Linking the environmental practice of construction firms and the environmental behaviour of practitioners in construction projects

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ARTICLE INFO

Article history:
Received 3 June 2015
Received in revised form 6 January 2016
Accepted 29 January 2016
Available online xxx

Keywords:
Environmental behavior
Environmental practice
Construction firms
Construction projects
Environmental sustainability

ABSTRACT

The notion that the construction industry can contribute to environmental sustainability has increased the demand for environmental sustainability in the sector. Research has shown that environmental quality is associated with human behaviour. Therefore, minimising waste generation and energy consumption in construction projects is important. This study investigates the influence of the environmental practice of construction firms on practitioners’ environmental behaviour during project implementation. Data for the study are obtained from a sample of 375 architectural, engineering, and contracting firms in Malaysia. The partial least squares technique is used for data analysis. The results indicate that firms’ energy efficiency and waste management practices have a positive effect on the environmental behaviour of practitioners during project implementation. The results imply that when construction firms are engaged in energy efficiency or waste management activities, an increase in environmental behaviour will occur in the projects in which these practitioners are involved. This study is one of the first attempts to investigate the relationship between the environmental practices of construction firms and the environmental behaviour of professionals during project implementation within the construction industry. The findings are useful for construction practitioners in terms of exerting environmental behaviour in project implementation, which is essential for facilitating environmental sustainability in the construction sector.

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1. Introduction

The severe pollution and exploitation of scarce natural resources caused by the construction industry is well documented (Hillestad et al., 2010). Fuertes et al. (2013) indicated that the construction industry is a main source of air, water, and noise pollution. In 2008, the European Union recorded a total of 859 million tons of waste generation from construction activities, which is more than one-third (37.56%) of all waste produced by economic activities (Eurostat, 2013). In China, construction-related activities account for 45.5% of the overall energy consumption (Zhaqian and Yi, 2006) and 25% of the overall solid waste (Lu and Tam, 2013). Buildings, as the major output of the construction industry in Malaysia, consumed 40% of annual energy and released up to 30% of energy-related greenhouse gas emissions (MIGHT, 2014). These problems demonstrate the great potential of the construction industry to contribute to environmental sustainability (ES) by minimising the negative effects of construction activities (Birkeland, 2014).

One of the main challenges in implementing ES in the construction industry is that most construction activities that harm the environment are dependent on a construction project team that has unique characteristics (Bakker, 2010; Pich et al., 2002). A construction project team is established to perform a certain task (e.g., constructing buildings and infrastructure such as highways, power
plants, or bridges) and will be dissolved once the task is completed (Bakker, 2010; Brockhoff, 2006). This temporary characteristic hinders learning from past experiences and knowledge sharing among key players (Tyssen et al., 2014). As an unsurprising result, the construction industry has progressed little in terms of environmental performance, and the number of projects that have adopted ES is limited (Shi et al., 2014; Zainul Abidin et al., 2013). Moreover, a construction project team is a heterogeneous organisation consisting of a project owner or client, architects, engineers, and contractors (Shi et al., 2014). Architects and engineers (AEs) provide professional services such as design and project management and interact with contractors as client representatives (Lu et al., 2013). During the design stage, AEs provide advice on materials and technology for use in the project (Low et al., 2014); AEs also monitor the work of the contractor and subcontractors and the overall implementation of the project until completion (Shi et al., 2014). Generally, contractors are involved in a project during the construction phase and are responsible for implementing the actual construction work, including site management and the supervision of subcontractors’ work (Yong and Mustaffa, 2013). In the construction phase, the use of machinery and heavy equipment for activities such as excavation, earthworks, concreting, and lifting, create significant environmental drawbacks (Waris et al., 2014). Furthermore, construction activities produce waste and consume significant amounts of energy and resources that contribute to the sector’s largest share of the total negative impact on the environment (Guggemos and Horvath, 2006). Therefore, the environmental behaviour (EB) of the aforementioned practitioners (architects, engineers, and contractors) during project implementation is important in promoting ES. Regulations and technology are insufficient for promoting ES in the construction industry but lack a contribution from all players to ensure that their actions do not harm the environment (Hakkinen and Belloni, 2011). AEs have the capacity to propose the ES agenda when advising clients on the appropriate materials and technology for a project (Hoof and Dijken, 2008). Similarly, contractors can support ES by implementing responsible construction practices during project implementation (Shen and Tam, 2002).

