Sustainability Transition of the Chinese Construction Industry: Practices and Behaviours of the Leading Construction Firms

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Abstract: Due to various economic, social and environmental challenges, the Chinese construction industry is under tremendous pressure to transition itself to a sustainability-oriented industry. Existing studies have extensively explored the technological innovations of environmental sustainability within the Chinese construction industry. By contrast, very little attention has been paid to holistically explore the economic and social dimensions related to sustainability, as well as the sustainability strategies and behaviours of construction firms in China. From a sustainability transition perspective, this paper analyses the sustainability practices and the strategic sustainability behaviours of three leading construction firms in China based on a multiple-case study approach. Twenty-nine aspects of sustainability practices implemented by the case firms are identified. The evolution of the strategic sustainability behaviours presented by the three case firms as well as the strengths and weaknesses of the sustainability practices of the firms are also critically analysed. The results reveal that the case firms present different strategic sustainability behaviours with practices toward environmental sustainability to be a weaker aspect of the firms compared to their practices in economic and social sustainability. The potential measures to facilitate sustainability transition of the Chinese construction industry are also discussed. This study helps industry practitioners to gain a better understanding of sustainability practices and behaviours of leading construction firms in China.

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Introduction

Since the implementation of the reform and opening up policy, China’s construction industry has experienced a tremendous growth, overtaking United States to become the world's largest since 2010 (GCP and OE, 2013). To be competitive in this booming industry, a number of Chinese construction corporations have increased the investment on research and development (MUHD, 2011). Enhanced technological capability has enabled Chinese constructors to undertake sophisticated projects, and many mega projects were completed in China during the last two decades (Lu et al., 2013). Advanced technologies were researched and adopted in these complex projects, which significantly improved the competitiveness of Chinese construction corporations (Zhao et al., 2009).

However, despite the enhanced technological capability of constructing complex projects, there is still lack of adequate awareness of sustainable development within the Chinese construction industry (MUHD, 2011). In terms of the social and environmental awareness, despite the recognition of the importance of a feasibility study prior to project design and construction, it is not unusual that various social and environmental factors (e.g. cultural and heritage conservation, safety standards, and environmental friendly design) were overlooked (Shen et al., 2010). With regard to the economic sustainability, Zhao et al. (2009) suggested that the lack of well-trained human resources is responsible for the poor business performance of many construction corporations in China. Similarly, the construction industry in China has been widely criticised for the lack of modernity (Xu et al., 2005). These issues are echoed by the 12th Five-year Development Plan for the Chinese Construction Industry, which highlights “lack of sustainable development capability” as one of the major challenges to the Chinese construction industry (MUHD, 2011).

Existing studies have revealed certain aspects of sustainability issues within the Chinese construction industry. However, gaps exist in the current body of knowledge in this field. First, existing studies predominantly focus on the environmental dimension of sustainability, such as energy conservation and green construction technologies. By contrast, few studies attempted to holistically explore the economic, social and environmental dimensions of sustainability of the construction industry. Second, much attention has been paid to the technological innovations of sustainability, such as Industrialized Building and energy-saving technologies, while studies on social and managerial practices as well as behaviours of construction firms are largely overlooked. The technological innovations of sustainability need to be adopted by construction firms to generate real-world impact. More importantly, as sustainable construction addresses both environmental protection and value creation, and thus embraces not only technological responses but also non-technical aspects
related to economic and social sustainability (Du Plessis, 2007), it is imperative to examine the strategies and practices that the Chinese construction firms adopt to respond to sustainability, not only technological, but also managerial and social. Furthermore, the Chinese government has issued a series of policies to transition the construction industry towards sustainability. By focusing on the technical aspects of sustainability, a static view of sustainability has been a common approach in existing studies. On the contrary, whether construction firms are moving towards sustainability is largely overlooked. This study is part of a research project which aims to examine the social-technical transition of the Chinese construction industry towards sustainability. The paper holistically explores the sustainability practices and behaviours of leading construction firms in China based on a multiple-case study approach. In this study, economic, social and environmental dimensions of sustainability, as well as the technological, social and managerial practices of the selected case firms, are holistically examined. Subsequently, the conditions of sustainability transition of the Chinese construction industry and possible strategies to facilitate the transition process are discussed.

**Literature Review**

**Sustainability Transitions**

Sustainability transition is one of the foci in the research areas of technological innovation systems and socio-technical systems. In these research areas, sustainability transitions are defined as changes of socio-technical systems towards more sustainable alternatives (Geels, 2011). Studies on sustainability transitions have identified three levels of factors that influence the transition outcomes, i.e. the niche, regime and landscape. The reason the existing systems may change is that sustainability practices emerge and challenge the systems, and niches are the ‘protected spaces’ of these sustainability practices (Geels, 2011). Even though niches may challenge the existing systems, transitions do not come about easily. This is because the established rules and practices stabilise the existing system, and these established practices are theorised as the regimes (Geels, 2014; Markard et al., 2012). The landscape is the wider context, which influences niche and regime dynamics, such as demographical changes or climate change (Rip and Kemp, 1998). The essence of the sustainability transition theory is that transitions come about through interactions among the processes at the three levels. First, niche-innovations accumulate internal momentum, through learning processes, performance improvements, and support from powerful groups. Second, changes at the landscape level create pressure on the regime; tensions in the regime appear and the regime becomes destabilised. Third, destabilized regime opens windows, providing opportunities for niche innovations which then diffuse into the regime (Geels and Schot, 2007).
For the Chinese construction industry, an example of sustainability niches is the various demonstration projects related to sustainability such as demonstrative green buildings or projects completed by sustainable construction practices, while the unsustainable way of construction is the regime. Rising energy consumption and rapid urbanization process of China can be viewed as examples of landscape factors. To transition the construction industry towards sustainability, various sustainability innovations such as green buildings need to be facilitated within construction firms, to challenge and gradually replace the unsustainable way of construction practices.

Thus, according to the sustainability transition theory, the key issues for sustainability transition of the construction industry are related to the transition goals, niche-innovations, and transition pathways: 1) transition goals, i.e. what sustainability means to the construction industry and the associated requirements, 2) niche-innovations, i.e. what kind of sustainability practices emerged in the industry which may challenge the regime, and 3) transition pathways, i.e. what measures can be taken to facilitate the transition of the construction industry towards sustainability.

**Sustainability Reporting Guidelines**

To understand what sustainability means to the construction industry, we reviewed the key sustainability reporting framework generally, and the existing frameworks specifically related to the construction industry. A sustainability report makes abstract issues tangible and conveys disclosures on an organization’s impacts on the environment, society and the economy (GRI, 2014). The Sustainability Reporting Framework produced by the Global Reporting Initiative (GRI) is one of most well established international standards for the corporate sustainability reporting. In China, the widely used guideline for sustainability reporting is the CASS-CSR Guidelines, released by the Chinese Academy of Social Sciences (CASS). In addition, specifically for construction firms, there is a guide entitled the Guide on Social Responsibility for Chinese International Contractors, issued by the Chinese International Contractors Association (CHINCA) (see Table 1).

