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.

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\(_2\)) 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; Saéz 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.
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 (Selih 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 Klanshek 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 Almuaieeb 2020; Stanitsas, Kirytopoulos, and Leopoulo 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-Arados, 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 CO₂ 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 (Baníhashemi 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 Ghabadian 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 (Selih 2007) and Turkey (Turk 2009a). Based on an analysis of data collected from
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. 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 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 |
| | Implement on-site waste management solutions |
| Energy saving | Use solar panels for hot water generation |
| | Use photovoltaic 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 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 |
| | 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 |
| Air-pollution reduction | Improve indoor-air quality using a proper ventilation system |
| | 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 |
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.

\[
\text{Sample Size} = \left( \frac{z^2 * p (1-p)}{\epsilon^2} \right) \left/ \left( 1 + \frac{z^2 * p (1-p)}{\epsilon^2 N} \right) \right.
\]

where

- \( N \) = Population size = 723
- \( \epsilon \) = 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.

### Practice usage (all firms category)

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

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

| Practice                                                                 | Never | Rarely | Occasionally | Often | Always |
|--------------------------------------------------------------------------|-------|--------|--------------|-------|--------|
| Implement on-site waste management solutions                            | 7%    | 23%    | 26%          | 24%   | 2%     |
| Segregate, tightly cover, and monitor toxic substances                   | 22%   | 11%    | 19%          | 22%   | 5%     |
| Choose sustainable suppliers                                            | 8%    | 25%    | 31%          | 30%   | 10%    |
| Use environmentally-friendly materials                                   | 0%    | 27%    | 36%          | 19%   | 1%     |
| Use recyclable materials                                                 | 18%   | 29%    | 34%          | 14%   | 2%     |
| Reduce the overuse of natural resources                                 | 5%    | 20%    | 39%          | 19%   | 2%     |

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

| Practice                                                                 | Never | Rarely | Occasionally | Often | Always |
|--------------------------------------------------------------------------|-------|--------|--------------|-------|--------|
| Feed excess energy that is generated on-site back into the grid          | 42.1% | 14.3%  | 25.1%        | 10.9% | 0.0%   |
| Reduce fossil fuel use                                                   | 24.3% | 24.3%  | 23.6%        | 15.4% | 0.0%   |
| Recover energy by using recovery wheels for the HVAC system              | 34.7% | 18.5%  | 20.8%        | 15.8% | 0.0%   |
| Use photocell panels for electricity generation                          | 27.8% | 29.7%  | 31.3%        | 9.3%  | 0%     |
| Use solar panels for hot water generation                               | 26.6% | 19.3%  | 32.4%        | 12.4% | 0.0%   |

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

| Practice                                                                 | Never | Rarely | Occasionally | Often | Always |
|--------------------------------------------------------------------------|-------|--------|--------------|-------|--------|
| Collect and treat the wastewater generated in construction sites         | 23.2% | 16.2%  | 19.7%        | 18.5% | 10.0%  |
| Use grease interceptors to intercept most grease and solids before they enter a wastewater disposal system | 19.7% | 23.6%  | 23.6%        | 17.4% | 12.8%  |
| Build on-site catchment systems for rainwater                            | 30.5% | 18.1%  | 24.3%        | 14.3% | 3.9%   |
| Build on-site systems for reclaiming/filtering condensate water that is derived from air conditioning units | 25.9% | 29.0%  | 25.1%        | 14.9% | 1.2%   |
| Build on-site systems for treating gray water                            | 13.8% | 17.4%  | 37.1%        | 11.6% | 2.0%   |
| Use irrigation and landscaping measures                                  | 16.6% | 14.7%  | 40.5%        | 17.0% | 12.2%  |
| Use ultra-low-flow plumbing fixtures to reduce fixture water consumption | 12.7% | 16.2%  | 34.0%        | 22.0% | 12.8%  |
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 (Zuofi 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 (Zuofi 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 (H₀) and alternative (H₁) hypotheses to address the second research question:

H₀: Usage frequency of environmentally sustainable practices by ISO 14001 certified firms significantly higher than that of the non-certified firms.

H₁: Usage frequency of environmentally sustainable practice i by ISO 14001 certified firms is significantly higher than that of non-certified firms, 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,” (4) “control dust with fine water sprays,” (5) “avoid burning materials on site,” (6) “use chlorine-free water for the AC,” (7) “install fine mesh screening close to dust sources,” (8) “build on-site systems for reclaiming/filtering condensate water,” (9) “feed excess energy that is generated on-site back into the grid (‘net metering),” and (10) “build on-site systems for reclaiming/filtering condensate water.”