Presently, evidence from the literature is lacking on whether the environmental practices (EPs) of firms have an effect on the EB of practitioners at project level. Existing studies on ES in the construction sector do not focus on whether the EP observed at construction firms will lead to similar behaviour on construction projects. Most studies on the environment in the construction industry concentrate on the implementation of environmental system in various construction organisations (e.g., Ahn et al., 2013; Zainul Abidin, 2010; Zainul Abidin et al., 2013). Ahn et al. (2013) explored and ranked the motivators and hindrances for sustainable construction and design in the US construction industry. They revealed that indoor environmental quality, energy conservation, resources conservation, and waste reduction are the key drivers for sustainable construction and design, whereas project start-up costs, long pay back periods for sustainable practices, the tendency to use conventional practices, and a lack of knowledge and skills of contractors are the main barriers. Zainul Abidin (2010) studied the implementation of ES in client organisations and investigated the drivers and barriers to ES in the Malaysian construction industry (Zainul Abidin et al., 2013). Rodriguez et al. (2011) assessed ES implementation with regard to resources, positions, duties, and power in Spanish civil engineering projects. They identified inadequate training, experience, and resources as the barriers that prevent true commitment to improving the deteriorating EP of construction companies. A few studies that concentrate on the implementation of an environmental system at the project level exist. Gangoel et al. (2014) analysed the effectiveness of waste management in construction projects to improve on-site environmental performance. Similarly, Fuertes et al. (2013) formed an environmental impact causal model that functions as a decision-making tool to reduce the adverse environmental impact of construction sites. Weston (2011) reviewed the actual planning applications for construction projects to justify whether such projects should be subjected to an environmental impact assessment (EIA). The results suggested that many local planning authorities that participated in the study do not apply EIA because of a lack of knowledge and training.

Little is actually known about the influence of the EP observed in construction firms on the EB of practitioners during project implementation. Fuertes et al. (2013) indicated the insufficient evidence on EP in the construction sector. The few studies on the relationship of EB in two different places focused on EB at the workplace and at home (e.g., Thogersen and Olander, 2003; Littleford et al., 2014). Thogersen and Olander (2003) investigated whether people will implement EB consistently between their workplace and their homes and revealed that the consistency of EB in these places depends on the perceived similarity between the behaviour in both places and on the perceived importance of behaving in an environmentally responsible way. Littleford et al. (2014) recently investigated the effect of the lighting and computer use behaviour of workers in an office on their behaviour at home. This study revealed that insufficient evidence exists to prove such an effect. To fill this gap in literature, the present study investigated whether the EP observed in construction firms influences the EB of practitioners in construction projects. Specifically, this study aims to investigate whether the EP in construction firms can lead to the development of EB in construction projects.

In acknowledgement of the major opportunities that a construction project has for improving their environmental performance, the present study adopts a different track by using the construction firm and construction project as research focus. Theoretically, this study extends existing knowledge that focuses on ES at only one specific level, either the organisational level (Ahn et al., 2013; Zainul Abidin, 2010; Zainul Abidin et al., 2013) or the project implementation level (Gangoel et al., 2014; Rodriguez et al., 2011; Weston, 2011). The present study also broadens the scope of Thogersen and Olander (2003) and Littleford et al. (2014) to include the effects of construction firms on projects in the construction sector, which scholars have indicated as a major environmental polluter.

The practical contribution of the paper is information on the effectiveness of environmental campaigns for firm EP. Demonstrating the relationship between firms’ EP and EB during project implementation may motivate construction firm managers to implement EP within their firms to improve the EB of practitioners during a construction project, which could cause the widespread implementation of ES in the industry. The findings will also serve as a guide to augment the industry’s ES initiatives and facilitate the achievement of the broader goal of sustainability in the construction industry.

2. Literature review

This section provides an overview of the underlying theoretical framework for this study. The environmental behaviour in construction projects and environmental practices of construction firms are reviewed.

