus at that time was on incentivizing practices related to reducing greenhouse gases (Morrow and Rondinelli 2002). In the 1980s, governments and industry associations worldwide increasingly began to concentrate on environmental protection by putting in place initiatives establishing voluntary policies to encourage firms to initiate practices related to the mitigation of air and water pollution along with the efficient use of materials

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and energy. This is evidenced, for example, by the establishment of the World Commission on Environment and Development (later known as the Brundtland Commission) by the United Nations in 1983 (see Dixon and Fallon 1989). By the 1990s, governments in numerous countries began to establish legislation and to launch various initiatives related to environmental protection as part of commitments made at the Earth Summit in Rio de Janeiro in 1992. The primary objective of the summit was to encourage the pursuit of economic development that would protect the planet's environment and nonrenewable resources (Šelih 2007). These actions reflected an increasing concern with global environmental issues. Consequently, thousands of companies worldwide, including those in the construction industry, started to adopt environmental management-system standards which were developed to control the negative impact of their activities on the environment. The goal was to achieve the companies' self-imposed sustainability goals and/or to fulfill the requirements stipulated by government agencies. Examples of these standards are the Carbon Trust Standard (CTS), the Eco-Management and Audit Scheme (EMAS), and the International Organization for Standardization's ISO 14001.

Issued in 1996, ISO 14001 is perhaps the most frequently issued environmental certification and is focused on the provision of the necessary principles, guidelines, and managerial practices required for organizations to develop and implement a formal environmental management system (Liu, Yuan, et al. 2020; Mosgaard and Kristensen 2020). According to International Organization for Standardization [ISO] (2020), by the end of 2020, 417,478 certificates had been issued in 195 countries. This is an increase of 74% compared with 2010 figures, when the total number of certificates issued in 156 countries was 239,880 (ISO 2010). The top three sectors for ISO 14001 certifications are construction (58,751 certifications); wholesale and retail trade, motor vehicle and motorcycles repairs, and goods for personal and household use (38,872 certifications); and electrical and optical equipment (31,426 certifications).

While there is an increasing body of research focusing not only on sustainability in construction (Araujo, Carneiro, and Palha 2020; Goh et al. 2020; Murtagh, Scott, and Fan 2020; Udomsap and Hallinger 2020; Alencar et al. 2021), and more specifically ISO 14001 certification (Turk 2009a; Chiarini 2019), there is very little work specifically devoted to the implementation of environmentally sustainable practices in the construction industry and their associations with ISO 14001 certification.

There is also a paucity of research on the association between construction-firm size and ISO 14001 certification. This study aims to address this gap and by doing so also contributes to understanding of this kind of certification in the context of the construction industry in the United Arab Emirates (UAE). Furthermore, the results of this work can serve as a guide for public policymakers as well as project managers in firms that are interested in implementing environmentally sustainable practices in the delivery of their projects and those that are planning to invest in ISO 14001 certification.

The rest of this article is organized as follows: In the following section, we briefly review the relevant literature on the concept of sustainability, environmentally sustainable practices in the UAE construction industry, environmental management systems, and firm size and adoption of the ISO 14001 standard. We then introduce the methodological approach for conducting this research. This section is followed by the results which report the main research findings. Finally, we conclude the article with final remarks, limitations, and recommendations for future research.

## Literature review

### *The concept of sustainability in construction*

For a number of reasons, including the need to mitigate the construction industry's impact on the environment, "sustainability" has been drawing the attention of practitioners and researchers (Banihashemi et al. 2017; Araujo, Carneiro, and Palha 2020; Goh et al. 2020; Murtagh, Scott, and Fan 2020; Udomsap and Hallinger 2020; Alencar et al. 2021). To meet its various objectives, scholars have proposed that the three pillars of sustainability (economic, environmental, and social) be incorporated into the practices of project management (Chofreh et al. 2019; Sabini, Muzio, and Alderman 2019; Stanitsas, Kirytopoulos, and Leopoulos 2021). This has led to emergence of the concept of sustainable project management which is defined by Silvius and Schipper (2014) as "[T]he planning, monitoring and controlling of project delivery and support processes, with consideration of the environmental, economic and social aspects of the life-cycle of the project's resources, processes, deliverables and effects, aimed at realizing benefits for stakeholders, and performed in a transparent, fair and ethical way that includes proactive stakeholder participation."

Many studies that address sustainable project management have focused on either developing frameworks or models (see Haavaldsen et al. 2014; Yates 2014; Silvius and Schipper 2015; Armenia et al. 2019; Dasović, Galić, and Klanšek 2020; Gijzel

et al., 2019; Hasheminasab et al. 2021), providing checklists or indicator-based guidelines for practices (e.g., O'Connor, Torres, and Woo 2016; Yates 2014; Yu et al. 2018; Adamec, Janoušková, and Hák 2021), defining the responsibilities of project stakeholders (Kibert 2013; Toljaga-Nikolić et al. 2020), investigating factors affecting the implementation of sustainability practices (Yusof, Iranmanesh, and Awang 2015; Gunduz and Almuajebh 2020; Stanitsas, Kirytopoulos, and Leopoulos 2021; Liu, Xue, et al. 2020) or identifying impediments and challenges that impact upon sustainability (e.g., Yates 2014; Zuofa and Ochieng 2016; Willar et al. 2020). Other studies have investigated perceptions and awareness of stakeholders regarding sustainable construction (e.g., Zuofa and Ochieng 2016; Yu et al. 2018; Pham, Kim, and Luu 2020), examined the effect of sustainability on project outcomes (Silvius and Schipper 2015; Banihashemi et al. 2017; Carvalho and Rabechini 2017; Onubi, Yusof, and Hassan 2020; Mansell, Philbin, and Konstantinou 2020), or identified sustainable practices and their usage frequencies (Yates 2014; Yusof, Iranmanesh, and Awang 2015; O'Connor, Torres, and Woo 2016).

