Sustainability attitude and performance of construction enterprises

A China study

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ABSTRACT

Construction industries have significant impacts on the economy, society and environment. To transform construction industry towards sustainability, construction enterprises’ perceptions and performance on sustainability needs to be understood and evaluated, which has not be fully explored by existing studies. This paper holistically examines the Chinese construction enterprises’ attitude towards and performance on various aspects of sustainability (e.g. the economic, social and environmental aspects) in order to identify those aspects the firms perceive to be the most and least important and those aspects the firms perform best and worst on. The associations among the sustainability attitude, sustainability performance, and firm size are also explored. The findings show that quality management and customer service are perceived as the most important as well as the best-performed aspects by the firms while supporting community development is the least important and worst-performed aspect. Sustainability attitude is positively correlated with performance, and larger firms tend to have better sustainability performance than that of small ones. However, larger construction firms do not necessarily perceive sustainability more important. This study provides a useful reference for policy makers and researchers to understand how sustainability is perceived and implemented by the Chinese construction firms.

Keywords

Sustainability; Sustainable development; China; Construction industry; Construction firms; Assessment
1. Introduction

As a major sector contributing to economic development, the construction industry also has significant impacts on the environment and society (Gan et al., 2015). There are various environmental issues derived from construction activities such as outdoor and indoor environmental pollution, greenhouse gas emission, and impacts on the ecological environment (Zuo and Zhao, 2014). As a response to these challenges, the shift of the construction industry from the traditional paradigm towards more balanced development among the economic, social and environmental dimensions, i.e. sustainable development, has received global attentions (Gan et al., 2015).

There is no lack of studies on the sustainability of the construction industries worldwide. Some studies focus on the social dimension of sustainability. Matinaro and Liu (2017), for instance, suggested that there is lack of innovativeness in the Finnish construction sector, impeding the societal change towards sustainability. Bevan and Yung (2015) investigated the implementation of corporate social responsibility (CSR) in Australian small and medium-sized construction firms. In Ghana, Lichtenstein et al. (2013) found that profitable construction firms place more emphasis on CSR issues than is the case with unprofitable firms.

Most related studies investigate the environmental aspects of sustainability. For instance, Serpell et al. (2013) explored the awareness and actions of sustainable construction in the construction industry of Chile, under a narrow definition of sustainable construction which only contains the environmental aspects. Chen et al. (2016) explored the linkage between multinational construction firms’ internationalization and environmental strategy, which were found to be positively correlated up to a certain extent. Focusing on Malaysia, Yusof et al. (2016) discovered the environmental practice of construction firms has positive impacts on practitioners' environmental behavior. Son et al. (2011) surveyed constructors from the USA and Korea, finding that government policy and local environmental and social issues have a significant impact on the sustainability knowledge of constructors.

Even though these studies have contributed to the understanding of sustainability in construction industry, gaps of knowledge exist. Existing studies have predominantly focused on the environmental dimension of sustainability, such as energy conservation and green construction technologies. In contrast, few studies have attempted to holistically explore the economic, social and environmental dimensions of sustainability in the construction industry. Furthermore, existing studies have placed much emphasis on the technological innovations of sustainability, while studies on social and managerial practices, and the behaviours of construction firms are largely overlooked. Without a holistic approach, existing studies have been inadequate in capturing the complete picture of sustainability in construction enterprises.
Furthermore, few existing studies have explicitly differentiated the sustainability perceptions and performance of construction enterprises. The sustainability aspects that are deemed to be important by these enterprises do not necessarily lead to their high-performance levels. Some studies have investigated firms’ attitude towards sustainability, for example, Zainul Abidin (2010) who suggested that, for many developers in Malaysia, survival is assigned a more important priority than environmental sustainability. Some studies have investigated how the implementation of sustainability practices reflects the performance levels of sustainability, for example, Qi et al. (2010). Few studies have simultaneously investigated the importance and performance of the holistic sustainability concept in construction enterprises, thereby comparing the perception and performance levels.

Moreover, existing studies have also suggested that firms’ sustainability perceptions and performance may be associated with firm size. Small businesses tend to have fewer technological options and, thus, face greater capability barriers to the adoption of sustainability (Kostka et al., 2013). Previous studies, for example, Zainul Abidin (2010) have argued that larger construction firms tend to have higher awareness of environmental sustainability than their smaller counterparts. However, these studies have not been based on statistical evidence, focusing only on the environmental aspects without holistically examining the impact of firm size on the sustainability concept covering economic, social and environmental dimensions.

These questions are particularly important for China where there is a lack of empirical studies exploring the association of firm size and the sustainability perceptions or performance of Chinese construction firms. Current national programs and policies in China that are related to sustainability issues, such as energy conservation, predominantly focus on regulating large, state-owned enterprises (Kostka et al., 2013). It is well known that government policies play a critical role in improving the sustainability perceptions and performance of firms (Zeng et al., 2011). Meanwhile, pressures from the public and the media could also be stronger for larger firms.

For instance, Zeng et al. (2011) argued that, in China, the impacts of environmental organizations and media attention on large enterprises are much stronger than those on small and medium-sized enterprises. As a result, it is likely that, compared to small and medium-sized enterprises, larger construction firms in China could attach more importance to sustainability issues. However, Du et al. (2014) examined obstacles to the adoption of energy-saving technologies in the Chinese construction industry, with their study indicating that large firms surprisingly perceive stronger barriers than small firms. Du et al. (2014) speculated that large construction firms are more likely to encounter operational barriers due to their diverse businesses. It thus remains unclear how firm size is associated with firms’ sustainability perceptions and performance in the Chinese construction industry.

To address these research gaps, the aims of this paper are twofold. First, this paper seeks to investigate the Chinese construction firms’ attitude towards and performance on various aspects of sustainability holistically (i.e. covering the economic, social and environmental dimensions), thereby identifying those aspects the firms perceive to be the most and least important, and those aspects as
the firms’ strengths and weaknesses. Second, by classifying firms according to the scale, this study aims to test statistically whether a more positive attitude towards sustainability is associated with better sustainability performance and whether firm size is associated with firms’ attitude towards and performance on sustainability.

