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Research Article

Critical Barriers and Challenges in Implementation of Green Construction in China

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Abstract

Environment and community is significantly influenced by activities. Therefore, these issues will be mitigated with the promotion of green construction. The stakeholders of construction industry in china were selected for questionnaire survey in order to find out issues related to green construction adoption. The results indicated that in view of berries, management barriers is high consideration and the biggest challenges is higher cost and unfamiliarity with the technologies.

Keywords: *Green construction, Construction management, Kolmogorov-Smirnov, projects mangers, environment*

1. Introduction

Construction of green building can be part of an overall plan for sustainable development. The design of green buildings aims at optimum energy efficiency and the construction process includes priority for recycled, reclaimed and natural materials (Kubba, 2010). The maximized efficient usage of resources like water, energy and raw materials in these buildings makes the indoor environment more productive, comfortable and healthier for occupants. According to American Society of Testing and Material (ASTM, 2009), the specified building performance requirements are provided by green buildings while disturbance is minimized and the service life and function of global, regional, local ecosystem both before and after its construction are improved. The five major features of ideal green buildings are summarized by (Burnett 2007): more use of renewable energy and passive design; optimizing the hydrologic cycles of building; integration with local ecosystems; full implementation of indoor environmental quality measures; and closed loop material systems. Project managers and owners must aim at this ideal green building strategy. Recently development of green buildings has been a worldwide focus. With the increase in the number of green buildings, it is necessary to raise the number of competent specialists for designing, constructing, managing and maintaining the specialized green services and facilities. Thus, a recognition and training program, namely the Certified Green Mark Professional program, was initiated by BCA in an effort to make the industry more capable in sustainable design and development (BCA Academy, 2011). The individual efficacies in green building design and practice are identified in this program. The candidates need to complete the certification course if they are looking for certified GMP (Green Mark Professionals) from BCA. The course of GMP includes short modules which focus on practical green solutions and technologies, design concepts, and the use of building simulation tools for prediction of building performance.

According to Green Construction Guideline mentioned that green construction is defined as an engineering construction process which is able to not only assure the safety, quality and other basic requirements but also maximize the resource conservation and minimize the negative influence on the environment to achieve goals of material saving, energy saving, land saving, water saving and environmental protection". This construction process needs scientific management and technological progress. There are five key words in this guideline, i.e., environmental protection, water conservation and utilization, construction management, and land protection. These six aspects cover five factors involved in the process of construction, i.e., manpower, method, material, machine, and environment.

Despite the importance of green construction development, studies on potential challenges and barriers in green construction in China still remain limited. This study uses questionnaire survey to investigate the green construction in China, with emphasis on the potential barriers and challenges. The specific objective of this study can be categorized into two parts: 1) to classify the general barriers in the

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implementation of green construction in China; 2) to classify the general challenges that facing the projects managers in the implementation of green construction in China.

2 Main barriers in green construction

Generally, environmental issues in construction industry are considered of utmost importance. For sustainable construction, (Hill, *et al*, 1997) suggested a framework clarifying that environmental issues must be considered in contract documents and specifications related to implementation of environmental tools like environmental impact system and environmental management system. For construction projects, particularly for those subject to environmental assessment, (Crawley, *et al*, 1999) considered "green" design and specification of utmost importance.

For specifications used in sustainable engineering, (Meryman, *et al*, 2004) highlighted three main barriers. Besides policy and technical issues, they argued economic factor as the most important barrier which can be possibly translated into green construction in China. According to (Li, *et al*, 2009) and Zhang *et al*. 2011), the emerging issues related to building energy conservation are because of rapid economic growth and urban development in China. Sustainable development of buildings and construction technologies for various conditions is particularly important in China because there is higher population and building density, and also there is less amount of reusable energy available per square meter floor area (Zhu, *et al*, 2004). (Liu, *et al*, 2012) addressed that motivation of construction industry practitioners in China is higher in adoption of green practice for the purpose of getting incentive and countenance from Chinese government. Currently, in developing countries like China, the limited understanding and pursuit of cost reduction make many developers uncertain in adoption of sustainability in their projects. (Abidin 2010) pointed out that knowledge, consciousness, and understanding the consequences of individual's actions determine the pace of action regarding sustainable application. Whereas according to (Qi, *et al*, 2010), contractors consider the managerial factor of utmost importance in the adoption of green practice. In summary, above studies categorize the main barriers of green construction into 4 fundamental aspects: management, technology, economics, and awareness. These 4 fundamental aspects cover 15 specific potential barriers as identified in Table 1.