2.1. Environmental behaviour in construction projects

Construction projects have been heavily criticised for their contribution to land, air, and water pollution and for their waste,
noise, dust, and hazardous emissions (Fuertes et al., 2013). Given the rising concerns regarding global warming and societal issues, the construction industry is challenged with growing pressure by stakeholders and regulatory bureaus to be environmentally friendly in their implementation of day to day business (Ahn et al., 2013; Zainul Abidin et al., 2013). Environmental awareness necessitates technological change in the production process (e.g., optimising the utilisation of materials, minimising on-site energy use, and reducing waste) and cultural and behavioural adjustments in terms of the outputs of the production process (e.g., eco-homes, green buildings) (Weston, 2011).

In this study, EB refers to behaviour from the beginning to the completion of a construction project that inflicts as little harm as possible on the environment or even benefits the environment (Gagnon et al., 2012; Yusof et al., 2015). EB is evident in practices of resource consumption reduction, reuse, and recycling during the design, planning, and implementation phases of a project (Gangolells et al., 2014; Oyedele et al., 2014). The EB in a construction project can be observed by addressing the effects of construction activities on water quality, air quality, public health, land pollution, energy consumption, and ecology (Shen et al., 2011). EB in construction projects includes behaviour during the selection of raw materials, consumption of energy, design and technology, and construction and project management approaches that are recyclable, biodegradable, reusable, remanufacturable, repairable, or disposable (Mora, 2007; Oyedele et al., 2014). Thus, EB is also reflected in the monitoring of waste production, including the reduction of waste and the scrutiny of the manner in which waste is disposed of and the amount of pollution it generates (Gangolells et al., 2014). The reuse and recycling of waste materials such as fly ash and iron slag instead of cement in concrete production to enhance concrete durability can also be considered as EB in a construction project (Mora, 2007). Gangolells et al. (2014) revealed that the most common waste management practices during the construction phase are on-site cleanliness and arrangement, proper storage of raw materials, and the presence of a waste management authority. The least common practices include the use of a mobile crusher on-site and the distribution of a waste management plan to all workers to ensure that the plan objectives are being met (Gangolells et al., 2014).

The negative impact of construction activities can be minimised if appropriate knowledge and skills are made available and put into practice during the construction phase of a project (Mora, 2007; Yusof et al., 2015). EB in a construction project requires commitment to environmentally friendly activities and awareness of the consequences of hazardous activities; thus, EB involves the attainment of a balance between actions and outcomes that induce negative environmental impacts (Fuertes et al., 2013). EB in construction projects requires collaboration among the key players of construction practitioners to ensure that both the product and project output yield positive environmental effects (Weston, 2011). Past evidence, however, shows that construction projects lack environmental performance for the following reasons: a lack in training and knowledge among environmental officers (Rodriguez et al., 2011; Weston, 2011; Zainul Abidin, 2010); a perception that environmental management is less important than project productivity (Rodriguez et al., 2011); resistance from project members (Weston, 2011); and a lack of enforcement by the respective authorities (Zainul Abidin, 2010).

2.2. Environmental practices of construction firms

Generally, the EP of a construction firm is the embodiment of proactively exceeding regulatory compliance on environmental concerns (Gadenne et al., 2009). A firms' EP can be classified into three major activities: energy efficiency, waste management, and involvement in environmental efforts (Gadenne et al., 2009; Lu et al., 2013). Energy efficiency is about minimising the use of energy while providing the same service or getting the most out of the total energy used (Gadenne et al., 2009). To achieve the overall objective of protecting the environment, energy efficiency must be implemented together with energy conservation (Rodriguez et al., 2011). Waste management is based on the commonly known concept of the 3Rs, i.e., reduce, reuse, and recycle (Wang et al., 2015). Effective waste management can prevent or minimise wastage and increase the rate of recycling or reuse, thus contributing to the overall aim of ES (Rodriguez et al., 2011; Wang et al., 2014). Firms' involvement in environmental efforts can be observed through the sponsoring of community activities to improve the environment, pledging to commit to environmental action, signing a petition against activities that destroy the environment, or using environment-friendly products (Gadenne et al., 2009). The involvement of firms in environmental efforts is developed through positive environmental responses, which involve changing traditional reactive attitudes to proactive ones (Fraj-Andrés et al., 2009).