Studies undertaken by Yates (2014), Yusof, Iranmanesh, and Awang (2015), and O'Connor, Torres, and Woo (2016) are most closely related to the work presented in this article. Yates (2014) developed a guide, two sustainability maturity models, and a comprehensive checklist comprising 77 environmentally sustainable practices that can be incorporated into construction projects. The study by Yates was supported by a survey which addressed numerous issues including the use of 23 environmental, economic, and socially sustainable practices at the project and corporate level. The results demonstrated that at the corporate level, the percentage of firms that implemented each practice varied from 58% to 96%, whereas at the project level the percentage of firms that implemented each practice varied from 12% to 70%. Moreover, sustainability practices were used 60% of the time during the life-cycle of a project.

Yusof, Iranmanesh, and Awang (2015) conducted a survey investigating the usage frequency of 20 environmental sustainability practices in the Malaysian construction industry. Based on the analysis of data collected from 375 practitioners, the authors observed that the usage frequency of these practices was generally acceptable, although a number of practices required more attention, particularly those related to industry codes such as compliance, site development, and transportation.

O'Connor, Torres, and Woo (2016) described the results of research aimed at developing a catalogue for the Construction Industry Institute. Apart from

the aforementioned research, they conducted a survey to validate the implementation of 54 identified sustainability practices referred to as “sustainability actions,” classified under the following eight categories: (1) project management, (2) contracting, (3) field engineering, (4) site facilities and operations, (5) management of labor, (6) management of materials, (7) management of equipment, and (8) management of quality, commissioning, and handover. The survey results demonstrated that 76% of the actions were implemented.

We can make the following general comments about these three studies. First, the study by Yates (2014) represents a very comprehensive list of environmentally sustainable practices that can be implemented during project execution. Second, these three studies were undertaken a few years ago and the reported usage frequencies of environmentally sustainable practices are unlikely to represent the current status. Finally, none of the aforementioned studies addressed issues related to the adoption of ISO 14001 standards and implementation of environmentally sustainable practices.

### ***Environmentally sustainable practices in the UAE construction industry***

Prior to the financial crisis in 2008, the UAE construction industry experienced a boom, which began around 1996 and peaked in 2007. Consequently, the country became one of the biggest producers of construction-related waste in the world (Al-Hajj and Hamani 2011). Concerns about the various consequences of such a high rate of waste generation led the UAE government to enact a number of laws, regulations, and initiatives focused on environmental protection (Gharzeldeen and Beheiry 2015). One example of this is the “Estidama” initiative in Abu Dhabi which was implemented by the Abu Dhabi Urban Planning Council (ADUPC). This program introduced a Pearl Rating System tool to evaluate construction projects according to principles outlined by the Council. The ADUPC established a minimum score that all construction projects were mandated to fulfill. This requirement provided the necessary impetus for Abu Dhabi to establish a policy for protecting the environment (Ramani and García de Soto 2021). Similarly, the requirement of sustainable construction was raised in the Dubai municipality through the introduction of the “Green Building Regulations and Specifications” in 2011 with which all construction projects initiated in Dubai since 2014 have been required to comply (Dubai Municipality 2017).

Based on the preceding review, we have formulated the following question:

*RQ1:* Which environmentally sustainable practices are being implemented in the UAE construction industry, and is there variation in the usage frequencies of implementation of different practices?

### **Environmental management systems and the construction industry**

The popularity of ISO 14001 as an international standard for effective environmental management extends to the construction industry (see Chiarini 2019; Johnstone 2020; Mosgaard and Kristensen 2020; To and Lam 2021). Thus, for example, by the end of 2020, the number of worldwide certifications in the construction sector reached 58,751, an increase of 100% compared with 2010. During this same period, the number of registered firms in the UAE construction sector reached 243 (ISO 2020), an increase of 228% compared with 2010 (ISO 2010). The primary elements of an ISO 14001-compliant management system include developing organizational capacity for formulating environmental policies, planning and implementing the developed policies, controlling operations through monitoring, and taking corrective actions (Treacy et al. 2019; Johnstone 2020). The standard does not require organizations to achieve a specified level of environmental performance, but it describes a system to help them achieve their own goals. The literature observes that adopting the ISO 14001 standard allows organizations to achieve their objectives, while simultaneously responding to the needs of both stakeholders and legal requirements (Phan and Baird 2015; Waxin, Knuteson, and Bartholomew 2019; Bravi et al. 2020). Moreover, the ISO 14001 standard covers the responsibilities of the project managers to employees, the public, and the environment (Orcos, Pérez-Aradros, and Blind 2018; Ma et al. 2021). In terms of environmental protection, adopting the ISO 14001 standard is intended to aid firms to implement practices to reduce CO<sub>2</sub> emissions and soil contamination, to use water and energy resources efficiently, and to develop better practices in waste management, among other objectives (Boiral, Heras-Saizarbitoria, and Brotherton 2018; Garrido, González, and Orcos 2020; Ikram et al. 2020). All things considered, adopting the ISO 14001 standard can reduce operational costs (Heras-Saizarbitoria, Arana, and Boiral 2016; Boiral et al. 2018; Wu et al. 2020; Brahmana and Kontesa 2021), protect the environment, and improve the firm's image and credit rating (Li et al. 2018).