2. Sustainability of the Chinese construction industry

Due to rapid urbanization and industrialization, China has become a global construction centre. Overtaking the United States as the largest over the world since 2010, the Chinese construction industry plays a crucial role in the sustainable development of not only China but also the entire world (EU SME Centre, 2015).

The energy consumption related to the construction industry constitutes more than 40% of the total consumption in China (Chang et al., 2015). The steel consumption of the Chinese construction industry alone comprises more than 20% of the world’s total consumption, and construction waste accounts for 45% of China’s total garbage (MOST, 2012). The huge impacts of the Chinese construction industry on the sustainable development of not only China, but also the globe is well illustrated by EU SME Centre (2015), which indicates that “China is building more than one third of all the buildings in the world, producing and consuming 55% of the cement globally in doing so. It builds the equivalent in square metres of living space of a city like Rome in about two weeks and a country like the UK or Spain every single year”.

Because of the huge impacts generated by the Chinese construction industry, studies have been conducted to specifically examine the sustainability of the Chinese construction industry, as shown in Table 1. Environmental sustainability of the industry received most attention from existing studies. For instance, Zhang et al. (2015) conducted three case studies to investigate the implementation of environmental management in the Chinese construction enterprises. This study suggested that the implementation was not satisfactory due to significant barriers such as the conflict between cost and environmental performance, passive response culture within the industry and lack of support and coordination by clients. Similarly, Jiang et al. (2013) analysed the barriers to energy conservation and carbon reduction in China’s commercial buildings, and indicated that most investors do not assign improvement of energy efficiency as a priority, while constructors have to deal with a number of barriers related to technology, risks, maintenance and costs.

<Insert Table 1 here>
Very few studies holistically examine and compare the economic, social and environmental dimensions of sustainability in the Chinese construction industry. An insightful study was conducted by Wang (2014), who analysed the economic, social and environmental impacts of the construction industry in China. This study concluded that there are various sustainability issues associated with the industry, e.g. labour crisis, health and safety hazard, low competitiveness, lack management of construction waste and poor awareness of social responsibility. There is lack of a holistic examination of the construction firms’ perceptions of and performance on various aspects of sustainability including economic, social and environmental dimensions.

Previous studies e.g. Abidin (2010) and Serpell et al. (2013) have argued that larger construction firms tend to have higher awareness and better performance of environmental sustainability than the smaller counterparts. However, these studies only focus on the environmental aspects without examining the impact of firm size on the sustainability concept holistically to cover economic, social and environmental dimensions. The study of existing literature reveals that there is lack of studies investigating the association between firm size and firms’ attitude or performance of sustainability in the context of the Chinese construction industry, which forms a gap of knowledge.

3. Hypothesis development

It has been reported that the uptake of sustainability practices in construction industries is relatively low in many countries, such as Chile (Serpell et al., 2013), South Africa (Othman, 2009), and China (Qi et al., 2010). Attitude towards sustainability could influence construction firms’ sustainability behaviours. Abidin (2010) suggested that for many developers in Malaysia, survival is assigned a priority rather than environmental and social sustainability. It is well recognized that attitude and awareness are the premises of sustainability actions (Bevan and Yung, 2015; Zhang and Zhou, 2015). If an enterprise does not perceive sustainability as an important issue, it will unlikely take sustainability seriously or have excellent sustainability performance. There is lack of empirical study to test this in the Chinese construction industry. Therefore, the following hypothesis is formulated:

H1. There is a positive relationship between construction firms’ attitude towards sustainability and their sustainability performance. The construction firms which perceive sustainability is of higher importance have better sustainability performance.

Firms’ attitude towards sustainability may be related to firm size. Current national programs and policies related to sustainability issues e.g. energy conservation in China predominantly focus on regulating large, state-owned enterprises (Kostka et al., 2013). For instance, back to 2006, the Chinese Central Government introduced the Top-1000 Energy-Consuming Enterprises program, setting energy saving targets for China’s 1000 largest energy consuming enterprises, which account for around one-
third of China’s energy consumption (Price et al., 2010). It is well received that government policies play a critical role in improving sustainability awareness and performance of firms (Zeng et al., 2011; Zhang and Zhou, 2015). Meanwhile, pressures from the public and media could also be stronger for larger firms. Zeng et al. (2011) argued that in China, the impacts of environmental organizations and media attention on large enterprises are much stronger than those on small and medium-sized enterprises. As a result, it is likely that compared to small and medium-sized enterprises, larger construction firms in China attach more importance to sustainability issues. Therefore, the following hypothesis is proposed:

**H2. There is a positive relationship between firm size and construction firms’ attitude towards sustainability. Larger construction firms perceive sustainability more important than smaller firms.**

Different from the traditional competitiveness-centered paradigm, sustainable development presents operational challenges for construction enterprises, which are usually resource constrained. Compared to large enterprises, small and medium-sized firms lack the motivation to improve sustainability performance due to various constraints such as limited resources, fewer opportunities to obtain benefits from implementing sustainability strategies, and limited technological capabilities (Torugsa et al., 2012).