Increasing awareness of the importance of EP among construction firms is the first step toward the true implementation of EP (Hakkinen and Belloni, 2011). For example, some firms may be adamant in adopting EP regardless of whether their profits will increase or because they are asked to do so by law (Mora, 2007). By contrast, other firms are willing to adopt EP but are faced with constraints that create resistance to adopting such behaviours (Rodriguez et al., 2011; Zainul Abidin et al., 2013). Thus, firms may wish to maintain their existing way of doing business because they may not be prepared to sacrifice convenience, accept low performance levels, or face competency realignment. These constraints may hinder such firms from implementing EP. Therefore, the implementation of EP requires firms to revisit their products and services, which entails a concerted effort between their different units and departments (Hillestad et al., 2010).

3. Model conceptualisation and hypotheses development

This study proposes that the EP integrated in construction firms, such as energy and resource efficiency, waste management, and environmental commitment, determines the EB of practitioners in construction projects. Most studies on ES do not focus on the influence of EP on the behaviour of practitioners in construction projects. To address this gap, the effects of EP in construction firms, specifically energy efficiency, waste management, and environmental involvement, on the EB of practitioners in a construction project were investigated. The relationship between independent variables (energy efficiency, waste management, and environmental involvement) and the dependent variable EB during project implementation is illustrated in Fig. 1.

3.1. Energy efficiency

Energy efficiency is the enhancement of the energy performance of a building through an artificial indoor climate by using heating and cooling systems, natural ventilation, surface insulation, and design optimisation, and controlling user behaviour (Li and Shui, 2015). Mardookhy et al. (2014) observed that the annual rate at which global energy consumption is increasing is on the rise. Energy consumption is generally dominated by electricity, followed by gas, diesel, kerosene, inverters, and so on. This trend prompts energy efficiency through EP at all levels. Energy efficiency remains a key threshold of the sustainable development agenda. Scholars have established that a remarkable percentage of energy saving can
be accomplished through energy efficiency (Li and Shui, 2015; Mardookhy et al., 2014). In the construction sector, energy efficiency is about sensitive design that utilises proper and existing technology that can reduce energy consumption (for heating and cooling) up to 65% (Li and Shui, 2015). The energy efficiency practices of construction firms are expected to affect the behaviour of practitioners during project implementation. Therefore, the following hypothesis is developed:

**H1**: A positive relationship exists between the energy efficiency practices of construction firms and the EB of practitioners in construction projects.

### 3.2. Waste management

Waste management involves the reduction, reuse, and recycling of products after they have served their primary function for improved environmental management (Barr et al., 2001). Most studies on waste management dwell on the implementation of waste management behaviour (e.g., Wang et al., 2014, 2015; Gangolells et al., 2014). Wang et al. (2015) studied waste management behaviour (reduce, reuse, and recycle) that emphasises environmental values, situational factors, and psychological factors.

Another study by Wang et al. (2014) focused on the design stage and identified factors that impact the success of construction waste minimisation in Shenzhen, China. Gangolells et al. (2014) studied the effectiveness of waste management practices in Spanish construction projects. Nevertheless, the extent to which such waste management practices by construction firms affect the EB of practitioners in construction projects remains unknown. Therefore, the following hypothesis is developed:

**H2**: A positive relationship exists between the waste management practices of construction firms and the EB of practitioners in construction projects.

### 3.3. Involvement

The involvement of firms in EB entails participation in activities such as workplace interventions to encourage responsible behaviour toward the environment in employees, use of environmentally responsible products, and partnering with environment-friendly suppliers (Hillestad et al., 2010). Stringer (2009) viewed involvement as action that is guided by strong political and organisational norms and as having the resilience of frameworks of power. These efforts are geared toward positive environmental outcomes, for example, assistance for environmentally friendly services, obvious steps in preserving resources, and joint efforts with eco-friendly suppliers (Fraj-Andrés et al., 2009). However, the effect of construction firms’ involvement in EPs on the EB of practitioners during project implementation is unknown. Therefore, the following hypothesis is developed:

**H3**: A positive relationship exists between the involvement of construction firms in EP and the EB of practitioners in construction projects.