2.1 Economics

2.1.1 Cost

In the process of decisions related to the implementation of green construction, cost efficiency is considered to be the most important factor (Kunzlik, 2003; Meryman *et al*.,2004). According to (Ofori, *et al*, 2004), one main barrier in the implementation of green construction is the extra cost occurred. The capital cost is often increased with the use of green techniques like water and energy saving equipments, and high performance insulation protection. In fact, the biggest challenge among the challenges in implementation of green practice in China is cost control (Liu, *et al*, 2012). In the process of relevant cost and impact assessment, life cycle approach must be used in order to assist in the promotion of green construction (Shi, *et al*, 2012).

2.1.2 Time

Another important benchmark for the construction projects' performance is schedule (Chan, *et al*, 2002). In most countries, stakeholders consider time as the main objective of projects (Ofori, *et al*, 2004). Cost is often increased with delay in construction which is detrimental to the stakeholders as well as influencing the corporation's reputation (Arditi, *et al*, 2006). (Hoffman, *et al*, 2008) stated that interaction with other components of the building and integrity of sustainable technologies are needed in green construction. If these issues are not considered well, some delay can be induced (Hwang, *et al*, 2012).

Table 1 Potential barriers in implementation of green construction (adapted from Shi, *et al*, 2013)

No.	
	Economics
	Cost
1	Additional costs caused by green construction
	Time.
2	Incremental time caused by green construction.
	Technology
3	Reduction of structure aesthetics.
4	Uncertainty in the performance of green materials and equipment's.
5	Imperfect green technological specifications.
6	Misunderstanding of green technological operations.
7	Restrictions of new green productions and technologies.
	Awareness
8	Regional ambiguities in the green concept.
9	Conflicts in benefits with competitors.
10	Dependence on promotion by government.
	Management
	Construction Management
11	Lack of support from senior management.
12	Lack of knowledge on green technologies and materials.
13	Limited availability of green suppliers and information.
14	Lack of quantitative evaluation tools for green performance.
	Contract management
15	Additional responsibility for construction maintenance.

2.2 Technology

Although the function of a building may not be impacted by its aesthetic appearance as the building's appearance is another aspect of concern for project owners, the architectural design of a building can sometimes be in trouble because of the application of green construction techniques. For example, architects are usually forced by the installation of solar panels to give more time for the integration with material either on the roof or on the façade of a house. Engineers face challenges, driven by regulations, in aesthetic issues (Pierce, *et al*, 2000). The concern of most stakeholders is the degradation of aesthetic appearance which results from the adoption of green construction technologies. The construction related embodied energy is influenced by aesthetic issues. he solar house or passive house will be more energy efficient in comparison with equivalent houses having conventional issues and appearances (Sartori, *et al*, 2007). To achieve green construction, the most important thing is green equipment's and materials (Lam *et al*., 2011; Shi *et al*., 2012). The efficiency of green construction is often reduced by performance uncertainty of green equipment's and materials. China is still in the early stage of green technology and proper establishment of specifications is yet to be considered. Implementation requirements and green construction operations still have many misunderstandings. The main barrier for green construction is the lack of green technologies.

2.3 Awareness

Green construction awareness and environmental issues related public awareness is closely related. Currently, public, owners, construction personnel, policy makers and designers' knowledge and cognition are in need of further enhancement. Although environmental pollution has been recognized as a serious issue by majority of residents, company's participation, government involvement, and public indifference like social issues are ranked with high priorities (CEAP, 2007) According to the report of CEAP (China Environmental Awareness Program), the perception of government is that local governments, authorities and companies are responsible for environmental protection (CEAP, 2007). The role of civil engineers in green initiatives was highlighted by (Bilec, *et al*, 2007) for the purpose of enhancing public and policy makers' awareness regarding the green design related costs and benefits. Therefore, another technical barrier is the disagreement of industry practitioners in making changes to the conventional ways of specifying current processes and methods (Chen, *et al*, 1999; Meryman , *et al*, 2004).