In China, there is lack of empirical studies exploring the influences of firm size on the sustainability performance of construction firms. There are limited studies focusing on environmental issues e.g. energy efficiency of small and medium-sized enterprises. It has been argued that small businesses in China have limited access to subsidies from the government in general and face enormous barriers to improve energy efficiency (Kostka et al., 2013). However, Du et al. (2014) examined obstacles to the adoption of energy-saving technologies in the Chinese construction industry, and their study indicated that surprisingly large firms perceive stronger barriers than small firms. Du et al. (2014) speculated that large construction firms are more likely to encounter operational barriers due to their diverse businesses. Thus, it remains unclear whether firm size is associated with firms’ sustainability performance in the Chinese construction industry. Therefore, the following hypothesis is proposed to be tested:

**H3. There is a positive relationship between firm size and the sustainability performance of construction firms in China. Larger construction firms perform better than smaller ones.**

## 4. Research methodology

### 4.1. Questionnaire survey

To achieve these research aims, firm size and a series of sustainability aspects need to be identified so that firms’ attitude and performance of sustainability can be captured. Firm size was reflected by a categorical variable. To determine the criteria used to classify the sizes of construction firms, relevant
national standards in China were analysed and compared, including *Qualification Standard for Construction Enterprises*, and *Criteria for the Classification of Small and Medium-sized Firms*. As a result, a four-level classification system based on annual turnover criteria was adopted in this study to differentiate sizes of construction enterprises, namely 1) small enterprises (SEs): an annual turnover of no more than 20 million RMB; 2) medium enterprises (MEs): an annual turnover of more than 20 million RMB and no more than 200 million RMB; 3) large enterprises (LEs): an annual turnover of more than 200 million RMB and no more than 1.5 billion RMB; and 4) huge enterprises (HEs): an annual turnover of more than 1.5 billion RMB.

A list of critical sustainability aspects (CSAs) for Chinese construction enterprises was developed in the previous study, i.e. Chang et al. (2016). The developed CSAs were used in this study to capture firms’ attitude and performance of sustainability. The final list of CSAs consists of 29 aspects, as shown in Table 2. The detailed procedure for identifying the CSAs is available in the authors’ previous paper Chang et al. (2016). The detailed research procedure and methodology of this study following the developed CSAs are illustrated by Fig. 1.

<Insert Fig. 1. here>

**Fig. 1.** Research procedure and methodology

It is important to note that as integrated components of the sustainability concept, the economic, social and environmental aspects of sustainability have complex interactions. For instance, occupational health and safety could impact the working efficiency of employees and thus the economic performance of organizations. Similarly, green innovations may influence the economic, social and environmental performance of organizations. There are studies such as Lozano and Huisingh (2011) investigating the interactions among various sustainability aspects. However, from a practical perspective of conducting sustainability assessment, the various sustainability aspects need to be categorised into different dimensions in order to obtain the evaluation values. For instance, in the widely used corporate sustainability reporting guideline issued by Global Reporting Initiative, the aspect of education and training is classified as a social sustainability issue, even though it could be argued that education and training for employees could apparently influence the economic performance of the organization.

In accordance with these existing approaches on sustainability assessment, this study classifies the various sustainability aspects into the economic, social and environmental dimensions according to the widely accepted perceptions in the literature. The formulation of the CSAs consists of two main steps. Firstly, three relevant sustainability guidelines were thoroughly examined to identify the common CSAs addressed, and 24 CSAs were identified after this step. The three examine
sustainability guidelines include the *Sustainability Reporting Framework* issued by the Global Reporting Initiative (GRI 2014), the *Chinese Academy of Social Sciences Guideline on Corporate Social Responsibility Reporting for Chinese Enterprises* issued by the Chinese Academy of Social Science (CASS-CSR, 2014), and the *Guide on Social Responsibility for Chinese International Contractors* issued by the Chinese International Contractors Association (CASS 2015).

Then, a directed content analysis of the sustainability reports of three leading Chinese construction enterprises was conducted to examine how leaders in the industry address sustainability against the sustainability guidelines. Five additional sustainability aspects were subsequently identified. The development of the 29 CSAs was based on a rigorous content analysis of both existing sustainability reporting frameworks and the sustainability reports of leading Chinese construction firms, ensuring the robustness of using these CSAs to conduct sustainability evaluations of Chinese construction firms. For the detailed procedure of identifying the CSAs, please refer to the authors’ previous paper Chang et al. (2016).

After identifying the CSAs, a questionnaire was then developed. Firstly, the background of this study and the basic concept of sustainability were introduced, followed by a section to collect the demographical information of the respondents e.g. the firm size. The main section solicits the respondents’ opinions on the importance and performance levels of the identified 29 CSAs, as shown in the Appendix.

Likert scales have been widely adopted in previous studies on sustainability or performance assessments to capture the performance levels. For instance, Bevan and Yung (2015) adopted a five-point Likert scale to measure the implementation levels of corporate social responsibility in Australian small and medium-sized construction enterprises. Similarly, Shen et al. (2010) employed a five-point Likert scale to measure the sustainability level of infrastructure projects. Tan et al. (2011) have used a five-point Likert scale to measure the performance levels of contractors in Hong Kong. Similar to these previous studies, a five-point Likert scale was adopted in this study, and respondents were asked to evaluate the relative importance of the identified 29 CSAs from 1 (“very unimportant”) to 5 (“very important”). After completing the importance evaluation, respondents were asked to evaluate their enterprises’ performance on these CSAs, similarly on a five-point Likert scale from 1 being “very bad” to 5 being “very good”.

The responses were collected by sending the website of this questionnaire to the emails of the Chinese construction firms included in the database of the largest academic online survey platform in China, i.e. www.sojump.com from May to June 2015. This online questionnaire platform has been used extensively by Chinese scholars e.g. Mao et al. (2013) and Xiang et al. (2015). A total of 4500 questionnaires were distributed and 262 effective responses were received. Web-surveys tend to have a lower response rate compared to self-administrated approach because of various factors, such as time and resource limitations, the volunteer nature, and the geographical separation between the researcher and respondents (Chang et al., 2017). Similar response rates of construction studies based
on web surveys have been observed, such as 2.9% in Said (2016). Of the 262 effective responses, 4.58%, 56.49%, 27.86% and 11.07% were from SEs, MEs, LEs, and HEs respectively. Over 79% of the respondents have more than five years of experience and 41% have more than ten years of experience in the industry. Around half of the respondents were project or corporate managers, who tend to have a holistic understanding of construction projects and corporate operation, while the other half respondents focus on the details and various facets of construction projects. Similar to Bevan and Yung (2015), this balanced respondent profile reduces the selection bias and improve the representativeness of sample selection (Zhao et al., 2015).