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

| Practice Description                                                                 | ISO 14001 Certified Firms | Non-Certified Firms |
|-------------------------------------------------------------------------------------|----------------------------|--------------------|
| Maintain the site equipment periodically                                            | 38.6%                      | 29.7%              |
| Minimize the utilization of generators                                             | 29.5%                      | 29.3%              |
| Use chlorine-free gases for the AC                                                 | 28.4%                      | 32.4%              |
| Avoid burning materials on site                                                    | 29.5%                      | 16.6%              |
| Choose local or regional materials to reduce transportation pollution               | 4.3%                       | 8.5%               |
| Control dust with fine water sprays                                                | 20.8%                      | 28.6%              |
| Install fine mesh screening close to dust sources                                  | 32.8%                      | 28.6%              |
| Cover piles of construction materials                                             | 17.0%                      | 25.5%              |
| Improve indoor air quality using a proper ventilation                              | 13.5%                      | 28.2%              |
| Improve indoor air quality using a proper ventilation                              | 14.3%                      | 32.0%              |
| Improve indoor air quality using a proper ventilation                              | 14.3%                      | 22.0%              |
| Improve indoor air quality using a proper ventilation                              | 36.3%                      | 27.4%              |
| Improve indoor air quality using a proper ventilation                              | 36.3%                      | 18.3%              |

*Table 3.* Summary of responses to the usage frequency of practices related to air pollution reduction.
(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

Table 3. Usage frequency of practices.

| Category                          | Practice                                                                 | All firms | Certified firms | Non-certified firms | p-Values for the Mann-Whitney U Test results |
|----------------------------------|--------------------------------------------------------------------------|-----------|----------------|---------------------|---------------------------------------------|
| 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                                       |
|                                  | Implement on-site waste management solutions                             | 3         | 3              | 3                   | 0.423                                       |
| Energy saving                    | Use solar panels for hot water generation                                | 3         | 3              | 3                   | 0.271                                       |
|                                  | Use photovoltaic 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 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         | 3              | 3                   | 0.107                                       |
|                                  | 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                                       |
| Air pollution reduction          | Improve indoor air quality using a proper ventilation system             | 3         | 4              | 3                   | 0.038                                       |
|                                  | 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                                       |
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:

\[ H_0: \text{There is no significant difference between the proportion of certified large firms and the proportion of certified SMFs.} \]

\[ H_1: \text{The proportion of large certified firms is significantly larger than the proportion of SMF certified firms.} \]

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 (Selih 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-Hagggar 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 polices 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).
References

Abraham, F., and S. Schmucler. 2017. “Addressing the SME Finance Problem.” Research and Policy Briefs. Kuala Lumpur: World Bank Malaysia Hub https://documents1.worldbank.org/curated/en/809191507620842321/pdf/Addressing-the-SME-finance-problem.pdf

Adamec, J., S. Janousková, and T. Hák. 2021. “How to Measure Sustainable Housing: A Proposal for an Indicator-Based Assessment Tool.” Sustainability 13 (3): 1152. doi:10.3390/su13031152.

Afabe, M. 2019. “Building Green – Minimizing the Environmental Impact of Construction.” Bold Business, January 10. https://www.boldbusiness.com/infrastructure/green-construction-environmental-impact

Alencar, L., M. Alencar, L. Lima, E. Trindade, and L. Silva. 2021. “Sustainability in the Construction Industry: A Systematic Review of the Literature.” Journal of Cleaner Production 289: 125730. doi:10.1016/j.jclepro.2020.125730.

Al-Hajj, A., and K. Hamani. 2011. “Material Waste in the UAE Construction Industry: Main Causes and Minimization Practices.” Architectural Engineering and Design Management 7 (4): 221–235. doi:10.1080/17452007.2011.594576.

Araujo, A., A. Carneiro, and R. Palha. 2020. “Sustainable Construction Management: A Systematic Review of the Literature with Meta-Analysis.” Journal of Cleaner Production 256: 120350. doi:10.1016/j.jclepro.2020.120350.

Ardic, O., N. Mylenko, and V. Saltane. 2012. “Access to Finance by Small and Medium Enterprises: A Cross-Country Analysis with a New Data Set.” Pacific Economic Review 17 (4): 491–513. doi:10.1111/j.1468-0106.2012.00596.x.

Armenia, S., R. Dangelico, F. Nonino, and A. Pompei. 2019. “Sustainable Project Management: A Conceptualization-Oriented Review and a Framework Proposal for Future Studies.” Sustainability 11 (9): 2664. doi:10.3390/su11092664.