2.4 Management

2.4.1 Construction management

The green construction adoption is directly influenced by the level of support from senior management (Meryman, *et al*, 2004). If the top management is not committed to the environmental issues, the organization employees at lower hierarchies cannot influence much due to their limited power (Ball, 2002). Durability of green materials and knowledge about green technologies are considered the main barriers which resist the implementation of green strategies and green construction specifications. According to (Shen, *et al*, 2010), in the early stages of construction projects, the suppliers and contractors must have interaction as they have knowledge on construction projects related environmental issues, plants and building materials. Another barrier in green construction is the supply chain of green material. The cost of green materials is high, and if stakeholders have conflict of interests, there will be inadequate trust relationship and uncertainties (Love , *et al*, 2002; Shi, *et al*, 2012). The supply of green materials is not flexible and reliable as there is no standard distribution network for green materials (Pearce and Vanegas, 2002). One significant barrier in green construction is the uncertainty of information and supplies. The performance of green construction cannot be assessed and monitored as there is no benchmark system (Lee, *et al*, 2008). In China, currently, there is no workable index system that is able to effectively assess the performance of green construction and the entire process of construction.

2.4.2 Contract management

There are two aspects of sustainable construction: construction insurance and post-construction liability (Pollington, 1999). The maintenance cost must be considered as 12% of total embodied energy is consumed by maintenance (Thormark, 2002). In some countries, "soft landing" like practice is adopted for the involvement of professionals if the building is completed in order to make sure that the building actually works as anticipated. This creates loops in the feedback of the project (Coles, *et al*, 2010; Leaman, *et al*, 2010) and, on the other hand, contract management faces challenges. Therefore, there is an increase in the responsibility of green construction warranty. Thus, there is a need to resolve contractual and liability puzzles.

2.5 Main challenges that facing projects mangers in green construction

Based on the literature review, Table 2 summarizes the potential challenges that facing the project managers in green construction in China.

Table 2 Potential challenges that facing projects mangers in implementation of green construction (adapted from Hwang, *et al*, 2013)

No.	
1	Higher costs for green construction practice and green materials.
2	Technical difficulty during the construction process.
3	Risk due to different contract forms of project delivery.
4	Lengthy planning and approval process for new green technologies and recycled materials
5	Unfamiliarity with green technologies.
6	Greater communication and interest required amongst project team members
5	More time required to implement green construction practice onsite.

1. Higher costs for green construction practice and materials

In comparison to conventional projects, the costs of green construction projects are higher. (Tagaza , *et al*, 2004) highlighted that the capital costs are usually 1-25% higher in green projects than in conventional projects. The complexity in design increases the cost, and modeling cost is needed to integrate the green practices into projects (Zhang, *et al*, 2011). Green technologies and green materials also increase the cost (Hwang, *et al*, 2010). The prices of green materials are commonly 3-4% higher if compared with conventional construction materials (Zhang, *et al*, 2011). Sometimes there is a significant cost difference in some green materials if compared with conventional materials. For example, the price of compressed wheat board is 10 time higher than that of ordinary plywood (Hwang , *et al*, 2010). The project manager is directly impacted by higher cost of green construction because the budget is pre allocated and managers have to control the project under the budget (Ling, 2003).

2. Technical difficulty during the construction process

Project plan is implemented by project managers with the help of making authorization for the execution of activities in order to produce project deliverables (Ling, 2003). Often, complex construction processes and techniques are needed for green technologies (Zhang, *et al*, 2011).

The performance of project manager will be impacted if there is no focus on complexities. According to (Tagaza, *et al*, 2004), the technical difficulties experienced during the process of construction are the main barrier in the green construction. Similarly, the alternative systems and materials are evaluated which make the design more complicated in comparison with conventional buildings (Hwang , *et al*, 2010).

3. Risk due to different contract forms of project delivery

The contract project delivery type determines the success of green design development and implementation (Tagaza, *et al*, 2004). The details of fully integrated green design must be incorporated in the type of green project contracts. According to Tagaza, *et al*, 2004), problems will be created if the design is locked before being fully developed. There will be various changes in significant scale if there is late incorporation of green features which will increase the overall cost of project (Hwang, *et al*, 2010).

4. Lengthy approval process for new green technologies and recycled materials

The planning process protraction is suggested by market environment as the process is lengthy in making approvals of recycled materials and new green technologies (Tagaza, *et al*, 2004). (Zhang, *et al*, 2011) and (Eisenberg, *et al*, 2002) made surveys which showed that the additional time is needed for gain approval The process of lengthy approval is considered to be a challenge to the project managers as they will follow the schedule and must make progressive approval for the payments to both vendors and suppliers (Ling, 2003).