4.2. Data analysis

Various techniques were employed to analyse the data and test the hypothesis. The relative importance value (RIV) and relative performance value (RPV) of each aspect were calculated to determine the relative ranking of the CSAs. RIV has been used in various construction studies as the basis to rank the relative importance of related factors. For instance, Shen et al. (2016) employed RIV to identify the critical factors affecting green procurement in real estate development. Chen et al. (2010) adopted one variant of RIV, severity index, to rank a list of sustainable performance criteria for construction method selection. Similarly, RPV has been used in construction studies to investigate the degree of performance or satisfaction evaluated by respondents. For instance, Mohit et al. (2010) developed a residential satisfaction index to assess the performance of public low-cost housing projects in Malaysia.

Even though there are different names of RIV (e.g. relative importance value, severity index, relative importance index, etc.) and RPV (e.g. relative performance value, satisfaction index, etc.) in the literature, the calculation methods are similar. This study adopts the calculation method proposed by Idrus and Newman (2002) to determine the RIV and RPV of the CSAs. This method allows converting ratings on a five-point Likert scales into a 100-point index which is easy to interpret.

To determine the sustainability attitude level (SAL) and sustainability performance level (SPL) of a certain enterprise, a method similar to Bevan and Yung (2015) was developed and adopted. In the context of multiple attribute decision making, the weighted sum method is one of the most common methods for integrating scores on multiple attributes into an aggregate value (Zhou et al., 2006). In this study, since one sustainability aspect is not necessarily more influential than the others for the overall sustainability level, equal weights were applied to the CSAs.

To summarize, the following formulas (1) to (4) were adopted to calculate the RIV and RPV of a particular sustainability aspect, and the SAL and SPL of a certain enterprise.

\[
RIV_i = \frac{\sum_{j=1}^{n} A_{ij}}{an} \times 100 
\]

(1)

\[
RPV_i = \frac{\sum_{j=1}^{n} B_{ij}}{an} \times 100 
\]

(2)
where \( i \) denotes the numbering of the 29 CSAs; \( j \) denotes the numbering of the surveyed enterprises; \( n \) denotes the number of the responses in the investigated sample, which could be the total sample or the samples formed by firms of different sizes; \( a \) denotes the highest rating (i.e. 5 in this case); \( b \) denotes the total number of the attribute (i.e. 29 in this case); \( A_{ij} \) denotes the score given to the \( i \)th sustainability aspect by the \( j \)th enterprises in the attitude (importance) evaluation; \( B_{ij} \) denotes the score given to the \( i \)th sustainability aspect by the \( j \)th enterprises in the performance evaluation.

The RIV and RPV were used to generate the relative ranking of the CSAs, thereby enabling the identification of the aspects perceived to be the most and least important, as well as firms’ strengths and weaknesses. SAL and SPL were used to test the three hypotheses. To test H1, non-parametric correlation analysis including both Kendall’s rank correlation and Spearman’s rank correlation were conducted. If the SAL is found to be positively correlated with the SPL, H1 is supported; otherwise, it will be rejected. To test H2 and H3, the Kruskal-Wallis Test and follow-up Mann-Whitney U Test were undertaken. The Kruskal-Wallis Test allows comparing the scores of variables for three or more groups, and it is used in this study to determine whether there is a statistically significant difference in SAL and SPL across several groups defined by the categorical variable of firm size. If a significant result is obtained, the Mann-Whitney U test will be conducted to identify which pair of groups are significantly different from each other.

A five-point Likert scale was employed in this study to evaluate the attitude and performance levels of the Chinese construction enterprises. The inherent nature of this approach suggested that such evaluation is influenced by personal perceptions. Both subjective and objective approaches have been adopted in sustainability or performance evaluations. The use of Likert-type ratings in sustainability or performance assessments is widely documented in previous construction-related studies, e.g. Bevan and Yung (2015) and Tan et al (2011). Likert-type ratings are also widely used in other areas e.g. the Importance-Performance Analysis and Multi-Criteria Assessment. Objective approach is not feasible in this study as currently there is no database available about the sustainability performance of the Chinese construction enterprises. Therefore, a subjective evaluation approach is adopted in this study based on a five-point Likert scale. Objective evaluations of construction firms’ sustainability performance are complex and difficult in nature as it not only involves the quantification of the firms’ environmental impacts, but also involves the assessment of social issues which are largely subjective in nature. Future research could explore how sustainability of construction firms can be better evaluated, e.g. through a combination of a Likert scale and Life Cycle Assessment.

\[
\text{SAL}_j = \frac{\sum_{i=1}^{b} A_{ij}}{ab} \times 100
\]

\[
\text{SPL}_j = \frac{\sum_{i=1}^{b} B_{ij}}{ab} \times 100
\]
5. Results and analysis

5.1. Relative rankings of the CSAs

The RIV and RPV of the whole sample, and the derived ranks of the CSAs are displayed in Table 2 for the evaluation of attitude and performance.

Specifically, the top four most important sustainability aspects are all economic related. These aspects are also the strengths of Chinese construction enterprises, clearly reflected by the performance evaluation. Quality management (A2) and customer service (A6) are regarded as the most important aspects by the firms. Risk management (A9) and corporate strategy (A1) are also highly ranked on both the attitude and performance evaluations. This is consistent with previous studies on the economic competitiveness of Chinese construction firms e.g. Lu et al. (2008).