< Insert Table 1 here>
An examination of the indicator systems and associated requirements presented by three guidelines reveal that corporate sustainability of construction firms is a highly complex construct. There are various aspects of sustainability in construction firms such as sustainability strategy, wages and welfare, construction waste management, energy conservation, etc. The fact that corporate sustainability involves so many aspects while existing studies predominantly focus on environmental sustainability demonstrates the necessity of a holistic examination of sustainability of construction firms. In addition, since all three guidelines have unique indicator system for sustainability, it is imperative to compare these systems and identify main sustainability aspects for construction firms.

**Strategic Sustainability Behaviours**

To facilitate sustainability transition, sustainable practices need to be popularized in the industry. There are a large number of firms within an industry, and thus firms may adopt different strategies to respond to sustainability. Therefore, besides examining sustainability guidelines, firms’ reactions to sustainability also need to be explored. Various classification models have been proposed for firms’ strategic behaviours to sustainability issues. For instance, Winn and Angell (2000) proposed that corporate sustainability responses can be classified into four categories, i.e. deliberate reactive, unrealised, emergent active, and deliberate proactive. Ghobadian et al. (1998) identified five theoretical options of firms to environmental issues, namely non-compliance strategy, compliance strategy, compliance plus, commercial and environmental excellence and leading edge. Similarly, based on a systematic review of sustainability-oriented innovations, Klewitz and Hansen (2014) classified the strategic sustainability behaviours of corporations into five categories:

- **Resistant.** Ignore environmental/social issues beyond compliance.
- **Reactive.** React to external stimuli and focus on efficiency.
- **Anticipatory.** Second mover advantage, piecemeal innovation and no integrative approach.
- **Innovation-based.** First mover advantage and proactive solutions to sustainability issues.
- **Sustainability-rooted.** Business model rooted in sustainability and strong interaction with stakeholders.

The literature on strategic sustainability behaviour suggests that some corporations are willing to embrace new concepts such as sustainability and actively transform their business according to sustainability principles, while other corporations are resistant to organizational changes and are more likely to maintain the current status. All these classification models suggest a similar pattern of the sustainability behaviours of firms. Lee and Ball (2003) offered an insightful analysis, explaining that companies’ strategic responsiveness to environmental
issues actually describes a continuum, which ranges from reactive compliance with legislation at the lower end
to proactive practices at the upper end. The classification of Klewitz and Hansen (2014) is considered as more
appropriate to be adopted in this study as it is more comprehensive compared to other studies e.g. Winn and
criteria to assess the sustainability behaviours. For instance, to describe the firms which have excellent
sustainability performance, Ghobadian et al. (1998) propose the category of leading edge firms, setting the
standard for other firms. However, this criterion is not easy to be applied in empirical studies since it is difficult
to assess whether a firm set standard for other firms. By contrast, Klewitz and Hansen (2014) proposed that the
highest sustainability level of firms is sustainability-rooted firms, which have the business model rooted in
sustainability and very strong interaction with its stakeholders. Due to its comprehensiveness and clearly defined
criteria, the classification proposed by Klewitz and Hansen (2014) is adopted in this study.

Conceptual Framework

In case studies, before the data analysis and interpretation process, a conceptual framework could be
developed based on the literature review findings to serve as an anchor for the study and identify who will and
will not be included in the study (Baxter and Jack, 2008). Underpinned by the literature reviewed in the previous
section, a framework is developed to illustrate the research focus and scope of this study (Fig. 1).

< Insert Fig. 1 here>

The Chinese construction industry is composed of a large number of construction firms with different
scales and impacts. Considering their critical role in sustainability transition of the industry, this study
specifically focuses on the leading construction firms in China. The importance of niche-innovations in
sustainability transition of industries has been highlighted by a number of scholars studying transition related
issues (Caniels and Romijn, 2008; Schot and Geels, 2008). Niche-innovations are various innovative
sustainability practices, which are adopted and nurtured by niche actors. Niche-innovations are crucial since
they provide the seeds for potential transitions in the future (Grin et al., 2010). Large firms tend to pay more
attention to sustainability, and thus be potentially niche actors (Abidin, 2010). In the context of China, large
construction firms are usually state-owned and have huge market influence in the industry. Especially the leading construction firms, in terms of financial performance, are usually multinational enterprises, which are amongst the main ‘creators’ of new technology (Crescenzi et al., 2015). Furthermore, since leading firms perform much better than the average, the practices of leading construction firms are often regarded as the benchmark or “learning model” by other firms. Thus, the study of the sustainability practices and behaviours of the leading construction firms in China not only contributes to the knowledge about the sustainability practices of large construction firms, but also helps to assess the potential of transitioning the entire Chinese construction industry towards sustainability.

It is a challenge to transition the construction industry towards sustainability as firms may have different responses to sustainability as indicated by the literature on strategic sustainability behaviours. Leading firms may not share sustainability strategies either. How the leading construction firms in China reacted to sustainability? Are they transitioning themselves towards sustainability? What sustainability practices have they adopted? Based on a case study approach, this study aims to holistically identify the sustainability behaviours and practices adopted by leading construction firms in China, thereby establishing a basis for understanding sustainability transition of the entire Chinese construction industry.

**Research Methodology**

The research methodology adopted in this study is a multiple-case study based on directed content analysis. Based on the research procedures proposed by Yin (2014), and Baxter and Jack (2008), the research procedure of this study is developed (see Fig. 2).

There are a number of advantages associated with the multiple-case design compared to the single-case design. Single-case design is vulnerable because researchers have put “all eggs in one basket”, and thus the evidence from multiple cases is often considered more compelling and the overall study is regarded as being more robust (Yin, 2014). Multiple-case design allows cross-case analysis and comparison, and the investigation of a particular phenomenon in diverse settings. Therefore, multiple-case design was adopted in this study.

< Insert Fig. 2 here>

**Selection of Cases and Data Collection**
Data in case study can be collected via a number of methods, such as interviews, documentation, questionnaire, and observation (Baxter and Jack, 2008). For this study, it was decided that documents are used as the data source. Interviewing employees in construction corporations may generate detailed information; however, it is restricted by the interviewees’ personal work experience and may induce response bias (Tellis, 1997). More importantly, one research aim of this study is to identify the evolution of the strategic sustainability behaviours of the case firms. These need to be based on detailed historical records and cannot be achieved by means of interviews. Some leading construction corporations in China have published annual sustainability reports presenting their sustainability practices in a systematic manner. Since these reports are annually published by the corporations, the changes of the sustainability practices in a chronologic order can be investigated by means of analysing these reports, which cannot be achieved by means of interviews. These reports are usually developed by senior managers of the sustainability or social responsibility departments in the corporations, and assessed by third-party evaluation agency, which ensures the authenticity of the information in these reports.