According to a number of studies, however, it is quite challenging to implement the ISO 14001 standard in construction firms that are predominantly oriented around particular projects, as

environmentally sustainable practices are often not embedded in project culture (Banihashemi et al. 2017; Carvalho and Rabechini 2017; Silvius 2017). By contrast, some studies have reported that adopting the ISO 14001 standard helped firms to increase their environmentally sustainable practices. For instance, in a survey investigating the benefits that accrued to construction firms in Turkey, respondents were asked whether the companies had implemented environmental protection practices. The results indicated that 100% of certified firms and 77.5% of non-certified firms had implemented sustainability practices (Turk 2009a). Implementing such practices has enabled ISO 14001-certified firms to minimize adverse impacts on the environment (Turk 2009b), while reducing construction expenditure by recycling resources, saving energy, and reducing occupational accidents (Liu, Lau, and Fellows 2012). From this review, our second research question is formulated as follows:

*RQ2:* Is the usage frequency of environmentally sustainable practices by ISO 14001-certified firms significantly higher than that of non-certified firms?

### **Firm size and adoption of the ISO 14001 standard**

Firm size may be a significant factor in adopting the ISO 14001 standard and a review of the literature suggests that there are two main potential reasons for this variation (Cassells, Lewis, and Findlater 2011; Johnstone and Hallberg 2020; Wang and Zhao 2020; Arocena et al. 2021). First, various stakeholders might apply significant pressure on larger firms with regard to their environmental performance. Large firms are likely to be seen as the biggest polluters in a community, especially because of their conspicuous visibility, and regulatory agencies are inclined to target them for contributing to environmental degradation (Holt and Ghobadian 2009). Second, firms that opt for ISO 14001 certification incur two main types of expenditures: (1) the costs of certification (registration and annual membership fees) and (2) the costs associated with executing projects. Because of these expenditures, ISO 14001 certification may be perceived by small- and medium-sized firms (SMFs) as a burden rather than an advantage (Arocena, Orcos, and Zouaghi 2021). Moreover, compared to that of SMFs, the financial capability of large firms enables them to seek ISO 14001 certification despite potential disruptions to their operations emanating from the introduction of new business practices. This has been confirmed in the context of studies focused on the construction industry in Slovenia (Šelih 2007) and Turkey (Turk 2009a). Based on an analysis of data collected from

**Table 1.** List of environmentally-sustainable practices implemented in the UAE construction industry.

Category	Practice
use of natural resources/materials	Reduce the overuse of natural resources
	Use recyclable materials
	Use environmentally friendly materials
	Choose sustainable suppliers
	Segregate, tightly cover, and monitor toxic substances
Energy saving	Implement on-site waste management solutions
	Use solar panels for hot water generation
	Use photocell panels for electricity generation
	Recover energy by using recovery wheels for the HVAC system
	Reduce fossil-fuel use
Water (usage and pollution reduction)	Feed excess energy that is generated on-site back into the grid
	Use ultra-low-flow plumbing fixtures to reduce fixture-water consumption
	Use irrigation and landscaping measures
	Build on-site systems for treating gray water
	Build on-site systems for reclaiming/filtering condensate water that is derived from air-conditioning units
Air-pollution reduction	Build on-site catchment systems for rainwater
	Use grease interceptors to intercept most grease and solids before they enter a wastewater-disposal system
	Collect and treat the wastewater generated in construction sites
	Improve indoor-air quality using a proper ventilation systems
	Cover piles of construction materials
	Use low-sulfur fuel oil in vehicle and equipment engines
	Install fine mesh screening close to dust sources
	Control dust with fine water sprays
	Choose local or regional materials to reduce transportation pollution
	Avoid burning materials on site
Use chlorine-free gases for the AC	
Minimize the utilization of generators	
Maintain the site equipment periodically	

11,668 firms in different countries in Asia and Eastern Europe by Hudson and Orviska (2013), it was also observed that the likelihood of adopting the standard increases with the size of the firm. It also merits observing that the association between firm size and certification is contextual; that is, it depends not only on firm size but also, in some cases, on other factors such as the type of industry and the location of the firm. From this review, the third research question is formulated as follows:

RQ3: Is there a relationship between firm size and having ISO 14001 certification?

## Methodology

The methodological approach employed in this study involved conducting interviews to identify the environmentally sustainable practices currently being used in the UAE construction industry and using a structured questionnaire to collect data on ISO 14001 certified and non-certified firms. The interviews were conducted individually and face-to-face with five project managers employed by different firms (two were ISO 14001 certified and three were non-certified). In each interview, a project manager was briefed about our research objectives and then asked to provide a list of environmentally sustainable practices being implemented by his/her organization during project execution by validating a comprehensive list of 77 items developed by Yates (2014). Validation included modifying, adding to, or removing any of the environmental sustainability practices included in the list. The provided five lists (one from each interviewee) were then compiled into a

single list consisting of 28 environmentally sustainable practices. As highlighted in Table 1, these practices were categorized into four groups: (1) practices related to the use of natural resources/materials; (2) practices related to energy saving; (3) practices related to water usage and pollution reduction; and (4) practices related to air-pollution reduction.