Compared to these traditional aspects, many new topics relevant to economic sustainability receive less attention, e.g. innovation system (A4) and corporate governance (A5). This echoes to the 12th Development Plan for Chinese Construction Industry, which suggests that the standardization level in the industry is low, and many Chinese construction firms invest too little on research and innovation (MHUD, 2011). Compared to other aspects (e.g. project quality, customer service and corporate strategy) which can directly influence corporate operation, research and innovation may not generate benefits which can be observed in the short run. However, critical to the long-term sustainable development of the industry, these aspects need to be further strengthened in the industry.

The highly ranked social issues in the attitude evaluation are obeying laws and regulation (A16) and occupational health and safety (A10), which receive high ranking in the performance evaluation as well. By contrast, wages and welfare (A12) is ranked as the 7th most important sustainability aspect, while it is only ranked 22nd among all the 29 CSAs in the performance evaluation. This suggests that the wages and warfare in the industry are still a concern from respondents’ perspectives. Three out of the nine social aspects were ranked within the least five important aspects. Supporting community development (A15) is one of the primary focus of corporate social responsibility, but it is rated as the least important aspect. This indicates that the awareness of social responsibility still needs to be largely improved in the industry. This is generally in line with Wang (2014)’s finding that poor awareness of social responsibility presents a serious issue in the Chinese construction industry.

It is interesting to note that anti-corruption and fair competition (F13) was also ranked very low. This contrasts to the fact that corruption is a serious issue in the industry (MHUD, 2011). The central government has only recently introduced specific policies to address anti-corruption related to the
construction industry since 2014, and these policies predominantly focus on regulating government officials working in construction and housing authorities rather than industry professionals (MHUD, 2014). It remains unclear how the anti-corruption policy could affect the perceptions and behaviours of construction professionals.

The environmental aspects which receive high importance rankings are *construction waste management* (A20) and *land use efficiency* (A21) while *managing impacts on biodiversity* (A25) is regarded as the least important aspect by the respondents. Regarding the performance evaluation, the highest ranked environmental aspect is *land use efficiency* (A21) while *green innovation and product* (A27) is ranked the lowest. It seems that the environmental aspects which are directly related to the economic gains of construction enterprises receive high attention. Due to the property boom and rapid industrial development, the land cost in China is generally high, and thus, construction companies need to adequately utilize the land to obtain profit (Wang, 2014). Therefore, *land use efficiency* (A21) was highly ranked in both the attitude and performance evaluation. Similarly, environmental issues e.g. construction waste management and the conservation of water, material and energy are highly rated since these issues could generate tangible impacts on construction firms’ operational cost.

By contrast, issues e.g. *light pollution control* (A28) and *managing impacts on biodiversity* (A25) are not directly related to firms’ economic competitiveness, and these factors received low rankings. An effective approach to address these issues (e.g. biodiversity protection) is to incorporate them into the compulsory environmental impact assessment. However, currently, not all construction projects have to go through environmental impact assessment in China (Wang, 2014).

### 5.2. Hypothesis testing

Non-parametric correlation analysis including both Kendall’s tau and Spearman’s rho were undertaken to examine the relationship between the SAL and the SPL. It can be found that the SAL is positively correlated with the SPL (Kendall’s tau b: 0.382; Spearman’s rho: 0.536, both significant at 0.01 level). H1 is therefore supported. The implication is that if a positive attitude to sustainability can be nurtured in the Chinese construction firms, the sustainability performance can be higher. This is consistent with similar studies e.g. Zhang and Zhou (2015), who suggested carbon reduction awareness of Chinese contractors can lead to their corresponding behaviours.

<Insert Fig. 2. here>

**Fig. 2.** RIV of CSAs among construction enterprises of different sizes

To examine how different sizes of firms perceive the relative importance of the CSAs, RIVs of the CSAs were calculated for the SEs, MEs, LEs and HEs respectively. As shown in Fig. 2, these four
groups of firms have very different attitudes towards sustainability. It seems HEs have higher RIV on almost all the 29 CSAs than the other three groups, suggesting the overall sustainability attitude (reflected by SAL) could be different in various firm groups. This is confirmed by the Kruskal-Wallis Test, which revealed a statistically significant difference (significance level: 0.01) in SAL across all four firm groups.

A series of follow-up Mann-Whitney U tests were conducted to identify the particular pairs of groups that have significantly different SAL, as shown in Table 3. The results of the Kruskal-Wallis test and the Mann-Whitney U tests together suggest H2 is partially supported. Specifically, HEs have significantly higher SAL than all other groups of firms, which supports H2. However, MEs and LEs do not have significantly higher SAL than SEs. More interestingly, Mann-Whitney U tests show that LEs have significantly lower, rather than higher SAL than MEs. Thus, H2 is only partially supported.

H2 was formulated based on the argument that larger firms perceive sustainability is more important than smaller firms because larger firms receive more pressures from the government, media and the public. However, this study suggests this may not be the case for all sizes of firms. This is arguably due to the complex nature of pressures from the public, media and government and its associated effects on firms’ attitude towards sustainability. For instance, the policies in China may be effective in driving preventive behaviour, e.g. preventing firms to damage the environment, but not so practical to make companies enthusiastic and proactive for environmental protection (Liu, 2009). Similarly, the mechanisms of how public pressures affect construction firms’ sustainability attitude could be very complex. Further research could be conducted to explore how various factors contribute to the different sustainability attitudes of construction firms with different sizes.