Since sustainability reports are the main data source of this multiple-case study, the corporations which have released the sustainability reports for a longer term than others should be selected to fulfil the information-richness requirement of purposeful sampling. Unlike probability sampling which selects random and statistically representative sample, purposeful sampling is more appropriate in qualitative case studies, which selects information-rich cases for study in depth (Patton, 1990). According to Patton (1990), intensity sampling selects information-rich cases that manifest the investigated phenomenon intensely. Intensity sampling was adopted in this study to select leading construction firms which have adequate experience in sustainability practices and dealing with sustainability issues, reflected by their detailed and information-rich sustainability reports. Following the logic of intensity sampling, the 14 Chinese construction firms that are ranked as top 50 global contractors in 2013 by Engineering News Records were screened in the first instance. As a result, eight Chinese companies were identified which released sustainability reports. Six of these eight companies started to release sustainability reports before 2010. Three of these six companies were chosen for further study because: 1) they have diverse business areas, covering most of the project types in the construction industry; and 2) an preliminary examination of the sustainability reports of these six firms suggests the selected three firms produced much more detailed reports than others, which manifested sustainability intensely. The details of the selected case firms are shown in Table 2.
Coding and Data Analysis

To holistically identify sustainability practices implemented by the case firms, the data analysis approach needs to be capable of examining contextual meanings of the sustainability reports and developing a category of the sustainability practices. Qualitative content analysis is such an approach that can fulfil these research requirements. There are three main approaches in qualitative content analysis, namely conventional content analysis (inductive category development), directed content analysis (combination of deductive and inductive category development) and summative content analysis (focusing on examining keywords rather than developing categories) (Hsieh and Shannon, 2005). Directed content analysis is adopted as the data analysis method in this study. In directed content analysis, an initial coding category is developed based on existing literature or theory (inductive category development), and then the research data are examined and coded based on the initial coding category (deductive category development). Following the research procedure suggested by Elo and Kyngäs (2008) and Zhang and Wildemuth, (2009), the directed content analysis was conducted in this study to systematically analyse the sustainability practices and behaviours of the three case firms. Firstly, following the standard procedure of inductive category development, the initial coding category composed of key sustainability aspects is developed based on a detailed examination of the reviewed three sustainability guidelines. The main steps of inductive category development are: 1) preparing the data, 2) defining the unit of analysis, 3) developing coding categories and 4) testing the coding scheme (Zhang and Wildemuth, 2009). In this study, the research data in the sustainability guidelines is the main sections explaining sustainability indicators and associated criteria, excluding the secondary sections e.g. the Introduction. The unit of analysis is themes, rather than the physical linguistic units. It is widely adopted in qualitative content analysis by using the individual themes as unit of analysis (Zhang and Wildemuth, 2009). By using themes as unit of analysis, researchers could assign a code to a text chunk of any size, as long as that chunk represents a single theme. In the coding process, the criteria for selecting the key sustainability aspects were: 1) the aspect is illustrated in a section under an individual title in at least one guideline, and 2) themes related to the aspects can be found in at least two guidelines. After the coding category, i.e. the key sustainability aspects was developed, the sustainability reports of Firm A in 2009 and 2010 were used as sample texts to test the clarity of the coding
category. Since most of the sample texts could be properly coded using the developed coding category, the consistency and clarity of the coding category is reaffirmed. The final coding category of corporate sustainability for Chinese construction firms consists of 24 key sustainability aspects, as shown in Fig. 3.

After developing the initial coding category, specific strategies were adopted to analyse the data based on the coding category. Firstly, to identify the strategic sustainability behaviours of three case firms, a pattern-matching analysis was adopted. In pattern-matching analysis, the observation of the cases reveals a certain pattern, and then the empirically based pattern is compared with the pattern suggested by the theory, to reach a judgement about the merit of the theory or gain a deeper understanding of the empirical cases (Hall, 2006; Yin, 2014). Since most research papers have a section explaining relevant theory, which always imply some pattern, the principals of pattern matching analysis are actually extensively applied unconsciously (Trochim, 1989). Trochim, a leading scholar in pattern matching analysis, even argued that “all research employs pattern matching principles, although this is seldom done consciously” (Trochim, 1989, pp357). In this study, the pattern matching analysis was employed consciously. The procedure of pattern matching analysis in this study draws on other studies which consciously adopt pattern matching analysis (Geels and Penna, 2015; Penna and Geels, 2012, 2015). In this study, all the sustainability reports of the three firms from 2009 to 2013 were thoroughly examined and compared with the coding category. By comparing the sustainability practices implemented by the firms with the coding category, the researchers form an overall understanding about whether the 24 key sustainability aspects were adequately addressed by the case firms and what features the firms had. Consequently, the features revealed by the firms (empirically based patterns) were compared with the ideal situation of the evolving strategic sustainability behaviours suggested by Klewitz and Hansen (2014) (theoretically based patterns), to identify the strategic sustainability behaviours of the case firms. For instance, Klewitz and Hansen (2014) suggested sustainability-rooted firms should have a business model rooted in sustainability and show strong interactions with various stakeholders. This pattern corresponds to the features of Firm A since 2012, because Firm A has responded to all the 24 key sustainability aspects since 2010, and in 2012 it started to implement the culture-led sustainability model in the corporation. This is a sustainability-rooted business model and shows strong interactions with various stakeholders. The main features of the three
firms from 2009 to 2013 are likewise compared with the ideal five strategic sustainability behaviours proposed by Klewitz and Hansen (2014). Based on this analysis, the sustainability behaviours of the three cases firms from 2009 to 2013 were identified.

The identification of strategic sustainability behaviours shows general features of the case firms. Consequently, deductive category development was employed to identify the specific sustainability practices and associated strengths and weaknesses of the case firms. All the texts of the sustainability reports are reviewed and coded for correspondence of the initial coding category, i.e. the 24 key sustainability aspects. The texts that could not be categorised in the 24 key aspects were firstly examined to identify new individual themes, and then the number of themes was reduced by collapsing those either similar or dissimilar into higher order categories. After this category development process, a list of sustainability practices implemented by the case firms was developed. The identified strategic sustainability behaviour and sustainability practices were further interpreted from the socio-technical transition perspective, to discuss the potential measures to facilitate the transition of the entire Chinese construction industry.

Results

The three case studies demonstrate various practices of leading Chinese construction firms responding to sustainability. In this section, the sustainability practices are firstly presented, followed by the evolving strategic sustainability behaviours of the case firm. Then the strengths and weaknesses of the case firms are discussed.

Sustainability Practices Implemented by the Case Firms

Based on the 24 identified sustainability aspects, all sustainability practices adopted by three Chinese leading firms were coded into 77 sub aspects. A thorough examination of sustainability reports has revealed several practices which are not covered by the pre-determined 24 sustainability aspects. A total of 5 new sustainability aspects and 15 new sub aspects are identified respectively. Thus, the final list of the sustainability practices implemented by the case firms composes of 29 sustainability aspects and 92 sub aspects, as shown in the Appendix.

This study also reveals that managerial, technical and social practices are implemented by the three case firms as a response to sustainability (see Fig. 4). Specifically, efforts have been made to improve the maturity of corporate management and governance related to sustainability, such as establishing specific department responsible for corporate sustainability and implementing customer relationship management (CRM) to improve customer service and satisfaction. Similarly, all the three firms understand the importance of technological
innovations, and adopted various technologies such as renewable energy technologies and rain water collection system to improve sustainability. Many social practices are also adopted by the firms to demonstrate their social responsibility, such as culture heritage protection and employment of migrant workers. These three types of sustainability practices interact with each other and form a holistic niche-innovation system.