## Survey design

To collect the required data, we designed a three-part questionnaire.<sup>1</sup> The first section asked respondents to provide their job title and the name of the firm (optional). The items in the second section included the profile of the respondent's employer and also requested information such as the number of employees, average value of projects, average duration of projects, and the firm's ISO 14001 certification status. The final section addressed the main aspect under investigation, namely implementation of the 28 environmentally sustainable practices that we had identified in the prior phase (Table 1). In this section, the respondents were asked to indicate on a scale ranging from 1 to 5 (with 1 = Never, 2 = Rarely, 3 = Occasionally, 4 = Often, and 5 = Always) how often the practices were implemented in the projects they had managed over the prior five years. We piloted the draft questionnaire with project managers from five different firms (three were ISO 14001 certified and two were non-certified) and used their responses to refine the questionnaire before distributing the larger survey. In the pre-test version, respondents were given an opportunity to add missing practices and to

**Table 2.** Profile of surveyed firms.

Item	Non-certified firms		Certified firms	
	Number	Percentage	Number	Percentage
Number of employees				
Less than 50	5	3.0	12	12.6
51–100	49	29.9	24	25.3
101–500	47	28.7	19	20.0
501–1000	50	30.5	26	27.4
Over 1000	13	7.9	14	14.7
Owner type				
Government	12	7.3	0	0.0
Government/Private	13	7.9	4	4.2
Domestic Private	87	53.1	53	55.8
International Private	43	26.2	34	35.8
Other	9	5.5	4	4.2

provide any comments with respect to the clarity of questionnaire items. Based on their responses, we revised the wording of few practices, though no new practices were added to the list.

### Data collection

An essential step in the data-collection process involved selecting the targeted population and sample size. In this study, the targeted population was 723 active construction-contracting firms operating in the UAE. Using the following equation (Olejnik 1984), the required minimum sample size was determined to be 252.

$$\text{Sample Size} = \left( \frac{z^2 * p (1-p)}{e^2} \right) / \left( 1 + \left( \frac{z^2 * p (1-p)}{e^2 N} \right) \right)$$

where

$N$  = Population size = 723

$e$  = Margin of error = 0.05

$z$  = 1.96 for 95% confidence level

$p$  = Percentage of population having the characteristics = 50%

We sent the questionnaire both electronically (via email) and manually (in person) (delivering hard copies) to a random sample of 350 project managers in construction-contracting firms in the UAE. A total of 259 respondents returned the questionnaire, representing a response rate of 74.3%. Of these respondents, 95 (36.7%) were associated with certified firms, whereas the remaining 164 respondents (63.3%) were employed companies that were ISO 14001 non-certified. As shown in Table 2, in terms of size, the majority of both types of firms (ISO certified and non-certified) had a number of employees in the range of 501–1000. With respect to ownership type, the majority of both certified and non-certified companies were domestic private firms. It is worth noting that we were unable to obtain information on the average value and duration of projects as apparently most of the participants considered that information to be confidential.

## Results

The responses to the questionnaire on usage frequency of environmentally sustainable practices are summarized in Figures 1–4. First, with regard to natural resources/materials-related practices (Figure 1), “segregate, tightly cover, and monitor toxic substances” was the most widely utilized practice while “use recyclable materials” was the least common practice. On one hand, the former practice was implemented either often or always by 47% of the firms. On the other hand, the latter practice was deployed either often or always by 19% of the companies. Second, with respect to energy-saving practices (Figure 2), “reduce fossil-fuel use” was the most extensively utilized practice while “use photocell panels for electricity generation” was the least common practice. The former practice was implemented either often or always by 27.8% of the firms and the latter practice was implemented either often or always by 11.2% of the surveyed companies. Third, as for water-related practices (usage and pollution reduction) (Figure 3), “collect and treat the wastewater generated in construction sites” was the most widespread practice and “build on-site systems for reclaiming/filtering condensate water that is derived from air conditioning units” was the least frequent. The former practice was implemented either often or always by 42.8% of the firms and the latter practice was implemented either often or always by 20.1% of the companies. Finally, with regard to air-pollution reduction practices (Figure 4), “avoid burning materials on site” was found to be the most extensively used practice and “use chlorine-free gases for the AC” was the least commonly utilized practice. The former practice was implemented either often or always by 67.9% of the firms and the latter practice was applied either often or always by 36.3% of the firms.

We further analyzed the responses regarding implementation of environmentally sustainable practices by construction firms in the UAE using the median, the Mann–Whitney U test, and the two-proportion z-test for hypothesis testing. The median and the Mann–Whitney U test were selected because they are appropriate for analyzing responses using the Likert scale, in which the assumption of normality is unjustified (Montgomery 2005). Table 3 presents the median for each of the 28 practices across three categories (all firms, certified firms, and non-certified firms) and  $P$ -values for the Mann–Whitney U test results.

### Practice usage (all firms category)

At the level of all firms, the results demonstrate varying usage of environmentally sustainable