### 4. Methods

The research method follows a questionnaire-based field survey approach to test the relationships within the research model. First, all constructs were operationalised, and a questionnaire was developed. Data were then collected within the Malaysian construction industry.

#### 4.1. Procedure

A quantitative survey with a structured questionnaire was employed, with construction firm practitioners (architects, engineers, and contractors) in Penang, Malaysia, constituting the population of the study. These construction professionals were selected as respondents because they have a major influence on the environment due to their key roles in designing, planning, project execution, and monitoring of construction projects (Lu et al., 2013; Yong and Mustaffa, 2013; Zainul Abidin et al., 2013). The state of Penang was chosen because it has the highest number of construction activities in Malaysia (Yusof et al., 2014). The total numbers of architects (138), engineers (453), and contractors (3354) in Penang were obtained from the Board of Architects Malaysia (2015), Board of Engineers Malaysia (2015), and Construction Industry Development Board (2015), respectively. For a 95% confidence level and a population of 3945 architects, engineers, and contractors, a sample size of 350 is required (Krejcie and Morgan, 1970).

The questionnaire survey was administered face-to-face at the offices of construction firms that operate in Penang, Malaysia. The researcher made telephone calls to all registered construction firms in Penang, explained to them the purpose of the study, and solicited their participation. The addresses and telephone numbers of the firms were obtained from the Board of Architects, Board of Engineers, and Construction Industry Development Board. A total of 1000 questionnaires were distributed and a total of 384 responses were received. Of the 384 responses, 4 were partially completed and 5 were discarded during the data cleaning process due to careless responses (e.g., selecting one number throughout the survey), for a total of 375 responses (37.5% response rate). This response rate is higher than that in the survey of client organisations performed by Zainul Abidin et al. (2013), the survey of developers, consultants, and contractor firms in Malaysia by Yong and Mustaffa (2013), and the survey of architectural firms in Singapore by Low et al. (2014). This result is probably due to the strategy adopted in the present study of distributing the survey forms face-to-face.

#### 4.2. Measure of constructs

The questionnaire comprised a total of 44 items dispersed across the following four sections: basic information about the firm, personal information about respondents, EPs (energy efficiency, waste management, and environmental involvement) of the firm, the relationship between EB and EPs in construction projects.
and project EB of the practitioners. Except for those in the basic information and personal information sections, questionnaire items were measured using a 5-point Likert scale anchored by “never” and “always”. To ensure the validity of the content, the items were adapted from previous studies. The items for energy efficiency (5 items) and environmental involvement (5 items) were adapted from Fraj-Andrés et al. (2009) and Stringer (2009). Waste management was measured using two sub-dimensions, namely, paper recycling (3 items) and office waste recycling (5 items), which were adapted from Stringer (2009). The measures for project EB (15 items) were adapted from Gangolells et al. (2014), Shen et al. (2011), and Gagnon et al. (2012).

5. Results

Many studies use structural equation modelling (SEM) (e.g., Zailani et al., 2015; Abdullah et al., 2015) due to its ability to perform a full test of theories and concepts (Rigdon, 1998). There are two techniques under SEM: covariance-based techniques (CB-SEM) and variance-based partial least squares (PLS-SEM). Researchers, for example, Sosik et al. (2009) and Gefen et al. (2011), have compared both techniques in terms of their methodologies and concepts. Sosik et al. (2009) revealed that the strengths of PLS-SEM are the weaknesses of CB-SEM, and vice versa. The technique that is selected will depend on one’s research objectives, data characteristics, and model structure (e.g., Gefen et al., 2011; Reinartz et al., 2009). Hair et al. (2013) suggested that for exploratory studies, PLS-SEM is superior to CB-SEM. PLS-SEM is therefore selected for this study as the study is exploratory in nature as the effect of EP of construction firms on the EB of practitioners has not been previously tested. The PLS-SEM technique was employed using SmartPLS 3.0. Following Hair et al. (2013), this study applied a two-step approach for data analysis to determine the reliability and validity of the measures prior to testing the model’s structural relationship. The first step involved analysing the measurement model, followed by analysing the structural relationships among the latent constructs as the second step (see Nikbin et al., 2015; Zailani et al., 2014).