Strategic Sustainability Behaviours of the Case Firms

All these three firms are leading construction firms in China, ranked among the top 50 global contractors. However, the sustainability behaviours of the three case firms vary significantly. From 2009 to 2013, Firm A adopted various sustainability practices to improve its sustainability, covering all the sustainability aspects identified in sustainability guidelines. It then gradually formed a sustainability-oriented corporate culture. Corporate policies were developed to systematically nurture sustainability culture in the corporation. By contrast, Firm B and C placed more foci on widening the scope of sustainability practices to respond to various sustainability aspects, and did not proceed to the stage of systematic second-order learning, i.e. nurturing the sustainable corporate culture. Fig. 5 demonstrates the evolving strategic sustainability behaviour of the three case firms.

Specifically, even though Firm A can be classified as a sustainability-rooted firm since 2012, it has a history of being only anticipatory and implementing limited sustainability practices. For instance, relevant sustainability guidelines suggest that apart from the traditional economic assessment of suppliers, firms should also conduct environmental assessment, labour practice assessment, human rights assessment and social impacts assessment of suppliers, to choose the responsible and sustainable suppliers. These various assessments of
suppliers related to sustainability were not implemented by Firm A until 2010. Similarly, practices related to protecting biodiversity were ignored by Firm A in 2009, and from 2010 Firm A released relevant polices to specifically respond to biodiversity protection. A systematic procedure of managing the impacts on biodiversity (a managerial innovation), covering the practices before, during and after construction, was issued and implemented.

Even though Firm A implemented various practices responding to all the identified sustainability aspects, it could not be categorized as sustainability-rooted firm before 2012 since the business model had not been fundamentally transformed. This started to change after 2012 as Firm A issued and implemented the Culture-led Social Responsibility Progression Model. In the 2012 Sustainability Report, the top managers of Firm A indicated that to promote sustainability, not only facts and figures about technologies had to be accumulated, but also the whole corporate culture and business model needed to be transformed. Firm A determined that since 2012 the overall culture and mission of this firm has been “expanding a happy living environment”. The 2012 Sustainability Report states that “our mission is to expanding a happy living environment which shall serve as the most essential principle for us to handle relations with clients, employees, shareholders, the community and other stakeholders.” Guided by this mission, Firm A identified the main expectations of seven key stakeholders, namely shareholders, customers, environment, employees, partners, industry and communities. To meet these expectations, a systematic management structure was established. A social responsibility committee consisting of senior executives and department directors was established in 2012 to guide the overall work of sustainability. Under the committee, there is a social responsibility office which is responsible for making sustainability plan, developing and improving the managerial system of sustainability, organizing sustainability practices, and compiling and releasing sustainability reports. The company also released an information management system for sustainability, facilitating the communication between headquarter and subsidiary enterprises about sustainability issues.

Unlike Firm A, Firm B and C can only be classified as anticipatory firms since 2012, as their sustainability practices are inadequate to fully respond to all the sustainability aspects and no effort has been made to transform the business model. Specifically, because of inadequate emphasis on occupational health and safety, in 2013 Firm B had a major safety accident in a bridge construction site, and 11 employees died in the accident. After the accident occurred, the top leaders of Firm B organised video conferences to strengthen safety education and management. In terms of environmental sustainability, Firm C implemented very limited practices to protect the environment before 2012. Even though Firm C realized the importance of environmental
protection and started to proactively improve its environmental sustainability after 2012, many aspects were still
neglected such as managing impacts on biodiversity.

Therefore, the three case firms present different strategic sustainability behaviours, even though they are all
leading construction firms in China. From 2009 to 2013, Firm A evolved from an anticipatory firm to a
sustainability-rooted firm, while Firm B and C only evolved from reactive firms to anticipatory firms. Existing
literature shows that large firms tend to pay more attention to sustainability and perform better in terms of
sustainability compared to small counterparts in the construction industry (Abidin, 2010). Therefore, many
medium and small construction firms in China may pay little attention to sustainability or even are not aware of
the concept of sustainability. All three case firms in China experienced an improvement during the studied
period. However, other firms may remain the same sustainability behaviour or even paid less attention to
sustainability over the years. As the largest construction industry in the world, the Chinese construction industry
consists of a large number of firms. As a result, this industry is likely to be quite heterogeneous in terms of the
strategic sustainability behaviours of firms.

Comparison of the Three Cases with Sustainability Guidelines

The previous section focuses on illustrating the evolution of the sustainability behaviours of the case firms.
This section further elaborates the sustainability practices of the three cases by identifying the strengths and
weaknesses of the case firms. The sustainability practices of the three leading firms are assessed against the
requirements of the sustainability guidelines. A 3-point scale was employed to rate each of the 29 sustainability
aspects for each firm, where 1 represented “cannot fulfil many requirements of the guidelines”, 2 “fulfil the
requirements of the guidelines on the whole”, and 3 “exceed the requirements of the guidelines”. For the 5
newly identified sustainability aspects, 3 is given to the firms which have relevant practices and 2 is given to the
firms which do not have. After rating each sustainability aspect for each firm, an average score for each
sustainability aspect was calculated to reflect the overall situation of the three case firms. The average score of
each aspect is from 1 to 3. If the average score of a certain sustainability aspect is below 2, it would be assumed
that the corresponding aspect was not adequately addressed by the three firms in general and that aspect is
classified as a weak aspect. By contrast, if the average score of a certain aspect is above 2, it indicates that the
three firms performed beyond the requirements and expectations of the sustainability guidelines in general. Fig.
6 depicts the assessment of the sustainability practices of the case firms and Table 3 illustrates the identified
strong and weak sustainability aspects.
Strong Aspects of the Case Firms

The case firms generally did well in several sustainability aspects, e.g. quality management, innovation system, communication management, education and training, wages and welfare, supporting community development, obeying laws and regulations, and energy conservation. For instance, in terms of quality management, Firm A has a very comprehensive quality management system, including full-process quality control, overall quality management, and overall staff capacity building. With regard to education and training, Firm B developed 40 policies about employee training and even has a corporate college managing the vast number of training programs. Similarly, promoting renewable energy and using energy efficient equipment were adopted by all the three firms to conserve energy.

In terms of the newly identified sustainability aspects, under the category of economic sustainability, network building is identified as a new aspect. Firm A established strategic corporation relationships with its various partners including governments, banks, universities, and other corporations. With regard to social sustainability, caring for all employees and promoting the development of the industry are identified as new aspects. Firm A adopted several practices which can be labelled as caring for all employees, such as providing milk powder for female employees, and establishing special fund supporting employees with huge difficulties. The sustainability guidelines do illustrated similar concept. For instance, the GRI guideline indicated that equal remuneration should be offered for men and women. However, there is no individual section in the guidelines discussing how to ensure the benefits for all employees. Similarly, the GRI guideline suggested that technological innovation may enable industry-wide innovation. However, there is no individual section in the guidelines related to promoting the development of the industry. Firm A specifically illustrated its practices in this aspect, such as participating in national research projects and drafting industry standards. Environmentally, Firm A showed its practices to prevent light pollution and noise, which is not illustrated in individual sections by the guidelines as well. Thus, the new aspects are: 1) network building in the economic dimension; 2) caring for all employees in the social dimension; 3) promoting the development of the industry in the social dimension; 4) light pollution control in the environmental dimension; and 5) noise control in the environmental dimension.