5. Unfamiliarity with green technologies

Different studies recognized that there are certain barriers for contractors, developers and clients in green technologies. (Eisenberg, *et al*, 2002) suggested two reasons: unfamiliarity with products, systems, materials or designs; and lack of knowledge or technical expertise. The difference and complexity of green technologies are most important challenges compared with conventional (Tagaza, *et al*, 2004). (Zhang, *et al*, 2011) also had similar opinions. According to (Ling, 2003), a project is to be delivered within the client specified performance and the performance outcome is influenced by unfamiliarity with performance of green technologies.

6. Greater communication and interest required amongst project team members

A larger number of team members, suppliers and subcontractors are managed by project manager in order to be successful. To gain team members' expected sustainable practice, green projects critically needs communication. The team members' interest is of utmost importance. According to (Tagaza, *et al*, 2004), there were mix of materials in recycling skips and the enthusiasm for separating waste material between sub-contractors dissipated the project progress.

7. More time required to implement green construction practices on site

For on-site implementation of sustainable practices, project managers must randomly check and make site visits (Tagaza, *et al*, 2004). This is important because workers will timely complete the sustainable practices which are time consuming and are to be completed timely.

3. Methodology

In order to examine the green construction status quo in China, a questionnaire is designed on the basis of assessment of various challenges summarized from an extensive literature review. There are three sections in questionnaire: 1) potential barriers in green construction implementation (Table 1); 2) potential challenges in green construction implementation (Table 2); 3) attitude of respondents about green construction implementation (Table 3).

Table 3 General statements on implementation of green construction (adapted from Shi *et al.*, 2013)

No.	
1	Specifications should consider environmental requirements.
2	Specifications and guides can be easily found interiorly.
3	Current public constructions have sufficiently considered green factors.
4	Current non-public constructions have sufficiently considered green factors.
5	Information or database about green construction is adequately available in your company.
6	Green considerations are mainly for satisfying mandatory requirements.
7	Senior management in your company is concerning and supporting green construction.
8	Adopting green construction should be voluntary.
9	Implementation of green construction is forced by government.

4. Results and discussion

4.1 Potential challenges in implementation of green construction

This section of the questionnaire consists of 7 components, as shown in Table 4. The Cronbach's Alpha coefficient is 0.80, suggesting that the instrument has high internal consistency.

The table 4 indicates that the average mean of all group 4.16, which depicts that there is an agreement among client, contract and supervisor that there are potential challenges in implementation of green construction. The biggest challenges among all are higher cost and unfamiliarity with the technologies with the mean value 4.31 and 4.33 respectively. At individual levels, clients consider higher cost but contractor consider unfamiliarity with technology whereas communication and interest among team members is considered by supervisors as the biggest challenge. The difference in their agreement is due to difference of roles. Lengthy planning and approval is the least considered challenge though they still believe it to be challenge with the mean value of 3.97.

Table 4 Mean and standard derivation for potential challenges in implementation of green construction

		Total		Client		Contractor		Supervisor	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	Higher costs for green construction practice and green materials	4.31	0.73	4.55	0.50	3.95	0.75	4.43	0.78
2	Technical difficulty during the construction process	4.03	0.85	4.20	0.79	4.05	0.81	3.83	0.93
3	Risk due to different contract forms of project delivery	4.12	0.84	4.30	0.76	3.93	0.80	4.13	0.94
4	Lengthy planning and approval process for new green technologies and recycled materials	3.97	0.80	4.08	0.80	4.00	0.72	3.83	0.87
5	Unfamiliarity with green technologies	4.33	0.73	4.33	0.69	4.43	0.71	4.25	0.78
6	Greater communication and interest required amongst project team members	4.23	0.52	4.13	0.71	4.30	0.78	4.52	0.71
7	More time required to implement green construction practice onsite	4.15	0.80	3.90	0.78	4.30	0.79	4.25	0.78
	Total	4.16	0.75	4.21	0.72	4.14	0.77	4.18	0.83

Table 5 Results of Mann-Whitney U tests and Kolmogorov-Smirnov tests for Potential challenges in implementation of green construction