The RIV of the CSAs reveals that for SEs and MEs, the most important factors are quality management (A2) and customer service (A6) while for HEs innovation system (A4) and communication management (A7) received more attention. This suggests that larger firms may pay more attention to innovations and stakeholder relations than smaller firms. It is also important to note that even though for all groups of companies, social and environmental aspects generally were ranked lower than economic aspects, in HEs, many social and environmental aspects received much higher RIV than in other groups of firms. For instance, all 11 environmental aspects received a score above 86 in HEs, while in SEs none of them received such a high score. This further complements the Mann-Whitney U test which found HEs have significantly higher SAL than all the other groups of firms.
In terms of the performance evaluation, RPVs of the CSAs were calculated for the SEs, MEs, LEs and HEs respectively, as shown in Fig. 3. The average scores of SPL for SEs, MEs, LEs and HEs are 68.97, 75.64, 76.26 and 80.07 respectively. This indicates that sustainability performance improves steadily along with the increase of firm size. A Kruskal-Wallis Test revealed a statistically significant difference (significance level: 0.032) in SPL across all four firm groups. Thus, a series of follow-up Mann-Whitney U tests were conducted to identify the specific pairs of groups that have significantly different scores (see Table 4). The results reveal that HEs have significantly higher SPL than SEs and MEs. However, other pairs of groups do not have significant differences. Thus, H3 is partially supported. It seems that the pairs of firm groups which have greater differences in firm size tend to have more significant differences in sustainability performance.

The average score of the RPV in the economic, social and environmental aspects are calculated respectively for enterprise with different sizes, as shown in Fig. 4. Economic sustainability received higher scores than social and environmental sustainability in each group of construction enterprises. This again indicates that it is still the mainstream paradigm of the construction business in China by focusing on economic competitiveness. This is consistent with Lu et al. (2008), who identified 35 critical success factors for contractor competitiveness, and discovered that the most critical success factors are all economic factors while environmental related factors such as environmental management were not highly ranked. Compared to other groups of firms, SEs have much lower scores on social and environmental performance, while HEs have much higher scores on these aspects (see Fig. 4).

Fig. 3. RPV of CSAs among construction enterprises of different sizes

Fig. 4. Sustainability performance for construction enterprises with different sizes
To further identify how SEs and HEs perform differently on the 29 CSAs, a Mann-Whitney U Test is conducted on the RPV of specific sustainability aspects. The results show that these two groups of firms are statistically different in nine CSAs, including 1) corporate strategy (A1) and network building (A8) in the economic dimension; 2) education and training (A11), caring for all employees (A17), and promoting the development of the industry (A18) in the social dimension; and 3) environmental management (A19), construction waste management (A20), green innovation and product (A27), and light pollution control (A28) in the environmental dimension. HEs significantly outperform SEs in these nine sustainability aspects.

Few existing studies explore the differences between sustainability performances among the Chinese construction firms of different size groups. This study reveals that the HEs have significantly higher performance than SEs on many social and environmental aspects. This could be the reason HEs gained sustained growth. Previous studies e.g. Rivoli and Waddock (2011) and Forsman et al. (2013) suggested the impacts of social and environmental sustainability on firms’ economic performance are rather complex. In the context of construction industries, Lu et al. (2013) argued that green construction companies have experienced more rapid growth, but could be highly vulnerable to unfavourable economic conditions. Future research opportunities exist to further explore how social and environmental sustainability could be utilized to drive the economic performance of construction firms with various scales.

6. Discussions and implications

There is lack of studies investigating various dimensions of sustainability (e.g. economic, social and environmental) in construction firms of various sizes, not only in the context of China but also in other countries. There are previous studies addressing similar issues, but these studies explore sustainability issues of the construction industry from different perspectives. For instance, at the firm level, Zuo et al. (2012) examined the sustainability policy of leading international contractors by analysing their sustainability reports. Li et al. (2017) investigated the stakeholder influence in decision/evaluations relating to sustainable construction in China. Infante et al. (2013) examined the evolution of five largest companies in the oil and gas industry from 2005 to 2011, by analyzing their sustainability reports based on Multicriteria Decision Analysis. Jiang and Wong (2016) investigated the key activity areas of corporate social responsibility (CSR) in the Chinese construction industry using questionnaire survey. At the building level, Heravi et al. (2017) developed a multi-criteria group decision-making framework for selecting sustainable options of industrial buildings, with the framework demonstrated by five petrochemical buildings in Iran. Similarly, Heravi et al. (2015) adopted structural equation modelling to identify and evaluate the sustainability indicators in the life cycle of industrial buildings based on a questionnaire survey in Iran. This paper has enriched the existing body of knowledge by holistically diagnosing the Chinese construction firms’ attitude
towards and performance on various economic, social and environmental sustainability aspects, and testing the association between firm size and the sustainability attitude and performance.

6.1. Theoretical implications

By simultaneously investigating construction firms’ attitude towards economic, social and environmental sustainability in China, this study revealed that economic aspects were perceived as more important compared to social and environmental aspects. This is in accordance with previous studies on the sustainability of the Chinese construction industry, such as Shen et al. (2010), who examined 87 feasibility study reports of various construction projects in China, and demonstrated that economic performance was given more concern in those reports than the social and environmental performance. In particular, the top four most important aspects identified in this study are all economic related. Few studies statistically explore the association between firm size and the sustainability attitude and performance of construction firms. Some studies e.g. Abidin (2010) argued larger construction enterprises are more aware of environmental sustainability without empirical evidence. Other studies e.g. Serpell et al. (2013) and Du et al. (2014) provide such evidence but did not illustrate the association between firm size and various dimensions of sustainability performance. Based on empirical evidence, this study reveals that larger construction enterprises in China tend to have better sustainability performance.

Specifically, existing studies argued concerns related to high costs and diminished economic competitiveness are main barriers to the implementation of environmental sustainability practices (Shi et al., 2013; Zhang et al., 2011). Previous studies have highlighted that the market preference of economic aspects, e.g. low cost rather than sustainability has locked the Chinese construction industry into an economy-oriented culture. For instance, Qi et al. (2010) revealed that project stakeholders pressure had no effect on the adoption of green innovations in the Chinese construction enterprises. This is because in China, clients are more concerned about the immediate economic outcomes than long-term benefits derived from the improvement of environmental performance. Similarly, Zhang et al. (2015) suggested that developers in China are often concerned with immediate rather than potential benefits that may occur in the future. Since economic aspects are assigned priorities by clients, the judgement of whether and how social and environmental sustainability will affect economic competitiveness could be a crucial factor determining construction firms’ strategies to sustainability.