Weak Aspects of the Case Firms
With the average score below 2, a total of 11 aspects were identified as weak aspects. To explain how these 11 aspects were not adequately addressed by the case firms, the major requirements of the sustainability guidelines which the case firms failed to fulfil are listed in Table 4.

Except the 5 newly identified aspects, a total of 24 sustainability aspects were identified in the three sustainability guidelines. 11 of them were weak aspects. This indicated that the three leading case firms still have a long way to go to promote its sustainability, even though they are all leading construction firms in China. Specifically, there are 3, 2, and 6 aspects, which are identified to be weak aspects of the case firms in economic, social and environmental sustainability respectively. For instance, the GRI guideline explains that corporate strategy making should be able to identify the key sustainability issues for firms, but both Firm B and C had a strategy in which the economy-centred feature was obvious and it is unclear how important sustainability is at the strategic level. In terms of supply chain management, the requirements of human rights assessments and social impacts assessments of suppliers were not fulfilled by Firm B and C either. Similarly, construction waste management, land protection and material conservation were addressed very inadequately by Firm B and C, which did not implement specific policies focusing on these issues.

Compared to economic and social sustainability, environmental sustainability is a weaker sustainability dimension of the three firms since there are 6 weak aspects relating to environmental sustainability. It has been illustrated in Table 1 that considering the Chinese context, two local sustainability guidelines were developed in China. Compared to the GRI guidelines, the two Chinese guidelines place more emphasis on the governance approach and practices for sustainability. By contrast, the GRI guideline requires the firms to release much quantitative information about sustainability, especially the environmental sustainability. Due to the lack of statistical methods and standards about environmental information, corporate policies on environmental statistics are not issued in most of Chinese construction firms. As a result, they are often not able to monitor their environmental impacts quantitatively. Even for Firm A, it merely started to establish monitoring system for
environmental issues in 2013, and thus still in the early stage in terms of environmental statistics. Indeed, more attention should be paid to environmental statistics by Chinese construction firms in the future.

**Discussion**

This paper analyses the strategic sustainability behaviours and sustainability practices of three leading construction firms in China. Three key implications can be drawn from the study.

- 92 sub aspects of sustainability practices implemented by the case firms have been identified, suggesting that sustainability is a complex concept and many practices need to be adopted to holistically respond to sustainability. This is echoed by Geels (2010) who suggest that sustainability transitions involve many potential solutions and practices.

- Even though all three case firms are leading construction firms in China, their strategic sustainability behaviour are very different, with Firm A significantly outperforming firm B and C. Considering the huge amount of firms engaged in the Chinese construction industry, it is expected that this industry could be heterogeneous in terms of the sustainability behaviours of firms.

- Assessment of the sustainability practices of the three case firms reveals that generally, the three case firms did well in social responsibility and some aspects of economic sustainability, while environmental sustainability is inadequately responded by the three firms.

From a sustainability transition perspective, these key conclusions contribute to the understanding of transitioning the entire Chinese construction industry towards sustainability significantly. Sustainability transition is the process in which sustainability practices gain momentum in the industry and gradually replace the dominant unsustainable practices in the regime. Transitioning the Chinese construction industry into a sustainability-oriented industry means to increase the share of sustainability-rooted or innovation-based firms in the industry. This study shows that China does have sustainability-rooted construction firms, such as Firm A. However, this study also reveals that there are different sustainability behaviours of construction firms, and even some leading construction firms, such as Firm B and C, are not sustainability-rooted or innovation-based firms. Measures need to be taken to empower the sustainable firms e.g. Firm A, to expand their influence in the industry, and make sustainability practices to become the new regime of the industry in the future. The transition concept emphasizes the complete transformation of the industry. Even though previously resistant firms may want to embrace sustainability and become sustainability-rooted corporations, they may still fail due to the lack of knowledge and improper implementation. For instance, Chai and Yeo (2012) studied energy efficiency
barriers, and to overcome them they proposed a conceptual framework which includes four stages, namely motivation, capability, implementation and results. According to their framework, barriers exist not only in the motivation stage, but also across other stages. Even if corporations such as Firm B and C have the motivation to become sustainability-rooted corporations, they still need to have the capability to properly implement relevant practices to improve sustainability performance, and correctly assess the outcomes. Klewitz and Hansen (2014) also highlights that capacity building is an important enabler in order to transition from anticipatory to innovation-based firms.

Thus, strategies should be proposed to not only motivate both resistant firms and reactive firms to embrace sustainability, but also provide sufficient resources to enable those firms to actually improve their sustainability. In addition, this study reveals that even though Firms B and C are leading construction firms, i.e. winners under the current market competition rules in China, they are still not sustainability-rooted firms. Thus sustainable firms in China need to be promoted through establishing a market competition mechanism by altering the current market competition rules, making sustainable construction firms more competitive than others and rewarded by economic gains. Considering the research results of this study and the insights gained from the socio-technical transition perspective, this paper suggests that the potential sustainability transition pathway for the Chinese construction industry could be a combination of: 1) top-down governmental steering which means providing sufficient incentives, knowledge and resources for resistant, reactive and anticipatory companies to encourage them to transform themselves based on sustainability principles, and 2) bottom-up market competition, which means establishing a proper business environment selecting sustainable firms as the winners in the market competition.

Conclusions

Undergoing the rapid development process in the last three decades, the Chinese construction industry faces various problems relating to its sustainable development. This paper has investigated the sustainability practices and behaviours of three leading construction firms in China and discussed the implications for sustainability transition of the Chinese construction industry. The results show that the three firms have different strategic sustainability behaviours from 2009 to 2013, forming different evolution trajectories. Only firm A has become sustainability-rooted since 2012, with firm B and C being anticipatory. 92 sub aspects of sustainability practices implemented by the case firms are identified. The detailed analysis of the strong and weak aspects of the three case firms reveals that the studied firms do implement some sustainability practices that are not
adequately emphasized in the sustainability guidelines, but generally they have a weaker performance on environmental sustainability than on economic and social sustainability, suggesting that the awareness of environmental protection still need to be promoted in the industry.

From a social-technical transition perspective, the fact that China has sustainability-rooted construction firms (e.g. firm A) and various sustainability practices (the identified 92 sub aspects) suggests that there are enabling conditions for China to promote sustainability transition of the whole construction industry. The key issue is to expand the influence of sustainability-rooted construction firms in the industry and empower the sustainability practices. Two major kinds of measures could be adopted to facilitate the sustainability transition, i.e. providing sufficient incentives, knowledge and resources to encourage firms, especially resistant and reactive firms, to accept and improve sustainability, and establishing a proper selection mechanism based on market competition, which thrive sustainable construction firms.