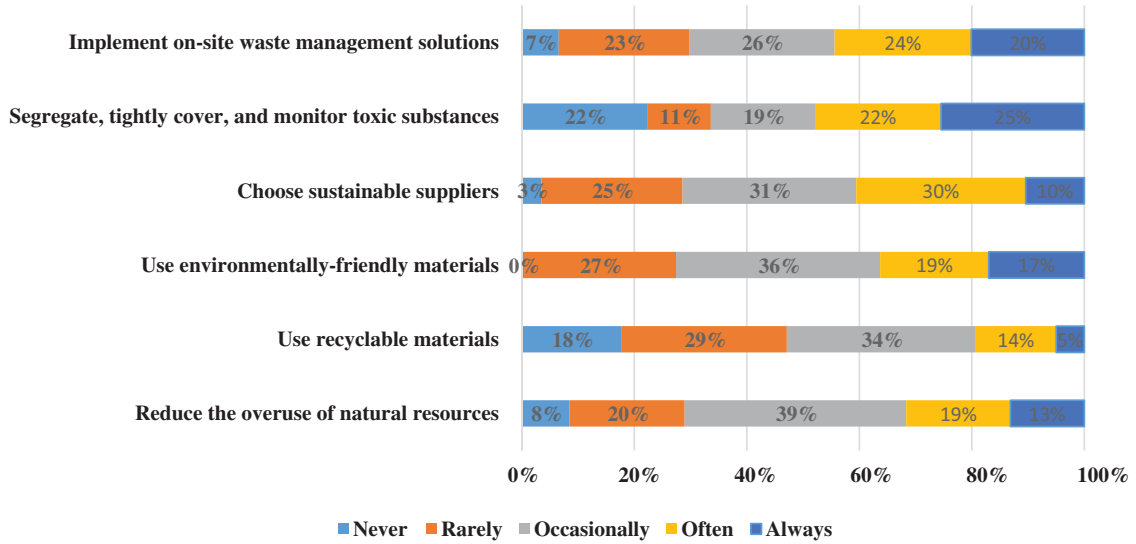


Figure 1. Summary of responses to the usage frequency of practices related to the use of natural resources/materials.

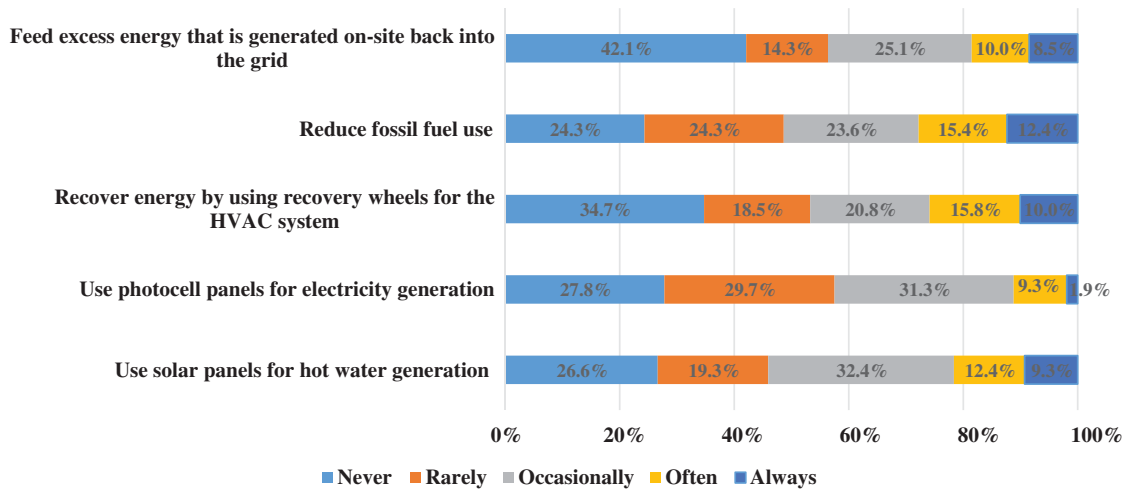


Figure 2. Summary of responses to the usage frequency of practices related to energy saving.

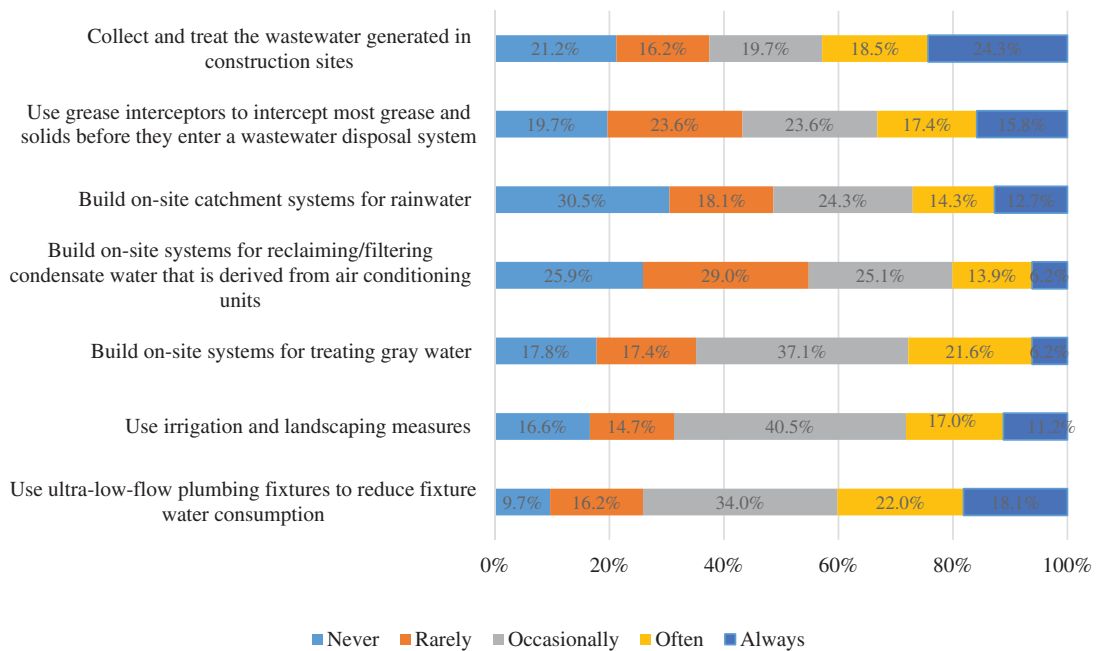
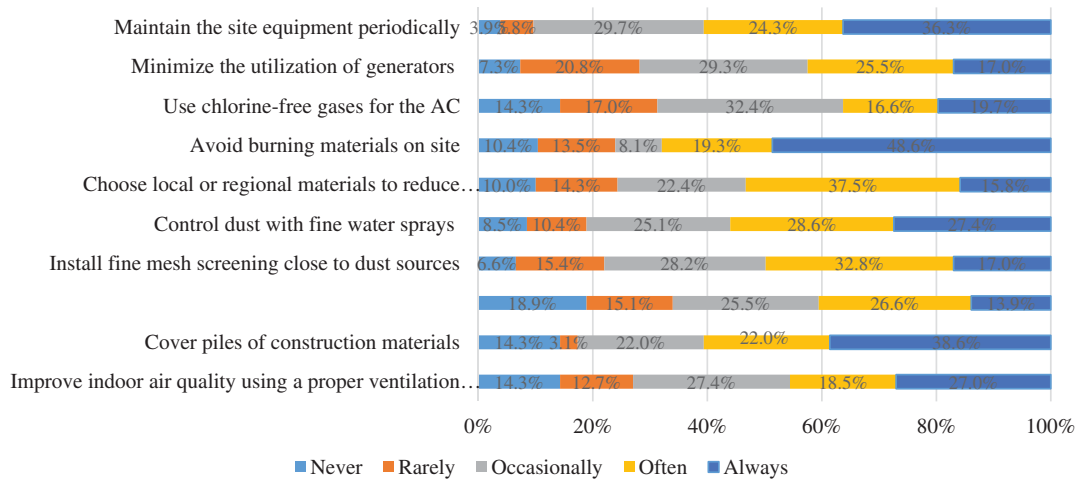