No.		Client vs contractor		Client vs supervisor		Contractor vs supervisor	
		MeW U test	KeS test	MeW U test	KeS test	MeW U test	KeS test
1	Higher costs for green construction practice and green materials	2.22*	1.11	2.24*	1.00	2.79*	0.11
2	Technical difficulty during the construction process	0.74	1.12	1.99*	0.89	1.20*	0.22
3	Risk due to different contract forms of project delivery	0.46	0.45	0.35	0.34	1.05*	0.45
4	Lengthy planning and approval process for new green technologies and recycled materials	2.11*	0.45	1.36*	0.89	1.08*	1.01*
5	Unfamiliarity with green technologies	0.83	0.89	0.70	0.89	1.02*	1.57*
6	Greater communication and interest required amongst project team members	0.83	0.89	0.70	0.89	1.03*	1.57*
7	More time required to implement green construction practice onsite	3.65*	0.34	1.90*	1.34	0.33	1.01*

*Statistically significant

In order to test the statistical difference among groups, Mann-Whitney test and K-S tests are performed. The results are summarized in table 5. The table shows that clients, supervisor and contractors do not differ in their opinions for the challenges in implementing of green construction. For statement 1 "Higher cost…" clients and supervisors considered it bigger challenge compare to contractors however, with the result of MeW test, we do not find the significant difference in their opinions. They all agreed to the same point. Similarly, for statement 3 contractors is less in favor to find it as challenging as other groups do with the value 3.93 relatively lower than clients and supervisors values. However, with the test of MeW no difference is found. On the contrary, contract is slightly more favourable for the statement 4 (Table 4) in comparing with other two groups. Interestingly, no difference is observed among three groups while MeW test is employed (Table 5). As far as KeS test for potential challenges, we do not find a significant difference in all statements of any pair of three groups. Both tests show the similar results which indicate that all groups do not statistically vary in their views for the challenges in implementation of green construction.

Spearman rank correlations test is employed to find the ranking of barriers by three groups. The table summary shows that all these groups have given the similar ranking. There is no significant difference in their rankings.

Table 6 Spearman rank correlations for the ranking of barriers

	Client	Contractor	Supervisor
Total	0.82	0.83	0.82
Client	-	0.45	0.44
Contractor	-	-	0.52

4.2 General statements on implementation of green construction

The following section of questionnaire consists of 9 components, as shown in Table 7. The Cornbrash's Alpha coefficient is 0.80, showing that the instrument has high internal consistency.

Table 7 shows that the mean ranges between 3.68 – 4.58, with the highest mean for "Specification and guide can be easily found interiorly" and the lowest mean was for " Adopting green construction should be voluntary". The mean average for all 9 statements is 4.13 indicate the agreement for general statements on implementation of green construction by all three groups. The statement 3 regarding current public constructions the mean value 4.05 by supervisors have no variability with 0.00 standard deviation whereas statement 7 regarding senior management has a standard deviation 1.01 which is relatively high and indicates that supervisors have the difference in their views about the support for green construction by the senior management. It is necessary for the senior management to address this issue and remove the doubts of supervisors about green construction.

Table 7 Mean and standard derivation for general statements on implementation of green construction

No.		Total		Client		Contractor		Supervisor	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	Specifications should consider environmental requirements	4.18	0.65	4.18	0.78	4.15	0.70	4.21	0.41
2	Specifications and guides can be easily found interiorly	4.58	0.72	4.18	0.78	4.58	0.78	4.05	0.98
3	Current public constructions have sufficiently considered green factors	4.51	0.78	3.95	0.78	4.58	0.81	4.05	0.00
4	Current non-public constructions have sufficiently considered green factors	4.53	0.77	4.00	0.78	4.58	0.81	3.45	0.77
5	Information or database about green construction is adequately available in your company	3.88	0.75	4.38	0.70	3.73	0.75	3.53	0.51
6	Green considerations are mainly for satisfying mandatory requirements	3.99	0.86	4.35	0.74	3.90	0.90	3.73	0.82
7	Senior management in your company is concerning and supporting green construction	3.93	0.90	3.83	0.78	3.93	0.89	4.05	1.01
8	Adopting green construction should be voluntary	3.68	0.83	3.95	0.78	3.65	0.80	3.45	0.85
9	Implementation of green construction is forced by government	3.90	0.77	3.89	0.76	3.82	0.78	3.06	0.78
	Total	4.13	0.78	4.08	0.76	4.10	0.80	3.73	0.68

Table 8 Results of Mann-Whitney U tests and Kolmogorov-Smirnov tests for General statements on implementation of green construction