5.1. The sample

The final sample consisted of 176 (46.9%) contractors, 137 (36.5%) engineers, and 62 (16.5%) architects. The majority of the participating companies (68.6%) have been operating for more than 10 years in Malaysia and have foreign-based ownership (72.5%). The majority of respondents have less than 10 years of working experience in the construction industry (62.7%). With regard to the number of employees in the firms, the data indicated that 75.7% of the firms have less than 50 employees.

5.2. Measurement model

The reliability and validity of the constructs were assessed. The loadings of all items were above 0.6 (Table 1), signifying satisfactory item reliability (Chin et al., 1997, pp. 354). The composite reliability (CR) of all constructs was above 0.7, thus satisfying the rule of

<table>
<thead>
<tr>
<th>Construct items</th>
<th>Factor loadings</th>
<th>CR</th>
<th>AVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>My firm uses sensors or timers to save electricity in intermittent-use areas 0.789</td>
<td>0.860</td>
<td>0.554</td>
<td></td>
</tr>
<tr>
<td>My firm uses energy-saving light bulbs in all areas 0.854</td>
<td>0.916</td>
<td>0.686</td>
<td></td>
</tr>
<tr>
<td>My firm encourages employees to power off their computers after a few minutes of inactivity 0.612</td>
<td>0.916</td>
<td>0.751</td>
<td></td>
</tr>
<tr>
<td>My firm uses energy efficient light bulbs for desk lamps 0.672</td>
<td>0.771</td>
<td>0.853</td>
<td></td>
</tr>
<tr>
<td>My firm uses energy efficient lighting systems and equipment 0.711</td>
<td>0.770</td>
<td>0.829</td>
<td></td>
</tr>
<tr>
<td>My firm recycles paper 0.759</td>
<td>0.824</td>
<td>0.819</td>
<td></td>
</tr>
<tr>
<td>My firm uses recycled paper 0.897</td>
<td>0.938</td>
<td>0.686</td>
<td></td>
</tr>
<tr>
<td>My firm recycles computer and office paper 0.950</td>
<td>0.880</td>
<td>0.785</td>
<td></td>
</tr>
<tr>
<td>My firm recycles magazines and brochures 0.893</td>
<td>0.950</td>
<td>0.880</td>
<td></td>
</tr>
<tr>
<td>My firm recycles toner and ink jet printer cartridges 0.770</td>
<td>0.916</td>
<td>0.686</td>
<td></td>
</tr>
<tr>
<td>My firm recycles glass containers 0.829</td>
<td>0.859</td>
<td>0.829</td>
<td></td>
</tr>
<tr>
<td>My firm recycles aluminium cans 0.770</td>
<td>0.916</td>
<td>0.686</td>
<td></td>
</tr>
<tr>
<td>My firm promotes walking, biking, and commuting 0.853</td>
<td>0.916</td>
<td>0.686</td>
<td></td>
</tr>
<tr>
<td>My firm participates in/sponsors projects/events in the community to improve the environment 0.829</td>
<td>0.770</td>
<td>0.829</td>
<td></td>
</tr>
<tr>
<td>My firm encourages/promotes/provides for carpooling of employees 0.859</td>
<td>0.829</td>
<td></td>
<td></td>
</tr>
<tr>
<td>My firm uses environmentally responsible products throughout the property/project 0.716</td>
<td>0.955</td>
<td>0.589</td>
<td></td>
</tr>
<tr>
<td>I consider sustainable site development in my projects 0.761</td>
<td>0.955</td>
<td>0.589</td>
<td></td>
</tr>
<tr>
<td>I consider energy and water efficiency in my projects 0.784</td>
<td>0.784</td>
<td></td>
<td></td>
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<tr>
<td>I consider the use of sustainable materials in my projects 0.805</td>
<td>0.784</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I consider indoor environmental quality in my projects 0.730</td>
<td>0.805</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I minimise resource consumption 0.798</td>
<td>0.730</td>
<td></td>
<td></td>
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<tr>
<td>I use renewable or recyclable resources 0.784</td>
<td>0.784</td>
<td></td>
<td></td>
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<tr>
<td>I protect the natural environment through my work 0.758</td>
<td>0.758</td>
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<tr>
<td>I consider the environmental effects of the projects I am involved in 0.806</td>
<td>0.784</td>
<td></td>
<td></td>
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<tr>
<td>I consider the effects on land pollution of the projects I am involved in 0.819</td>
<td>0.819</td>
<td></td>
<td></td>
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<tr>
<td>I consider the effects on air pollution of the projects I am involved in 0.810</td>
<td>0.810</td>
<td></td>
<td></td>
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<tr>
<td>I consider the effects on water pollution of the projects I am involved in 0.805</td>
<td>0.805</td>
<td></td>
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</tr>
<tr>
<td>I minimise the resource consumption of the projects I am involved in 0.763</td>
<td>0.763</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I use recycled paper 0.824</td>
<td>0.824</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I use environmentally responsible products 0.897</td>
<td>0.938</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I minimise resource consumption 0.853</td>
<td>0.938</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I use energy efficient lighting systems and equipment 0.770</td>
<td>0.829</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I use energy efficient lighting systems and equipment 0.770</td>
<td>0.771</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I use low energy lighting systems and equipment 0.770</td>
<td>0.829</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I always power off my computer when going to a meeting or leaving my office after a few minutes of inactivity 0.612</td>
<td>0.854</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CR – composite reliability; AVE – average variance extracted.