Figure 3. Summary of responses to the usage frequency of practices related to water (usage and pollution reduction).





**Figure 4.** Summary of responses to the usage frequency of practices related to air pollution reduction.

practices. As indicated in Table 3, the medians of usage practices by the 259 firms ranged from a high of 4 (often) for “cover piles of construction materials,” “control dust with fine water sprays,” “choose local or regional materials to reduce transportation pollution,” “avoid burning materials on site,” and “maintain the site equipment periodically” to a low of 2 (rarely) for “use photocell panels for electricity generation,” “recover energy by using recovery wheels for the HVAC [heating, ventilation, and air-conditioning] system system,” “feed excess energy that is generated on-site back into the grid (‘net metering’),” and “build on-site systems for reclaiming/filtering condensate water.” It is worth noting that practices with high rates of implementation correspond to air-pollution reduction. This finding is consistent with objectives of the United Nations Environment Assembly (UNEA) that has made air-pollution reduction a top priority for sustainable development (UNEA 2014). However, the overall results indicate that the usage frequency of 19 out of 28 (68%) of the practices was 3 (occasionally), that is 68% of practices were only occasionally or rarely implemented by 50% of firms. Similar to the findings from previous studies (Zuofa and Ochieng 2016), we found that, despite initiatives and regulations established by the UAE government at various levels, environmentally sustainable practices have not yet been completely embraced by the country’s construction industry. This is most likely due to these types of practices not yet being embedded in project culture (Zuofa and Ochieng 2016; El-Sayegh et al. 2020; Gijzel et al. 2019).

#### **Practice usage: ISO 14001 certified firms and non-certified firms**

As illustrated in Table 3, compared to non-certified firms, ISO 14001 certified firms reported a higher usage frequency of ten of the environmentally

sustainable practices: one practice related to the use of natural resources and materials (“segregate, tightly cover, and monitor toxic substances”); two practices related to energy saving (“use photocell panels for electricity generation” and “recover energy by using recovery wheels for the HVAC system”); one practice related to water (“use irrigation and landscaping measures”); and six practices related to air-pollution reduction (“improve indoor air quality,” “install fine mesh screening close to dust sources,” “control dust with fine water sprays,” “avoid burning materials on site,” “use chlorine-free water for the AC,” and “minimize the utilization of generators”).

For comparison at the population level, we formulated the following null ( $H_0$ ) and alternative ( $H_1$ ) hypotheses to address the second research question:

Is the usage frequency of environmentally sustainable practices by ISO 14001 certified firms significantly higher than that of the non-certified firms?

$H_0$ : Usage frequency of practice  $i$  by non-certified firms does not differ significantly from that of ISO 14001 certified firms,  $i = 1, 2, \dots, n$ , where  $n = 28$  (number of environmentally sustainable practices).

$H_1$ : Usage frequency of environmentally sustainable practice  $i$  by ISO 14001 certified firms is significantly higher than that of non-certified firms,  $i = 1, 2, \dots, n$ , where  $n = 28$  (number of environmentally sustainable practices).