No.		Client vs contractor		Client vs supervisor		Contractor vs supervisor	
		MeW U test	KeS test	MeW U test	KeS test	MeW U test	KeS test
1	Specifications should consider environmental requirements	-0.23	0.34	-0.14	1.00	-0.17	0.78
2	Specifications and guides can be easily found interiorly	-2.61	1.57	-5.73	2.68	-3.35	1.12
3	Current public construction have sufficiently considered green factors	-3.62	2.24	-6.54	3.24	-3.16	1.01
4	Current non-public construction have sufficiently considered green factors	-3.42	2.12	-6.38	3.13	-3.16	1.01
5	Information or database about green construction is adequately available in your company	-3.66	1.45	-5.07	2.24	-1.00	0.78
6	Green considerations are mainly for satisfying mandatory requirements	-2.28	1.34	-3.34	1.57	-0.84	0.56
7	Senior management in your company is concerning and supporting green construction	-0.46	0.56	-1.01	1.34	-0.58	0.78
8	Adopting green construction should be voluntary	-1.77	1.01	-3.08	2.01	-1.55	1.01
9	Implementation of green construction is forced by government	-3.66	-3.42	-3.62	1.45	1.47	1.52

Results of MeW tests and KeS tests are employed to find the difference of views regarding implementation of green construction by all three groups. Table 8 shows that all groups have no difference in their views in this regard. In Table 7 we can see that supervisors are less favorable to agree about private sectors' role in green construction comparing with other two groups. However, the result of Mew and KeS tests prove that these groups have no significant difference for this statement. Similarly, in statement 6 of table 7, clients are more favorable for the statement that green considerations are mainly for satisfying mandatory requirements with the mean value 4.35 which is higher than two other groups values; contractors 3.93 and supervisors 3.73.

Spearman rank correlations test is employed to find the ranking of barriers by three groups. The table 9 shows that all these groups have given the similar ranking. There is no significant difference in their rankings.

Table 9 Spearman rank correlations for the ranking of barriers

	Client	Contractor	Supervisor
Total	0.85	0.86	0.83
Client	-	0.55	0.45
Contractor	-	-	0.53

4.3 Potential barriers in implementation of green construction

Table 10 shows that the mean ranges between 2.84 – 3.41, with the highest mean for " Reduction of structure aesthetics " and the lowest mean for " Limited availability of green suppliers and information ". The overall mean for the total components is 3.08. For the economic barriers, clients do not agree with statement with the mean value 2.20 (statement 1) and 2.10 (statement 2). Regarding the technological and awareness barriers, likewise, clients in unfavorable and do not agree with statements 3 – 10. For the statements 13, 14 and 14 about management barriers, all groups have disagreed with the statements which infers that top management should take some major steps to remove this barrier for achieving the fruitful results.

Table 10 Potential barriers in implementation of green construction

		Total		Client		Contractor		Supervisor	
No.		Mean	SD	Mean	SD	Mean	SD	Mean	SD
	Economics								
1	Additional costs caused by green construction	3.29	1.25	2.20	1.49	3.90	0.31	3.77	0.77
2	Incremental time caused by green construction	3.22	1.45	2.10	1.49	3.83	0.99	3.73	1.14
	Technology								
3	Reduction of structure aesthetics	3.41	1.40	2.17	1.49	4.13	0.63	3.93	0.98
4	Uncertainty in the performance of green materials and equipment's	3.34	1.38	2.20	1.52	4.00	0.69	3.83	0.99
5	Imperfect green technological specifications	3.23	1.35	2.13	1.46	3.83	0.75	3.73	1.01
6	Misunderstanding of green technological operations	3.12	1.38	2.23	1.57	3.53	0.97	3.60	1.10
7	Restrictions of new green productions and technologies	3.09	1.30	2.17	1.51	3.60	0.77	3.50	1.01
	Awareness								
8	Regional ambiguities in the green concept	2.97	1.33	2.13	1.50	3.43	0.90	3.33	1.12
9	Conflicts in benefits with competitors	2.96	1.44	2.23	1.61	3.30	1.12	3.33	1.30