As an explorative study, this paper analyses three leading Chinese construction firms, establishing a research basis for larger empirical studies. Further research could be done by using questionnaire survey to investigate the strategic sustainability behaviours of medium and small construction firms in China. In addition, the driving forces and barriers of sustainability transition could also be investigated in future studies, which is essential to develop more detailed measures eliminating the barriers and facilitating the sustainability transition.

Since sustainability issue is a global challenge and many other economies are promoting sustainability in their construction industries, this paper provides useful references for relevant policy makers in other economies. Likewise, key sustainability aspects identified in this study can also be applied to examine the sustainability practices of construction firms in other countries.

Appendix

The final list of the sustainability practices implemented by the case firms composes of 29 sustainability aspects and 92 sub aspects. Table 5 is the final list.

<Insert Table 5 here>

Acknowledgements
This study was supported by the National Natural Science Foundation of China (Grant No.71371072), as well as the National Social Science Foundation of China (Grant No. 15CJY030).

References


GCP (Global Construction Perspective), and OE (Oxford Economics), (2013). Global Construction 2025: A global forecast for the construction industry to 2025, London, U.K.


<table>
<thead>
<tr>
<th>Corporate sustainability guidelines</th>
<th>Issuing purpose</th>
<th>Main contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>The GRI guideline</td>
<td>GRI promotes the use of sustainability reporting as a way for organizations to contribute to sustainable development, involving thousands of professionals and organizations from many sectors and regions.</td>
<td>The GRI Guidelines offers Reporting Principles, Standard Disclosures and an Implementation Manual for the preparation of sustainability reports by organizations. Following the launch of the G4 Guidelines in GRI in accordance with the G4 Guidelines.</td>
</tr>
<tr>
<td>CASS-CSR guideline</td>
<td>China’s national conditions and the current development status of Chinese corporations determine that at present the GRI standard cannot effectively guide Chinese firms. To better service for Chinese corporations, CASS released the CASS-CSR guidelines in China.</td>
<td>Similar to the GRI guideline, CASS-CSR 3.0 is also composed of general guidelines and sector guidance. The core components of the general guidelines are the indicator systems of the market performance, social performance and environmental performance of firms.</td>
</tr>
<tr>
<td>The CHINCA guideline</td>
<td>CHINCA has formulated a sustainability guide to establish a benchmark of social responsibility specifically for the construction industry. The guide incorporates recent best practices in the Chinese construction industry and reflects the common understanding about sustainability of the Chinese international contractors.</td>
<td>The Guide lists the core subjects of social responsibility for Chinese international contractors, rather than adopting the widely used Triple Bottom Line (TBL) approach to organize sustainability indicators. Seven core subjects have been identified that are closely related to construction corporations.</td>
</tr>
<tr>
<td>Case firms</td>
<td>Positions in global contractors in 2013</td>
<td>The business scope</td>
</tr>
<tr>
<td>------------</td>
<td>----------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Firm A</td>
<td>Top 10</td>
<td>Residential construction, international project contracting, real estate development</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and investment, infrastructure construction and investment, survey and design</td>
</tr>
<tr>
<td>Firm B</td>
<td>Top 10</td>
<td>Infrastructure design and construction, dredging, heavy machinery manufacture, and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>investment</td>
</tr>
<tr>
<td>Firm C</td>
<td>Top 40</td>
<td>Infrastructure design and construction, low-carbon cement manufacturing, investment,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>property development, and civil explosives manufacturing</td>
</tr>
</tbody>
</table>
Table 3. Strong and weak sustainability aspects of the three case firms

<table>
<thead>
<tr>
<th>Sustainability dimensions</th>
<th>Strong aspects</th>
<th>Weak aspects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic dimension</td>
<td>• Quality management</td>
<td>• Corporate strategy</td>
</tr>
<tr>
<td></td>
<td>• Innovation system</td>
<td>• Supply chain management</td>
</tr>
<tr>
<td></td>
<td>• Communication management</td>
<td>• Risk management</td>
</tr>
<tr>
<td></td>
<td>• Network building</td>
<td></td>
</tr>
<tr>
<td>Social dimension</td>
<td>• Education and training</td>
<td>• Anti-corruption and fair competition</td>
</tr>
<tr>
<td></td>
<td>• Wages and welfare</td>
<td>• Human right</td>
</tr>
<tr>
<td></td>
<td>• Supporting community development</td>
<td></td>
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<tr>
<td></td>
<td>• Obeying laws and regulations</td>
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<td></td>
<td>• Caring for all employees</td>
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<td></td>
<td>• Promoting the development of the industry</td>
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<tr>
<td>Environmental dimension</td>
<td>• Energy conservation</td>
<td>• Construction waste management</td>
</tr>
<tr>
<td></td>
<td>• Light pollution</td>
<td>• Land protection and use efficiency</td>
</tr>
<tr>
<td></td>
<td>• Noise control</td>
<td>• Water conservation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Material conservation</td>
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<tr>
<td></td>
<td></td>
<td>• Managing impacts on biodiversity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Emission reduction</td>
</tr>
</tbody>
</table>
**Table 4. Major requirements which the case firms failed to fulfil**