As illustrated in Table 3, the Mann–Whitney U test at the 0.05 significance level suggests that compared to non-certified firms, ISO 14001 certified firms report significantly higher levels of implementation in 29% (8 out of 28) of the environmentally sustainable practices. These practices are: (1) “use photocell panels for electricity generation,” (2) “recover energy by using recovery wheels for the HVAC (heating, ventilation, and air-conditioning) system,” (3) “minimize the utilization of generators,”

**Table 3.** Usage frequency of practices.

Category	Practice	Median			<i>p</i> -Values for the Mann–Whitney U Test results
		All firms	Certified firms	Non-certified firms	
Use of natural resources/materials	Reduce the overuse of natural resources	3	3	3	0.285
	Use recyclable materials	3	3	3	0.469
	Use environmentally-friendly materials	3	3	3	0.214
	Choose sustainable suppliers	3	3	3	0.393
	Segregate, tightly cover, and monitor toxic substances	3	4	3	0.221
Energy saving	Implement on-site waste management solutions	3	3	3	0.423
	Use solar panels for hot water generation	3	3	3	0.271
	Use photocell panels for electricity generation	2	3	2	0.004
	Recover energy by using recovery wheels for the HVAC system	2	3	2	0.012
	Reduce fossil fuel use	3	3	3	0.152
	Feed excess energy that is generated on-site back into the grid	2	2	2	0.167
Water (usage and pollution reduction)	Use ultra-low-flow plumbing fixtures to reduce fixtures' water consumption	3	3	3	0.051
	Use irrigation and landscaping measures	3	4	3	0.017
	Build on-site systems for treating gray water	3	3	3	0.334
	Build on-site systems for reclaiming/filtering condensate water that is derived from air conditioning units	2	2	2	0.439
	Build on-site catchment systems for rainwater	3	2	3	0.438
	Use grease interceptors to intercept most grease and solids before they enter a wastewater disposal system	3	3	3	0.198
	Collect and treat the wastewater generated in construction sites	3	3	3	0.252
	Improve indoor air quality using a proper ventilation system	3	4	3	0.038
Air pollution reduction	Cover piles of construction materials	4	4	4	0.025
	Use low-sulfur fuel oil in vehicle and equipment engines	3	3	3	0.301
	Install fine mesh screening close to dust sources	3	4	3	0.253
	Control dust with fine water sprays	4	5	4	0.03
	Choose local or regional materials to reduce transportation pollution	4	4	4	0.316
	Avoid burning materials on site	4	5	4	0.205
	Use chlorine-free gases for the AC	3	4	3	0.034
	Minimize the utilization of generators	3	4	3	0.001
Maintain the site equipment periodically	4	4	4	0.261	

(4) “use irrigation and landscaping measures,” (5) “improve indoor air quality,” (6) “cover piles of construction materials,” (7) “control dust with fine water sprays,” and (8) “use chlorine-free water for the AC [air conditioning].” These findings suggest that adoption of the ISO 14001 standard corresponds to partial improvement in the extent of environmentally sustainable practices among construction firms in the UAE. This ambivalent outcome might be due to one or a combination of several factors, including ineffectiveness of programs currently being implemented by firms for environmental protection, lack of top-management support, perverse incentives in the original adoption of the standard (i.e., for marketing purposes or what is called “symbolic environmental behavior”), and insufficient training on how to use the operating procedures and processes in the interest of ultimately embedding them in project culture (Chiarini

2019). Addressing such factors could potentially enhance the effectiveness of implementing the standard, and thus improve a firm’s environmental performance.

#### ***The relationship between firm size and ISO 14001 certification***

Firm size can be measured by different criteria such as total assets, market value of equity, number of employees, total revenues, and scale of projects (Hashmi et al. 2020). In this study, we adopted the number of employee criterion since it is a widely used and recognized benchmark. However, this does not mean that there is widespread consistency with respect to this measure.

In order to address the third research question (“Is there a relationship between firm size and having ISO 14001 certification?”), the firms we surveyed

were classified into two groups according to their size: “large” and “small and SMFs.” There were two reasons for restricting our comparison to these two groups (as against, for example, using comparisons of “micro,” “small,” “medium,” and “large.” First, is that micro-, small-, and medium-sized firms have common limitations and share generally the same experiences such as limited access to finance which is remarkably different even within the same country (see Ardic, Mylenko, and Saltane 2012) from the experiences of large firms (Abraham and Schmukler 2017; Paul, Parthasarathy, and Gupta 2017). Second, there is a lack of specific reference to firm classifications for the construction industry in the UAE. Accordingly, we adopted the closest categorization which we gleaned from the United States Small Business Administration (2019). In this instance, there are no classifications for the “Construction (Sector 23).” However, there is under “Mining, Quarrying, and Oil and Gas Extraction (Sector 21), a classification for “Construction Sand and Gravel Mining” firms with those having fewer than 500 employees being classed as SMFs. Thus, in our study, we defined large firms as those with more than 500 employees while SMFs are those with up to this number.

Based on this demarcation, 38.8% of our surveyed large firms were certified and 35.3% of our SMF firms were certified. Therefore, we inferred that the difference between the two groups was not significant. To generalize this inference to the population of certified construction firms in the UAE, the following null and alternative hypotheses were formulated:

$H_0$ : There is no significant difference between the proportion of certified large firms and the proportion of certified SMFs.

$H_1$ : The proportion of large certified firms is significantly larger than the proportion of SMF certified firms.

According to the two-proportion  $z$ -test results,  $H_0$  cannot be rejected at a significance level of 0.05, so the research indicates that there is no association between firm size and having ISO 14001 certification in the UAE construction industry. This outcome does not correspond with findings from previous studies that found a significant difference in the incidence of certification on the basis of firm size (Šelih 2007; Turk 2009a). However, the inconsistency can be explained by Hudson and Orviska’s (2013) claim that having ISO certification is contextual; that is, it does not absolutely depend on firm size. In some contexts, firms may opt to adopt the ISO 14001 standard regardless of their size, because the benefits of certification outweigh the associated costs. These benefits may not necessarily include

improving environmental performance. In fact, even if the cost is considered high, some firms may nonetheless select to adopt the standard to gain a competitive advantage, to burnish their image, and so forth (Sakr, Sherif, and El-Haggar 2010; Turk 2009a, 2009b; Zeng et al. 2005).