This is further illustrated by the finding that compared to those aspects (e.g. managing impacts on biodiversity) which may not be directly related to economic performance, the environmental aspects which can directly influence the economic gains of construction enterprises are more acknowledged, e.g. land use efficiency and construction waste management. This study reaffirmed that the conflict between short-term economic gains and long-term benefit of sustainable development presents a significant challenge for the proliferation of sustainable construction practices (Häkkinen and Belloni, 2011).
This conflict could explain the various sustainability performance levels of construction firms with different sizes. Acting in a sustainable way requires firms to consider the social and environmental impacts rather than solely focusing on economic competitiveness. This presents operational challenges for construction enterprises, which, like other firms, are usually resource constrained. Studies indicate that a primary driver for firms, especially small and medium sized firms, to invest on sustainability is the increased opportunity for profits (Moore and Manring, 2009). Compared to large enterprises, small and medium-sized firms face great difficulties to improve sustainability performance such as limited resources, fewer opportunities to obtain benefits from implementing sustainability strategies, and limited technological capabilities (Torugsa et al., 2012). Similarly, Moore and Manring (2009) indicated that the high costs and resource demands make it difficult for small and medium-sized firms to adopt sustainability practices. This is further echoed by Williamson et al. (2006), who indicated that because of various constraints, small and medium-sized enterprises normally adopt socially responsible behavior forced by factors such as regulations, not voluntarily. Therefore, this study highlights the challenge of motivating small and medium-sized construction firms to invest on sustainability.

6.2. Policy and managerial implications

Following the above discussions, to facilitate the transition of the entire Chinese construction industry, including the small and medium-sized construction firms, towards sustainability, the government may have to alter the current approach of focusing on regulating large firms. Policy instruments for sustainability issues in the construction industry could be classified into three types, namely mandatory regulation instrument, economic incentive instrument and voluntary scheme instrument (Shen et al., 2016). Compared to Western countries, Eastern countries e.g. China use regulation instruments more often (Shen et al., 2016). Even though a number of regulations exist for sustainable construction, there is generally lack of adequate economic incentives in China. Gan et al. (2015), for instance, argued that the subsidies provided by the government for green building projects account for only around 20% of the incremental costs. Especially for small and medium-sized enterprises, it is extremely difficult to obtain the relevant subsidies in China because of the high minimum investment thresholds established by the government (Kostka et al., 2013). Thus, this study indicates that relevant policies could be enhanced to specifically address the sustainability issues of small and medium-sized construction enterprises. These include ensuring the continuity of the policies, seeking for more funding channels and designing multiple subsidy schemes.

Similarly, this study highlighted the most and least important, and best- and worst- performed sustainability aspects perceived by Chinese construction enterprises of various scales. This holistic diagnose provides a valuable reference for the government to understand how various sustainability aspects are perceived and performed by the industry, thereby facilitating the design of efficient policies to tackle the weakness of the industry. For instance, this study revealed that anti-corruption
and green innovation received low ranks in both the attitude and performance evaluations. Thus, the government could further strengthen the legislations to reinforce anti-corruption within construction professionals. Similarly, strong incentives could be introduced to encourage construction firms’ research and development in green technologies.

Through this study, construction enterprises of various scales could also have a better understanding of how their peers of similar, smaller or larger sizes in the industry perceive and perform on sustainability, thereby informing the decision-making of sustainability strategies. For instance, regarding economic sustainability, this study revealed that HEs pay much attention to stakeholder relations and innovations. Therefore, small and medium-sized enterprises could re-think their strategies whether to stick to project quality and customer satisfaction (i.e. their current priorities), or to invest more on stakeholder relations and innovations. Similar studies could also be conducted in construction industries of other countries to facilitate the international benchmarking exercise.

However, challenges remain in terms of facilitating the sustainability transition of the entire construction industry. This study revealed that there is a weak association between firm size and sustainability attitude. Even though larger firms receive higher pressures from the government, media and the public (Zeng et al., 2011), these firms do not necessarily believe sustainability is more important, as this study found LEs have significantly lower, rather than higher SAL than MEs. This contrasts to existing studies e.g. Abidin (2010) and Serpell et al. (2013) who implicitly indicate larger firms have a more proactive attitude towards sustainability. Thus, it could be a challenge to develop a holistic and efficient approach to improve the sustainability attitude of all sizes of construction firms. Future research could be conducted using more intricate technique e.g. Structural Equation Modelling to further explore the underlying factors explaining why larger construction enterprises in China do not necessarily believe sustainability is more important.

7. Conclusions

This study adopted a holistic approach to investigate the sustainability attitude and performance of construction enterprises in China. A five-point Likert scale was utilised to measure both the attitude and performance levels of construction enterprises on 29 critical sustainability aspects (CSAs) covering the economic, social and environmental dimensions of sustainability. This holistic approach is different from most existing studies which only investigate the environmental dimension of sustainability or merely focus on a particular group of firms. This study suggests that compared to social and environmental aspects, economic aspects generally received higher ranks in both the attitude and performance evaluation. Quality management and customer service are perceived as the most important sustainability aspects while supporting community development and anti-corruption and fair competition are the least important aspects.
Hypotheses were developed to reflect the relationships among sustainability attitude, sustainability performance, and firm size. Most existing studies exploring similar issues provide arguments without empirical evidences or have such evidences but fail to illustrate the association between firm size and the holistic sustainability performance. By employing statistical techniques to empirically test the hypotheses, this study has responded to this knowledge gap. Non-parametric correlation analysis shows that the construction firms which perceive sustainability is of higher importance have higher sustainability performance. Kruskal-Wallis test and Mann-Whitney U test show overall larger firms tend to have higher sustainability performance than smaller firms, but the association between firm size and sustainability attitude is weaker. Contrasting to existing studies, this study suggests larger construction enterprises do not necessarily believe sustainability is more important in China.