<table>
<thead>
<tr>
<th>Sustainability aspects</th>
<th>Major requirements which the case firms cannot reach</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Corporate strategy</td>
<td>The GRI guideline explains that corporate strategy making should be able to identify the key sustainability issues for firms and the factors influencing sustainability priorities.</td>
</tr>
<tr>
<td>2. Supply chain management</td>
<td>The GRI guideline suggests that besides the traditional economic assessment of suppliers, firms should also conduct environmental assessment, labour practice assessment, human rights assessment and social impacts assessment of suppliers.</td>
</tr>
<tr>
<td>3. Risk management</td>
<td>The GRI guideline suggests that policies and practices for assessing, addressing and managing corporate, operational, regulatory and strategic risk that might impact financial performance need to be implemented.</td>
</tr>
<tr>
<td></td>
<td>The CHINCA guide suggests that construction firms should establish relevant risk management and crisis prevent plans based on their business types.</td>
</tr>
<tr>
<td>4. Anti-corruption and fair competition</td>
<td>There is a whole section entitled anti-corruption in the GRI guideline, which suggests three factors to be considered related to anti-corruption, i.e. number and percentage of operation assessed for risks related to corruption, training on anti-corruption policies and procedures, and confirmed incidents of corruption.</td>
</tr>
<tr>
<td>5. Human right</td>
<td>In the GRI guideline, human right is a very important issue and a number of sub sections under the human right are listed, such as non-discrimination, freedom of association and collective bargaining, forced or compulsory labour, and indigenous rights.</td>
</tr>
<tr>
<td>6. Construction waste management</td>
<td>The GRI guideline suggests construction firms should monitor the total amount of hazardous and non-hazardous waste by different disposal methods.</td>
</tr>
<tr>
<td></td>
<td>The CHINCA and CASS-CSR guidelines suggest that construction firms should pay attention to the recycling of construction waste and advanced construction techniques to reduce the amount of construction waste.</td>
</tr>
<tr>
<td>7. Land protection</td>
<td>In the GRI guidelines, land protection is emphasized under the section of <em>Land Degradation, Contamination and Remediation</em>. It suggests that policy on land assessment and remediation should be released by construction firms.</td>
</tr>
<tr>
<td>8. Water conservation</td>
<td>The GRI guideline suggests that policy and practices on water use management throughout the project life cycle should be implemented by construction firms.</td>
</tr>
<tr>
<td>9. Material conservation</td>
<td>The GRI guideline suggests that material selection and engagement with suppliers on various issues such as re-usability of materials used, recycled content materials and toxicity of materials should be researched.</td>
</tr>
<tr>
<td>10. Managing impacts on biodiversity</td>
<td>The GRI guideline indicates that firms should be aware of the operational sites related to protected areas or areas of high biodiversity value, and significant impacts of their activities, products and services on biodiversity.</td>
</tr>
<tr>
<td>11. Emission reduction</td>
<td>The GRI guideline explained that practices should be taken to reduce various emissions including: 1) greenhouse gas (GHG) emissions, 2) ozone-depleting substances, and 3) NO$_x$, SO$_x$, and other significant air emissions.</td>
</tr>
<tr>
<td>Sustainability dimension</td>
<td>Sustainability aspects</td>
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</tbody>
</table>
| Economic                 | Corporate strategy    | 1. Scientific process and tools of analysing and generating strategy  
                        |                       | 2. Clear corporate vision and strategy  
                        | Quality management    | 3. A comprehensive quality management system, including organization system, institution building and supervision & assessment  
                        |                       | 4. Implement quality control throughout the whole construction process, including design, procurement, preparation for construction, construction and completion of construction  
                        |                       | 5. Design and implement various training programs on quality management for all staff  
                        | Supply chain management| 6. A clear procurement process  
                        |                       | 7. A clear set of criteria to assess and select suppliers, and incorporate sustainability principals into the selection criteria  
                        |                       | 8. Conduct training programs for suppliers and establish long-term corporation with excellent suppliers  
                        | Innovation system     | 9. Have relevant departments, policies and employees focusing on management innovation, such as the whole life cycle project management  
                        |                       | 10. Have relevant departments, policies and employees focusing on technology innovation  
                        |                       | 11. Have relevant departments, policies and employees focusing on concept innovation  
                        |                       | 12. Have relevant departments, policies and employees focusing on service innovation  
                        | Corporate governance  | 13. Establish departments responsible for corporate sustainability and social responsibility  
                        |                       | 14. Design and implement a management system focusing on sustainability, such as an assessment standard for evaluating corporate sustainability  
                        | Customer service and satisfaction | 15. Establish management system for customer service and satisfaction, such as customer relationship management (CRM)  
                        |                       | 16. Conduct satisfaction survey for clients of completed projects  
                        |                       | 17. Actively release project information for clients, including adverse information  
                        |                       | 18. Meet and surpass the demands of clients, such as introducing new construction technologies for clients  
                        | Communication management| 19. Have an individual section on the corporate website introducing sustainability and social responsibility of the corporation  
                        |                       | 20. Release annual sustainability reports  
                        |                       | 21. Establish complete communication mechanisms with various stakeholders  
                        | Network building      | 22. Cooperate with banks  
                        |                       | 23. Cooperate with enterprises  