Please cite this article in press as: Yusof, N., et al., Linking the environmental practice of construction firms and the environmental behaviour of practitioners in construction projects, Journal of Cleaner Production (2016), http://dx.doi.org/10.1016/j.jclepro.2016.01.090
The convergent validity of all constructs was evaluated using average variance extracted (AVE). All constructs had an AVE above 0.5, which signifies a satisfactory degree of convergent validity according to Fornel and Larcker (1981).

Two approaches are used to assess the discriminant validity of the constructs. First, the cross loadings were examined, revealing that no indicator loads were higher than the opposing constructs (Hair et al., 2012). Second, Table 2 shows that each construct’s square root of AVE exceeded the intercorrelations of the construct with the other constructs in the model (Fornel and Larcker, 1981). Both analyses confirmed the discriminant validity of all constructs.

The same measurement model evaluation criteria were applied to second-order constructs, namely, waste management. The outer loading of paper recycling (0.769) and office waste recycling (0.948) were well above the cut-off point of 0.6. The composite reliability of both second-order constructs is above 0.7, which ensures internal consistency. Furthermore, the AVE values were above the threshold of 0.5, which signifies a satisfactory degree of convergent validity.

5.3. Assessment of the structural model

The explanatory power of the research model was assessed using the total explainable variation of the model. The results showed that the model is capable of explaining 26.3% of the explainable variation of project EB. Furthermore, the predictive relevance ($Q^2$) value (0.153) of the project EB confirmed that the model has satisfactory predictive relevance (Chin, 2010). The nonparametric bootstrapping of Efron and Tibshirani (1993) with 2000 resamples was applied to test the structural model. The significant effects specified by the research model were evaluated (Table 3). The results indicate that the effect of energy efficiency ($\beta = 0.505, p < 0.001$) and waste management ($\beta = 0.213, p < 0.01$) on project EB is significant and positive. In contrast, no significant relationship exists between involvement and project EB ($\beta = 0.009, p > 0.05$). Therefore, H1 and H2 are supported, whereas H3 is rejected.

6. Discussion

This study was conceptualised to ascertain whether the EP (energy efficiency, waste management, and involvement) of construction firms influences the EB of practitioners during project implementation. Three hypotheses were developed. The first hypothesis claimed a positive association between energy efficiency and project EB. This hypothesis was confirmed by the PLS test output. A moderately positive relationship was confirmed between the two variables. The findings show that energy efficiency is one of the key motivators of project EB. Concerns about energy utilisation and preservation in the offices determine the EB of practitioners during project implementation, which is a great source of carbon dioxide emissions. The findings imply that when construction firms are consciously engaged in activities for monitoring energy usage, such as through the use of sensors and energy saving or energy efficient equipment, an increase in EB will occur in the projects in which these practitioners are involved.