## Conclusion

Despite global growth in the adoption of the ISO 14001 standard by numerous firms across a range of different industries, there has been only a limited amount of research focused on examination of the implementation of environmentally sustainable practices and its relationship with ISO 14001 certification. This study aimed, at least partially, to fill this gap by examining the extent to which environmentally sustainable practices, the link between the usage frequencies of those practices and ISO 14001 certification, and the association between adopting this standard and firm size. Our study was set within the context of the UAE construction industry. Data were collected from a combination of interviews and a questionnaire of representatives from 95 ISO 14001 certified firms and 164 non-certified firms. From the interviews, we identified a list of 28 out of 77 practices being implemented by construction firms in the UAE for the purpose of environmental protection.

A general conclusion drawn from analysis of the data is that environmentally sustainable practices have generally not yet been fully embraced by the UAE construction industry. This is supported by data, which showed that the 28 identified practices had varying usage frequencies, and that firms have mainly focused on implementing practices associated with air-pollution reduction. However, firms that have adopted this standard have significantly improved the extent of implementation in just eight of 28 environmentally sustainable practices. This situation leads us to conclude that adoption of the ISO 14001 standard has partially facilitated the degree of implementation. To enhance the effectiveness of the standard, firms need to implement a comprehensive framework that includes policies and practices, engagement of all stakeholders, and enhanced eco-awareness at all levels of the firm (Armenia et al. 2019) so that implementing environmentally sustainable practices becomes embedded in project culture.

Within this context, the government can play a significant role by adopting a combination of three different types of policies that seek to mandate, to support, and to encourage (Zeng et al. 2005). First, mandatory policies include issuing and enforcing laws and regulations that protect the environment.

Second, supporting policies consist of the provision of training and awareness programs. Finally, encouraging policies include the provision of short-term subsidies, tax or fee waivers, or other incentives. With regard to adoption, we found no association between ISO 14001 adoption and firm size.

This article makes both conceptual and practical contributions. In terms of the conceptual contribution, this study (within the context of the UAE), opens a fresh area of discussion in relation to the implementation of environmentally sustainable practices and how such measures are related to ISO 14001 certification. Furthermore, despite significant growth in the global adoption by construction firms, our study is one of the first to examine the relationship between uptake of the standard and actual progress achieving environmentally sustainable practices in the UAE construction industry. In doing so, we have sought to contribute to development of the knowledge required to minimize the adverse environmental impacts of the industry (see Alencar et al. 2021).

Our findings also have implications for practice in that the implementation of ISO 14001 certification may inevitably be utilized as a type of control system, and thus the process of implementation provides managers with an opportunity to legitimize the monitoring and evaluation of environmentally sustainable practices. However, in instances where there is a lack of clarity over how the implementation of environmentally sustainable practices affects ISO 14001 certification, it is likely that unintended consequences will arise suggesting that firms should during the implementation of such practices seek full stakeholder engagement. Doing so will help to eliminate contested priorities (Murmura et al. 2018). Within the context of this study, stakeholder engagement refers to the systematic means by which the interest of individuals, groups and entities (the stakeholders) interested in the project outcomes will be galvanized (Chipulu et al. 2019). Bal et al. (2013) identifies a six-stage process for achieving stakeholder engagement in sustainability-related projects which, broadly speaking, includes (1) stakeholder identification, (2) linking individual stakeholders to varying targets, (3) prioritization; (4) management, (5) performance measurement, and (6) target setting.

Our study has a number of limitations which sets the scene for future studies. The first limitation relates to the extent to which the results may be generalized. To address this limitation, subsequent work could focus on conducting multi-industry studies within the UAE (in effect, studies that are not confined to the construction industry). However, one concern with research undertaken on this basis is that because

environmentally sustainable practices often vary considerably across different industries (Hudson and Orviska 2013), such a study could lead to misleading results due to the use of heterogeneous samples. The second limitation relates to the consideration of the practices of only one pillar of sustainability which in this instance, is the environment. Future studies could therefore focus on investigating practices associated with the other two pillars of sustainability, namely social and economic. The third limitation of this study is that to address the third research question (Is there a relationship between firm size and having ISO 14001 certification?), the firms were grouped into only two classes “large” and “small and medium-sized firms.” However, a future study needs to be conducted to address this research question by classifying the sizes of firms into four classes: “micro,” “small,” “medium,” and “large.” This is because differences may appear among these four classes of firm sizes as reported in previous literature. Also, future studies will need to consider previous work evaluating size as a critical success factor for standard implementation.

The empirical results from this study pose two future research opportunities. First, we found a significant difference between ISO 14001 certified and non-certified firms in the usage frequency for only eight practices. This result might be due to unsuccessful implementation of the standard. Investigating this issue could be an objective for a future study. Second, our work indicates that firms might opt to adopt the ISO 14001 standard regardless of their size, most likely because they find that the benefits of certification outweigh the associated costs. Therefore, a need exists for a study to explore the motives and perceived benefits of obtaining ISO 14001 certification in the UAE construction industry and their associations with firm size.

## Note

1. The survey was designed to address several issues including the questions investigated here. Other issues are not reported in this article as they are not within the scope of this study.

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No potential conflict of interest was reported by the author(s).

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