Arocena, P., R. Orcos, and F. Zouaghi. 2021. “The Impact of ISO 14001 on Firm Environmental and Economic Performance: The Moderating Role of Size and Environmental Awareness.” Business Strategy and the Environment 30 (2): 955–967. doi:10.1002/bse.2663.

Arochi, I., W. Rasdorf, J. Hummer, and P. Lewis. 2016. “Time and Cost Characterisation of Emissions from Non-Road Diesel Equipment for Infrastructure Projects.” International Journal of Sustainable Engineering 10 (2): 1–134. doi:10.1080/19397038.2016.1218569.

Bai, M., D. Bryde, D. Fearon, and E. Ochieng. 2013. “Stakeholder Engagement: Achieving Sustainability in the Construction Sector.” Sustainability 5 (2): 695–710. doi:10.3390/su05020695.

Bamburgde, J., A. Kamaruddeen, M. Nawi, A. Adeleke, M. Salimon, and W. Ajibieke. 2019. “Analysis of Some Factors Driving Ecological Sustainability in Construction Firms.” Journal of Cleaner Production 208: 1537–1545. doi:10.1016/j.jclepro.2018.10.229.

Banihashemi, S., M. Reza Hosseini, H. Golizadeh, and S. Sankaran. 2017. “Critical Success Factors (CSFs) for Integration of Sustainability into Construction Project Management Practices in Developing Countries.” International Journal of Project Management 35 (6): 1103–1119. doi:10.1016/j.ijproman.2017.01.014.

Benachio, G., M. Freitas, and S. Tavares. 2020. “Circular Economy in the Construction Industry: A Systematic Literature Review.” Journal of Cleaner Production 260: 121046. doi:10.1016/j.jclepro.2020.121046.

BIMhow. 2015. “Impact of the Construction Industry on the Environment.” http://www.bimhow.com/impact-of-the-construction-industry-on-the-environment

Boiral, O., I. Heras-Saizarbitoria, and M. Brotherton. 2018. “Corporate Biodiversity Management through Certifiable Standards.” Business Strategy and the Environment 27 (3): 389–402. doi:10.1002/bse.2005.

Boiral, O., L. Guillaumie, I. Heras-Saizarbitoria, and C. Tayo. 2018. “Adoption and Outcomes of ISO 14001: A Systematic Review.” International Journal of Management Reviews 20 (2): 411–432. doi:10.1111/ijmrv.12139.

Brahmana, R., and M. Kontesa. 2021. “Does Clean Technology Weaken the Environmental Impact on the Financial Performance?” Insight from Global Oil and Gas Companies.” Business Strategy and the Environment 30 (7): 3411–3423. doi:10.1002/bse.2810.

Bravi, L., G. Santos, A. Pagano, and F. Murmura. 2020. “Environmental Management System According to ISO 14001: 2015 as a Driver to Sustainable Development.” Corporate Social Responsibility and Environmental Management 27 (6): 2599–2614. doi:10.1002/csr.

Carvalho, M., and R. Rabechini. 2017. “Can Project Sustainability Management Impact Project Success? An Empirical Study Applying a Contingent Approach.” International Journal of Project Management 35 (6): 1120–1132. doi:10.1016/j.ijproman.2017.02.018.

Cassells, S., K. Lewis, and A. Findlater. 2011. “SMEs and ISO 14001 Adoption: A New Zealand Perspective.” Small Enterprise Research 18 (1): 19–32. doi:10.5172/ser.18.1.19.

Chen, W., R. Jin, Y. Xu, D. Wanatowski, B. Li, L. Yan, Z. Pan, and Y. Yang. 2019. “Adopting Recycled Aggregates as Sustainable Construction Materials: A Review of the Technical Literature.” Construction and Building Materials 218: 483–496. doi:10.1016/j.conbuildmat.2019.05.130.

Chiarini, A. 2019. “Factors for Succeeding in ISO 14001 Implementation in Italian Construction Industry.” Business Strategy and the Environment 28 (5): 794–803. doi:10.1002/bse.2281.

Chipulu, M., U. Ojiako, A. Marshall, T. Williams, U. Bittici, C. Mota, Y. Shou, et al. 2019. “A Dimensional Analysis of Stakeholder Assessment of Project Outcomes.” Production Planning & Control 30 (13): 1072–1090. doi:10.1080/09537287.2019.1567859.

Chofreh, A., F. Goni, M. Malik, H. Khan, and J. Klemeš. 2019. “The Imperative and Research Directions of Sustainable Project Management.” Journal of Cleaner Production 238: 117810. doi:10.1016/j.jclepro.2019.117810.