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|   | 24. Cooperate with universities  
|   | 25. Cooperate with governments  |
| Risk management | 26. Establish risk assessment criteria and classification system of risks for early warning and emergency response  
|   | 27. Have response strategies if various risks happen, such as financial risks and operational risks  |
| Social | 28. Conduct physical checks for employees regularly and establish health records  
|   | 29. Conduct psychological consultation for employees  
|   | 30. Establish relevant organizations specifically responsible for safety management  
|   | 31. Establish a safety inspection and training system  
|   | 32. Have emergency response system if accidents happen  |
| Occupational health and safety | 33. Conduc physical checks for employees regularly and establish health records  
|   | 34. Conduct psychological consultation for employees  
| Education and training | 35. Conduct physical checks for employees regularly and establish health records  
|   | 36. Establish a safety inspection and training system  
|   | 37. Have emergency response system if accidents happen  |
| Wages and welfare | 35. Establish risk assessment criteria and classification system of risks for early warning and emergency response  
|   | 36. Have response strategies if various risks happen, such as financial risks and operational risks  |
| Anti-corruption and fair competition | 38. Establish risk assessment criteria and classification system of risks for early warning and emergency response  
|   | 39. Have response strategies if various risks happen, such as financial risks and operational risks  |
| Human right | 38. Establish risk assessment criteria and classification system of risks for early warning and emergency response  
|   | 39. Have response strategies if various risks happen, such as financial risks and operational risks  |
| Support community development | 40. Establish risk assessment criteria and classification system of risks for early warning and emergency response  
|   | 41. Have response strategies if various risks happen, such as financial risks and operational risks  |
| Obey laws and regulations | 42. Establish risk assessment criteria and classification system of risks for early warning and emergency response  
|   | 43. Have response strategies if various risks happen, such as financial risks and operational risks  |
|   | 44. Establish risk assessment criteria and classification system of risks for early warning and emergency response  
|   | 45. Have response strategies if various risks happen, such as financial risks and operational risks  |
|   | 46. Establish risk assessment criteria and classification system of risks for early warning and emergency response  
|   | 47. Have response strategies if various risks happen, such as financial risks and operational risks  |
|   | 48. Establish risk assessment criteria and classification system of risks for early warning and emergency response  
|   | 49. Have response strategies if various risks happen, such as financial risks and operational risks  |
|   | 50. Establish risk assessment criteria and classification system of risks for early warning and emergency response  
|   | 51. Have response strategies if various risks happen, such as financial risks and operational risks  |
|   | 52. Establish risk assessment criteria and classification system of risks for early warning and emergency response  
|   | 53. Have response strategies if various risks happen, such as financial risks and operational risks  |
|   | 54. Establish risk assessment criteria and classification system of risks for early warning and emergency response  
|   | 55. Have response strategies if various risks happen, such as financial risks and operational risks  |
|   | 56. Establish risk assessment criteria and classification system of risks for early warning and emergency response  
|   | 57. Have response strategies if various risks happen, such as financial risks and operational risks  |
|   | 58. Establish risk assessment criteria and classification system of risks for early warning and emergency response  
|   | 59. Have response strategies if various risks happen, such as financial risks and operational risks  |
|   | 60. Establish risk assessment criteria and classification system of risks for early warning and emergency response  
|   | 61. Have response strategies if various risks happen, such as financial risks and operational risks  |
|   | 62. Establish risk assessment criteria and classification system of risks for early warning and emergency response  
|   | 63. Have response strategies if various risks happen, such as financial risks and operational risks  |
|   | 64. Establish risk assessment criteria and classification system of risks for early warning and emergency response  
|   | 65. Have response strategies if various risks happen, such as financial risks and operational risks  |
|   | 66. Establish risk assessment criteria and classification system of risks for early warning and emergency response  
|   | 67. Have response strategies if various risks happen, such as financial risks and operational risks  |
|   | 68. Establish risk assessment criteria and classification system of risks for early warning and emergency response  
|   | 69. Have response strategies if various risks happen, such as financial risks and operational risks  |
|   | 70. Establish risk assessment criteria and classification system of risks for early warning and emergency response  
<p>|   | 71. Have response strategies if various risks happen, such as financial risks and operational risks  |</p>
<table>
<thead>
<tr>
<th>Caring for all employees</th>
<th>54. Caring for female employees through various activities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>55. Caring for front-line works</td>
</tr>
<tr>
<td></td>
<td>56. Caring for employees with huge difficulties, such as the establishment of health fund for employees with major diseases</td>
</tr>
<tr>
<td>Promoting the development of the industry</td>
<td>57. Actively participate in the research projects organized by the government</td>
</tr>
<tr>
<td></td>
<td>58. Actively participate in various international industry conferences</td>
</tr>
<tr>
<td></td>
<td>59. Actively participate in various domestic industry conferences</td>
</tr>
<tr>
<td>Environmental management</td>
<td>60. Set up environmental department at the headquarters</td>
</tr>
<tr>
<td></td>
<td>61. Formulate relevant corporate policies about environmental management</td>
</tr>
<tr>
<td></td>
<td>62. Set up environmental targets and conduct regular monitoring</td>
</tr>
<tr>
<td></td>
<td>63. Implement green office policy to encourage employees to save water, electricity, and paper</td>
</tr>
<tr>
<td></td>
<td>64. Establish incentive mechanisms to enhance environmental management</td>
</tr>
<tr>
<td>Construction waste management</td>
<td>65. Classify construction waste and recycle as much as possible on site</td>
</tr>
<tr>
<td></td>
<td>66. Adopt environmentally friendly materials and advanced techniques to reduce the amount of construction waste</td>
</tr>
<tr>
<td>Land use efficiency</td>
<td>67. Optimize the site design of buildings</td>
</tr>
<tr>
<td></td>
<td>68. Rational exploitation of the underground space of buildings</td>
</tr>
<tr>
<td></td>
<td>69. Have policy on land assessment and remediation</td>
</tr>
<tr>
<td>Water conservation and harvesting</td>
<td>70. Reduce water consumption by adopting various approaches, such as using sack moisturizing technology</td>
</tr>
<tr>
<td></td>
<td>71. Strengthen water recycling by various approaches, such as using rainwater collection system</td>
</tr>
<tr>
<td>Material conservation</td>
<td>72. Use quantitative indicators to manage materials and reduce material waste</td>
</tr>
<tr>
<td></td>
<td>73. Select local building materials if possible</td>
</tr>
<tr>
<td></td>
<td>74. Promote structural system with high durability</td>
</tr>
<tr>
<td></td>
<td>75. Promote the use of green building materials</td>
</tr>
<tr>
<td></td>
<td>76. Optimize the construction programs to save materials</td>
</tr>
<tr>
<td>Energy conservation</td>
<td>77. Promote construction technologies which consume low energy</td>
</tr>
<tr>
<td></td>
<td>78. Promote the use of energy-saving equipment and tools</td>
</tr>
<tr>
<td></td>
<td>79. Promote the use of renewable energy sources such as wind and solar power</td>
</tr>
</tbody>
</table>
| Managing impacts on biodiversity | 80. Before construction, investigate the ecological environment and biodiversity of the construction site and make protection plans  
| | 81. Mark the protected species on the construction site to indicate employees  
| | 82. Conduct education and training for employees about biodiversity protection  
| | 83. Maximize the retention of native trees within the construction site  
| Emission reduction | 84. Promote the use of dust-proof net and sealed cars  
| | 85. Set up washing tanks for vehicles at the doors to the construction site  
| Green innovation and product | 86. Establish an enterprise database for green products and technologies  
| | 87. Mitigate negative impacts on end user health through various approaches, such as paying attention to the indoor air quality issue  
| Light pollution | 88. Rational distribution of site lightning to reduce light pollution  
| | 89. Use shielding measures to reduce light pollution  
| Noise control | 90. Promote the equipment of low vibration and noise  
| | 91. Use sound insulation and seismic isolation measures  
| | 92. Make rational schedule to avoid the concentration of noisy operations  

Note: Aspects which are not covered by the initial coding category are marked by shades of gray.
Past

The Chinese construction industry

Leading firms

Sustainability transition

Future

Present

Past

This study
Strategic sustainability behaviours
Practices
Economic
Social
Environmental
Multiple-case study

**Intensity sampling:** three leading firms

**Data source:** sustainability reports from 2009 to 2013

**Directed content analysis**

**Inductive category development:** developing the initial coding category

**Pattern matching:** the strategic sustainability behaviours

**Deductive category development:** the list of sustainability practices of the case firms

Identify the strategic sustainability behaviours, the sustainability practices and associated strengths and weaknesses, and interpret them from the transition perspective

**Conclusion**
<table>
<thead>
<tr>
<th>Economic dimension</th>
<th>Social dimension</th>
<th>Environmental dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Corporate strategy</td>
<td>- Occupational health and safety</td>
<td>- Construction waste management</td>
</tr>
<tr>
<td>- Quality management</td>
<td>- Education and training</td>
<td>- Land use efficiency</td>
</tr>
<tr>
<td>- Supply chain management</td>
<td>- Wages and welfare</td>
<td>- Water conservation and harvesting</td>
</tr>
<tr>
<td>- Technology development</td>
<td>- Anti-corruption and fair competition</td>
<td>- Material conservation</td>
</tr>
<tr>
<td>- Corporate governance</td>
<td>- Human right</td>
<td>- Energy conservation</td>
</tr>
<tr>
<td>- Customer service and satisfaction</td>
<td>- Support community development</td>
<td>- Managing impacts on biodiversity</td>
</tr>
<tr>
<td>- Communication management</td>
<td>- Obey laws and regulations</td>
<td>- Emission reduction</td>
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<tr>
<td>- Risk management</td>
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<td>- Green innovation and product</td>
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<td></td>
<td></td>
<td>- Environmental management</td>
</tr>
</tbody>
</table>

Figure 3
Technical practices
(e.g. enterprise database for green products, rain water collection system)

Managerial practices
(e.g. customer relationship management, risk management)

Social practices
(e.g. culture heritage protection, employment and education of migrant workers)
Firm A:
- Total coverage of the sustainability aspects and more niche-innovations responding to sustainability
- Establishment of the cultural-led corporate sustainability model, and further exploration of the model

Firm B & C:
- Partial coverage of the sustainability aspects
- More practices responding to sustainability, but still partial coverage of the sustainability aspects
- Firm B: from very limited to partial coverage of the sustainability aspects
- Firm C: limited economic and social sustainability practices, with the almost ignored environmental sustainability

Other Chinese firms (several possible scenarios)
• **Fig. 1.** Conceptual framework

• **Fig. 2.** Research methodology

• **Fig. 3.** 24 key sustainability aspects

• **Fig. 4.** Sustainability practices of the case firms

• **Fig. 5.** Evolving strategic sustainability behaviour of the case firms

• **Fig. 6.** Assessment of the sustainability practices implemented by the case firms in 2013