This study has several theoretical and managerial implications. This study indicates in China, the conflict between the short-term economic gains and long-term benefits of sustainability presents a significant challenge for the adoption of sustainability practices in the construction industry. It is suggested that rather than predominately focusing on regulating large firms, relevant policies could be issued or enhanced to specifically address the sustainability issues of small and medium-sized construction enterprises. By identifying the most and least important, and best- and worst- performed sustainability aspects perceived by the Chinese construction enterprises of various scales, this study provides a reference for the government to allocate the resources to address the worst-performed sustainability aspects, such as green innovation and anti-corruption. Similarly, by referring to this study, construction enterprises of various scales could understand how their peers of similar, smaller or larger sizes in the industry perceive and perform on sustainability, thereby informing their decision-making of sustainability strategies.

Acknowledgment

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Appendix

Critical sustainability aspects for Chinese construction enterprises

This research has identified 29 critical sustainability aspects that impact construction enterprises’ sustainability performance. Please according to the following instructions to evaluate 1) the importance degree of; and 2) the performance of your enterprises on these aspects. Please give the score that you think is appropriate.

- Importance evaluation
1-very unimportant; 2-unimportant; 3-neutral; 4-important; 5-very important

- Performance evaluation
1-very bad; 2-bad; 3-neutral; 4-good; 5-very good

<table>
<thead>
<tr>
<th>Sustainability dimension</th>
<th>Critical sustainability aspects</th>
<th>Importance evaluation</th>
<th>Performance evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic</td>
<td>Corporate strategy</td>
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<td>Quality management</td>
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<td>Supply chain management</td>
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<td>Risk management</td>
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<td>Human rights</td>
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<td>Supporting community development</td>
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<td>Obeying laws and regulations</td>
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<td>Caring for all employees</td>
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<td>Promoting the development of the industry</td>
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<td>Environmental</td>
<td>Environmental management</td>
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<td>Construction waste management</td>
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<td>Land use efficiency</td>
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<td>Water conservation and harvesting</td>
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<td>Materials conservation</td>
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<td>Energy conservation</td>
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<td></td>
<td>Managing impacts on biodiversity</td>
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<td>Emission reduction</td>
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<td></td>
<td>Green innovation and products</td>
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<td></td>
<td>Light pollution control</td>
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<td></td>
<td>Noise control</td>
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</tbody>
</table>

References


Critical sustainability aspects (CSAs)

Importance evaluation
- Relative importance value (RIV)
- Sustainability attitude level (SAL)

Performance evaluation
- Relative performance value (RPV)
- Sustainability performance level (SPL)

Relative rankings of the CSAs

Testing of the three hypotheses

Conclusions & implications
Performance evaluation

Table 1. Representative studies on the sustainability of the Chinese construction industry

<table>
<thead>
<tr>
<th>Studies</th>
<th>Research focus</th>
<th>Sustainability aspects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Li et al. (2017)</td>
<td>Investigated the stakeholder influence in decision/evaluations relating to sustainable construction in China</td>
<td>Economic, Social, Environmental</td>
</tr>
<tr>
<td>Qin et al. (2016)</td>
<td>Examine the perceived risks of developing green buildings in China among the Chinese construction firms</td>
<td>Environmental</td>
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<tr>
<td>Jiang and Wong (2016)</td>
<td>Investigated the key activity areas of corporate social responsibility (CSR) in the Chinese construction industry using questionnaire survey</td>
<td>Social</td>
</tr>
<tr>
<td>Ye et al. (2015)</td>
<td>Examined the effect of market competition on the sustainability performance of the Chinese construction industry</td>
<td>Economic, Social, Environmental</td>
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<tr>
<td>Zeng et al. (2015)</td>
<td>Developed a systematic framework for major infrastructure projects' social responsibility (MIP-SR) in China</td>
<td>Social</td>
</tr>
<tr>
<td>Shi et al. (2015)</td>
<td>Provided an example of the social risk assessment of an infrastructure project in China</td>
<td>Social</td>
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<tr>
<td>Xue et al. (2015)</td>
<td>Measured the changing energy consumption efficiency of the Chinese construction industry from 2004 to 2009</td>
<td>Environmental</td>
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<tr>
<td>Zhang et al. (2015)</td>
<td>Conducted three case studies to investigate the implementation of environmental management in Chinese construction enterprises</td>
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<tr>
<td>Wang (2014)</td>
<td>Analysed the economic, social and environmental impacts of the construction industry in China</td>
<td>Economic, Social, Environmental</td>
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<td>Jiang et al. (2013)</td>
<td>Analysed the barriers to energy conservation and carbon reduction in China’s commercial building sector</td>
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<td>Zhang et al. (2011)</td>
<td>Explored the benefits of applying green strategies in the process of housing development and facilities management</td>
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<td>Qi et al. (2010)</td>
<td>Investigated the driving forces for green construction in Chinese construction firms</td>
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<td>Lu et al. (2008)</td>
<td>Identified 35 critical success factors for contractor competitiveness and investigated Chinese contractors’ perceptions on these factors</td>
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<td>Shen et al. (2006)</td>
<td>Surveyed Chinese contractors’ competitiveness using 45 competitiveness indicators</td>
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Table 3. Results of Mann-Whitney U tests for the SAL

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<th>SEs vs. LEs</th>
<th>SEs vs. HEs</th>
<th>MEs vs. LEs</th>
<th>MEs vs. HEs</th>
<th>LEs vs. HEs</th>
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<td>0.041*</td>
<td>0.001**</td>
<td>0.0005**</td>
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* Significant at the 0.05 level
** Significant at the 0.01 level
**Table 4.** Results of Mann-Whitney U tests for the SPL

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<th>LEs vs. HEs</th>
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<tr>
<td>M-U test</td>
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<td>0.064</td>
<td>0.007**</td>
<td>0.548</td>
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* Significant at the 0.05 level
** Significant at the 0.01 level