Similarly for hypothesis H2, a positive association was established between waste management (reuse, reduce, and recycle) and project EB, thus implying that an increase in the waste management activities of construction firms, such as reusing and recycling, will impact the overall project EB. Construction practitioners who are used to EB such as recycling will be willing to implement similar EB in future construction projects. They will want to integrate such behaviour to form part of the entire project management strategy at project inception. This finding strengthens the claim of Wang et al. (2014) regarding the importance of waste management in the construction industry.

The findings are in contrast to those of Littleford et al. (2014), who found that insufficient evidence exists on the spill-over effect of EB between the workplace and the home. One possible explanation for these differences is that in the present study, the respondents considered energy efficiency and waste management as important aspects of EB. This condition triggered consistency in the behaviour of the practitioners at the office and during project implementation, thus strengthening the argument by Thogersen and Olander (2003) for consistency in EB between two different places if the behaviour is considered important.

The last hypothesis for this research (H3) was rejected because of the nonexistent linear relationship between the involvement of firms in environmental efforts and the EB of practitioners during project implementation. Neither an increase nor a decrease in the involvement of construction firms in environmental programs or initiatives results in EB during project implementation. This result may be attributed to the fact that the involvement of most firms, particularly in developing countries, revolves around social responsibility practices, which may not necessarily translate into project EB.

7. Conclusion

In addition to providing a model depicting the linear relationship between the dependent variable (EB during project implementation) and independent variables (energy efficiency, waste management, and involvement), the present study determines the role played by each of the predictor variables and their contribution toward the explanatory variable. The findings further confirmed that both energy-efficient and waste management practices in construction firms have a positive association with EB during project implementation. The consistency of EB at different levels was demonstrated at the firm and project levels, thus strengthening the work by Thogersen and Olander (2003), who claimed that consistency in EB exists if such behaviour is perceived as important by the individuals involved.

In terms of its theoretical contribution, to our knowledge, the present study is the first to investigate the relationship between EP in construction firms and EB during project implementation within the construction industry. This sector is particularly important because it is a rapidly growing industry that has a significant environmental impact. Specifically, the study extends the work of Ahn et al. (2013), Zainul Abidin (2010), and Zainul Abidin et al.
(2013) that focuses on environmental sustainability at the organisational level only and the work of Gangoilless et al. (2014), Rodríguez et al. (2011) and Weston (2011), who focus on environmental sustainability at the project implementation level. The present study also supplements the existing literature on EP in the construction sector by providing a scenario that demonstrates the effect of EP at the firm level on EB during the implementation of construction projects in Malaysia.

The results show that energy efficiency and waste management in construction firms influence EB during project implementation, and the involvement of construction firms in EP has no linear association with EB. From a practical perspective, the findings are beneficial for both construction industry stakeholders and policy makers. The significant effect of energy efficiency and waste management on the EB of practitioners portrays an interesting scenario for the construction firms’ managers attempts to perform in sustainable manner in the construction industry. In addition, these findings can provide direction on the design of strategic policies to encourage construction firms to be conscious of their environmental impact and for the establishment of targets and incentives on the basis of environmental assessment criteria that are applicable during project implementation.

Several limitations must be considered before the results of this study can be generalised. First, the hypotheses of the study were tested and verified using a questionnaire survey, which, in essence, only provides a cross-sectional study, thus preventing the ability to imply causal relationships among the variables. Observations of the dynamic changes in the EB of construction practitioners during the development of ES in construction firms are beyond the scope of this study. Thus, a longitudinal study that examines these relationships for an extended period of time should be attempted to provide precise results. Second, the survey sample used in the study is limited to the Malaysian construction industry. The maturity of the EB of practitioners may be different in different countries. Thus, the research model should be tested in different countries to provide the opportunity for data comparison.

Acknowledgement

The authors sincerely acknowledge the financial support from the Malaysian Government through the Exploratory Research Grant Scheme (ERGS) [Grant No. 203/PBPBN/6730132].

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