10	Dependence on promotion by government	3.02	1.45	2.30	1.66	3.40	1.13	3.37	1.27
	Management								
11	Lack of support from senior management	3.01	1.39	2.27	1.66	3.37	0.93	3.40	1.19
12	Lack of knowledge on green technologies and materials	3.00	1.40	2.30	1.66	3.27	1.01	3.43	1.19
13	Limited availability of green suppliers and information	2.84	1.35	2.20	1.56	3.13	1.04	3.20	1.19
14	Lack of quantitative evaluation tools for green performance	2.90	1.43	2.20	1.56	3.23	1.19	3.27	1.28
15	Additional responsibility for construction maintenance	2.86	1.21	2.23	1.59	3.33	1.15	3.00	0.20
	Total	3.08	1.22	2.20	1.53	3.55	0.57	3.50	0.82

Table 11 Results of Mann-Whitney U tests and Kolmogorov-Smirnov tests for Potential barriers in implementation of green construction

		Client vs contractor		Client vs supervisor		Contractor vs supervisor	
No.		MeW U test	KeS test	MeW U test	KeS test	MeW U test	KeS test
	Economics						
1	Additional costs caused by green construction	4.46*	2.32*	4.17*	2.07*	0.09	0.26
2	Incremental time caused by green construction	4.20*	2.32*	3.96*	2.02*	0.12	0.26
	Technology						
3	Reduction of structure aesthetics	4.78*	2.32*	4.32*	2.07*	0.47	0.26
4	Uncertainty in the performance of green materials and equipment's	4.24*	2.33*	3.89*	2.02*	0.30	0.26
5	Imperfect green technological specifications	4.12*	2.31*	3.90*	2.12*	0.02	0.26
6	Misunderstanding of green technological operations	3.15*	2.30*	3.22*	2.07*	0.56	0.52
7	Restrictions of new green productions and technologies	3.56*	2.30*	3.33*	2.07*	0.04	0.26
	Awareness						
8	Regional ambiguities in the green concept	3.35*	2.07*	3.05*	1.81	0.12	0.26
9	Conflicts in benefits with competitors	2.73*	1.81*	2.69*	1.81	0.31	0.39
10	Dependence on promotion by government	2.63*	2.07*	2.49*	1.81	0.10	0.26

	Management						
11	Lack of support from senior management	2.61*	2.07*	2.59*	1.81	0.50	0.39
12	Lack of knowledge on green technologies and materials	2.26*	2.07*	2.59*	1.94	0.84	0.65
13	Limited availability of green suppliers and information	2.28*	2.04*	2.40*	1.68	0.49	0.39
14	Lack of quantitative evaluation tools for green performance	2.57*	1.81*	2.57*	1.68	0.21	0.13
15	Additional responsibility for construction maintenance	2.52*	1.81*	1.96	2.32*	2.75*	1.81

*Statistically significant

The results of MeW U and KeS tests are given in table for potential barriers in implementing the green construction. The result predicts that view of contractors regarding imperfect green technology specifications (Statement 5) and restrictions of new green productions and technologies (statement 7) is different from client and supervisors.

Spearman rank correlations test is employed to find the potential barriers in implementation of green construction by three groups. The table 11 shows that all these groups have given the similar ranking. There is no significant difference in their rankings.

Table 12 Spearman rank correlations for Potential barriers in implementation of green construction

	Client	Contractor	Supervisor
Total	0.75	0.85	0.86
Client	-	0.75	0.65
Contractor	-	-	0.54

Conclusion

There are some issues that affect environment and community significantly. These issues may be mitigated by promoting green construction. The stakeholders of construction industry in china were selected for questionnaire survey in order to find out issues related to green construction adoption. There questionnaire contains three subparts: potential barriers in green construction implementation, potential challenges in green construction implementation and attitude of respondents about green construction implementation. The study surveyed three major groups of stakeholders, i.e. clients, contractors and construction supervisors.

The findings reveal that that major group of stakeholder view that there are barriers which should be taken into consideration by the concern authorities. The biggest challenge for potential challenge is higher cost and unfamiliarity with the technologies. Another important finding is that supervisors have the difference in their views about the support for green construction by the senior management. It is necessary for the senior management to address this issue and remove the doubts of supervisors about green construction. In view of barriers, a particular perspective of management barriers is of high consideration. It infers that top management should take some major steps to remove this barrier for achieving the fruitful results.

There are some limitations associated with this study. Future research opportunities exist to conduct similar studies in other regions to validate of these findings. It is also worth noting that people's attitude may to some extent affect their decision to pursuit sustainability. Therefore, further studies are required to investigate the attitudes and knowledge of site personnel on green construction with a comparison to those of decision makers.

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