Dasović, B., M. Galić, and U. Klansék. 2020. “A Survey on Integration of Optimization and Project Management Tools for Sustainable Construction Scheduling.” Sustainability 12 (8): 3405. doi:10.3390/su12083405.

Dixon, J., and L. Fallon. 1989. “The Concept of Sustainability: Origins, Extensions, and Usefulness for Policy,” Society & Natural Resources 2 (1): 73–84. doi:10.1080/08941928909380675.

Dubai Municipality. 2017. “Green Build in Dubai.” https://www.dm.gov.ae/municipality-business/al-safat-dubai-green-building-system/green-building-in-dubai
El-Sayegh, S., T. AbdRaboh, D. Elian, N. ElJarad, and Y. Ahmad. 2020. "Developing a Bi-Parameter Bidding Model Integrating Price and Sustainable Construction Practices." International Journal of Construction Management: 1–8. doi:10.1080/15623599.2020.1768625.

Garrido, E., C. González, and R. Orcos. 2020. "ISO 14001 and CO2 Emissions: An Analysis of the Contingent Role of Country Features." Business Strategy and the Environment 29 (2): 698–710. doi:10.1002/bse.2402.

Gharzelddeen, M., and S. Beheiry. 2015. "Investigating the Use of Green Design Parameters in UAE Construction." International Journal of Sustainable Engineering 8 (2): 93–101. doi:10.1080/19397038.2014.895066.

Gijzel, D., M. Bosch-Rekveldt, D. Schraeven, and M. Hertogh. 2019. "Integrating Sustainability into Major Infrastructure Projects: Four Perspectives on Sustainable Tunnel Development." Sustainability 12 (1): 6. doi:10.3390/su12010006.

Goh, C., H. Chong, L. Jack, and A. Faris. 2020. "Revisiting Triple Bottom Line within the Context of Sustainable Construction: A Systematic Review." Journal of Cleaner Production 252: 119884. doi:10.1016/j.jclepro.2019.119884.

Gunduz, M., and M. Almuajebh. 2020. "Critical Success Factors for Sustainable Construction Project Management." Sustainability 12 (5): 1990. doi:10.3390/su12051990.

Haavaldsen, T., O. Laedre, G. Volden, and J. Lohne. 2014. "Sustainable Tunnel Development. Infrastructure Projects: Four Perspectives on Environment Role of Country Features.

Ikram, M., Q. Zhang, R. Sroufe, and S. Shah. 2020. "Towards a Sustainable Environment: The Nexus between ISO 14001, Renewable Energy Consumption, Access to Electricity, Agriculture and CO₂ Emissions in SAARC Countries." Sustainable Production and Consumption 22: 218–230. doi:10.1016/j.spc.2020.03.011.

International Organization for Standardization. 2010. ISO Survey of Certifications to Management System Standards. Geneva: ISO. https://isotc.iso.org/livelink/livelink

International Organization for Standardization. 2020. ISO Survey of Certifications to Management System Standards. Geneva: ISO. https://www.iso.org/the-iso-survey.html.

Johnstone, L. 2020. "The Construction of Environmental Performance in ISO 14001-Certified SMEs." Journal of Cleaner Production 263: 121559. doi:10.1016/j.jclepro.2020.121559.

Johnstone, L., and P. Hallberg. 2020. "ISO 14001 Adoption and Environmental Performance in Small to Medium Sized Enterprises." Journal of Environmental Management 266: 110592. doi:10.1016/j.jenvman.2020.110592.

Kabirifar, K., M. Mojtabahed, C. Wang, and V. Tam. 2020. "Construction and Demolition Waste Management Contributing Factors Coupled with Reduce, Reuse, and Recycle Strategies for Effective Waste Management: A Review." Journal of Cleaner Production 263: 121265. doi:10.1016/j.jclepro.2020.121265.

Kibert, C. 2013. Sustainable Construction: Green Building Design and Delivery. Hoboken, NJ: Wiley.

Li, D., M. Huang, S. Ren, X. Chen, and L. Ning. 2018. "Environmental Legitimacy, Green Innovation, and Corporate Carbon Disclosure: Evidence from CDP China 100." Journal of Business Ethics 150 (4): 1089–1104. doi:10.1007/s10551-016-3187-6.

Liu, A., W. Lau, and R. Fellows. 2012. "The Contributions of Environmental Management Systems towards Project Outcome: Case Studies in Hong Kong." Architectural Engineering and Design Management 8 (3): 160–169. doi:10.1080/17452007.2012.681173.

Liu, B., B. Xue, J. Meng, X. Chen, and T. Sun. 2020. "How Project Management Practices Lead to Infrastructure Sustainable Success: An Empirical Study Based on Goal-Setting Theory." Engineering, Construction and Architectural Management 27 (10): 2797–2833. doi:10.1108/ECAM-08-2019-0463.

Liu, G., H. Yang, Y. Fu, C. Mao, P. Xu, J. Hong, and R. Li. 2020. "Cyber-Physical System-Based Real-Time Monitoring and Visualization of Greenhouse Gas Emissions of Prefabricated Construction." Journal of Cleaner Production 246: 119059. doi:10.1016/j.jclepro.2019.119059.

Liu, J., C. Yuan, M. Hafeez, and X. Li. 2020. "ISO 14001 Certification in Developing Countries: Motivations from Trade and Environment." Journal of Environmental Planning and Management 63 (7): 1241–1265. doi:10.1080/09640568.2019.1649642.

Ma, Y., Y. Liu, A. Appolloni, and J. Liu. 2021. "Sensitivity of Firm Size Measures to Practices of ISO 14001, Renewable Energy Consumption, Access to Electricity, Agriculture and CO₂ Emissions in SAARC Countries." Sustainable Production and Consumption 22: 218–230. doi:10.1016/j.spc.2020.03.011.

Ma, Y., Y. Liu, A. Appolloni, and J. Liu. 2021. "Does Green Public Procurement Encourage Firm’s Environmental Certification Practice?" The Mediation Role of Top Management Support." Corporate Social Responsibility and Environmental Management 28 (3): 1002–1017. doi:10.1002/csr.2101.

Mansell, P., S. Philbin, and E. Konstantinou. 2020. "Redefining the Use of Sustainable Development Goals at the Organization and Project Levels – A Survey of
United States Small Business Administration (USSBA). 2019. *Table of Small Business Standards Matched to North American Industry Classification Codes*. Washington, DC: USSBA. https://www.sba.gov/sites/default/files/2019-08/SBA%20Table%20of%20Size%20Standards_Effective%20Aug%2019%2C%202019

Wang, J., and M. Zhao. 2020. “Economic Impacts of ISO 14001 Certification in China and the Moderating Role of Firm Size and Age.” *Journal of Cleaner Production* 274: 123059. doi:10.1016/j.jclepro.2020.123059.

Waxin, M., S. Knuteson, and A. Bartholomew. 2019. “Drivers and Challenges for Implementing ISO 14001 Environmental Management Systems in an Emerging Gulf Arab Country.” *Environmental Management* 63 (4): 495–506. doi:10.1007/s00267-017-0958-5.

Willar, D., E. Waney, D. Pangemanan, and R. Mait. 2020. “Sustainable Construction Practices in the Execution of Infrastructure Projects: The Extent of Implementation.” *Smart and Sustainable Built Environment* 10 (1): 106–124. doi:10.1108/SASBE-07-2019-0086.

Wu, W., S. An, C. Wu, S. Tsai, and K. Yang. 2020. “An Empirical Study on Green Environmental System Certification Affects Financing Cost of High Energy Consumption Enterprises – Taking Metallurgical Enterprises as an Example.” *Journal of Cleaner Production* 244: 118848. doi:10.1016/j.jclepro.2019.118848.

Yates, J. 2014. “Design and Construction for Sustainable Industrial Construction.” *Journal of Construction Engineering and Management* 140 (4): 673. doi:10.1061/(ASCE)CO.1943-7862.0000673.

Yu, W., S. Cheng, W. Ho, and Y. Chang. 2018. “Measuring the Sustainability of Construction Projects throughout Their Lifecycle: A Taiwan Lesson.” *Sustainability* 10 (5): 1523. doi:10.3390/su10051523.

Yusof, N., M. Iranmanesh, and H. Awang. 2015. “Pro-Environmental Practices among Malaysian Construction Practitioners.” *Advances in Environmental Biology* 9 (5): 117–119. doi:10.6084/m9.figshare.1437780.v1.

Zeng, S., C. Tam, V. Tam, and Z. Deng. 2005. “Towards Implementation of ISO 14001 Environmental Management Systems in Selected Industries in China.” *Journal of Cleaner Production* 13 (7): 645–656. doi:10.1016/j.jclepro.2003.12.009.

Zuofa, T., and E. Ochieng. 2016. “Sustainability in Construction Project Delivery: A Study of Experienced Project Managers in Nigeria.” *Project Management Journal* 47 (6): 44–55. doi:10.1177/875697281604700604.