Challenges in managing green building projects from the view of the contractors: An exploratory study in Vietnam

QuangDung Tran
National University of Civil Engineering, Hanoi, Vietnam

E-mail: dungtq@nuce.edu.vn

Abstract. Success of green building projects is significantly dependent on the capacity of all stakeholders. In order to improve the success of such projects, this study seeks to gain a better and deeper understanding of the critical challenges facing the contractors in executing green building projects. The methodological framework used consists of a literature review and a questionnaire survey of green construction experts in Vietnam. The data collected from 163 expert responses was used to conduct the test of Kendall's coefficient of concordance, Chi square tests, ANOVA and mean ranking analysis. The results indicate that the top five challenges facing the contractors in executing green building projects are “lack of legal regulations and technical codes, standards, guidelines on green building”, “more difficult to early establish a competent, integrated, multidisciplinary green project team”, “more difficult for comprehending the green specifications”, “more difficulty in the selection of competent subcontractors in providing green building services”, and “shortage of reliable green building methods, materials, technologies, and equipments in the market.” The findings bring out valuable implications for the government, the industry practitioners and stakeholders in improving the success of the green building projects in the future. Given the limited empirical studies on issues influencing the success of delivering green building projects, the present study also makes a contribution to the body of knowledge.

Keywords: green building; project management; contractors; challenges; Vietnam

1. Introduction
With the growing awareness of green building’s potential to positively impact environmental, economic, and social issues, there is a significant increase in numbers of green buildings constructed over the world during the past 10 years [1]. In order to gain succeed and popularity of green building projects, a better understanding of challenges in executing green building projects is crucial.

Green building projects are inherently different from traditional building projects from both technical and managerial perspectives. Green buildings often adopt new, innovative, and environmental friendly building technologies that bring out many challenges in managing such project. For example, a green building very often has higher initial cost and likely has an increase in cost during the phase of construction. It also requires much more extensive documentation and reporting if a green certification is required as the project’s mandatory project goal. Especially, such a green building project requires strong integration and closely collaboration among the members of its multi-disciplinary project team through the feasibility, design, implementation, and close out phases to appropriately integrate the sustainable goals at the very early phase and fully achieve the goals at all subsequent project phases [2].
In Vietnam, the Government has strong commitments on the development of environmentally friendly building market by establishing green building (GB) standards and regulations as well as providing financial incentives for sustainable construction [3]. Up to 09/2019, about 108 green buildings have international or domestic green certifications across the market, including approximately 30 LOTUS certified projects, 56 LEED certified projects, 10 EDGE certified projects, and about 12 Green Mark certified projects. The majority of these GB projects are for industrial-use facilities, office spaces, educational facilities and commercial buildings [4]. Presently, the number of environmentally friendly buildings is significantly increasing and the trend of GBTs adoption into buildings become more and more popular. However, this trend is criticized being very slow as compared to many countries in the region [5]. For example, Singapore has more than 2,100 Green Mark certified projects and Australia has approximately 750 Green Star certified projects. Therefore, there is a need to better understand critical challenges in managing green building projects in the specific context of Vietnam [4].

The construction process involves a large number of the relationships amongst many stakeholders from different backgrounds and with different goals; the main stakeholders of construction processes can be divided into four categories, which correspond to different sides with respect to the project: client, design, construction, and public sides. Each stakeholder has the key responsibilities for different functions and duties in the construction process [6]. For helping policy makers and practitioners take suitable measures to promote green building adoption, several studies have investigated influential factors on the development and success of green building projects from various perspectives such as project managers, designers, developers; however, there has been little attention specifically paid on the contractor side. In order to fill the gap, this study seeks to better understanding about critical barriers/challenges in executing green building projects under the view of contractors with reference to the developing country of Vietnam. The challenges are investigated through a questionnaire survey among construction managers who have professional expertise and much experience in managing green building projects in Vietnam.

2. Literature review on barriers and challenges in executing green building projects

Green buildings are defined as the facilities which are the outcomes of sustainable construction activities for the purpose of promoting occupant health and resource efficiency, minimizing their impacts on the natural ecology system [7]. A green building project is expected to achieve not only the traditional goals such as cost, schedule, and quality but also the life cycle goal of environmental sustainability, energy and water savings [18].

Green building projects have the unique characteristics as compared with the traditional projects; for example using special, advanced, innovative, and environmental friendly materials, equipment and practices, adopting the integrated design process, and requiring a more interdisciplinary cross-team interaction and coordination. It is necessary to early establish a green building project team that should consist of all key players, such as prospective users and community members, code officials, architects, building technologists, contractors, civil engineers, mechanical and electrical engineers, structural engineers, commissioning agent, operating staffs, and consultants from many specialized fields such as materials consultants, landscape consultants, cost consultants, the BIM specialist, lighting designers, energy analysts, etc; especially, green specifications specialists [18].

Previous studies have investigated the factors affecting the development of green building from many different perspectives, such as potential challenges perceived by project managers [1, 8, 9]; successful factors of projects perceived by the owners [10-13]; barriers to adoption of GBTs [3, 4, 14]; and factors affecting the implementation of green specifications under the view of designers [15, 16]...Hwang and Ng [1] conducted a literature review and point out six critical challenges that project managers face in managing green building projects including: higher costs for green construction practices and green material, technical difficulty during the construction process, risk due to different contract forms of project delivery, lengthy planning and approval process for new green technologies and recycled materials, unfamiliarity with green technologies, greater communication and interest are
required amongst project team members, and more time is required to implement green construction practices onsite. The study of Hwang and Tan [8] on green building in Singapore found the top five obstacles encountered during green building project management, including (1) the high premium cost associated with green building construction, (2) the lack of communication and interest between project members, (3) the lack of expressed interest from clients or market demand, (4) the lack of credible research on the cost-benefits of green buildings, and (5) green building practices are costly to implement. The study of Li, Chen [17] on the critical success factors for delivering green building projects in Singapore stated that construction firms are now facing challenges on how best to attain green certification with minimum cost and resources; and summarized the important requirements need to be met to successfully deliver the green projects including: strong support from senior management, skilled designers, skilled project managers, troubleshooting, project team motivation, strong commitment of all project participants, strong/detailed plan effort in design and construction, adequate communication channels, effective control, such as monitoring and updating plans, effective feedback, and adequate financial budget. Furthermore, Robichaud and Anantatmula [18] also cited that lacking appropriate tools, equipments, methods or third-party entities to validate green products or technologies was one of the significant challenges within an immature market of sustainable building technologies. As a result, green building products can inflate a project’s cost without delivering the expected performance or quality.

Green buildings often require much more complicated construction processes and methods in comparison with traditional buildings [8, 19]. Therefore, technical difficulties experienced during the construction process are consistently considered as one of the primary challenges in green building projects [1]. Previous studies empirically confirmed that the unfamiliarity with GBTs and green design will also affect the performance outcome of the project delivery process; as a result, this makes considerable challenges for managers to effectively deliver the green project. Regarding this, project teams need to have technical expertise, advanced skills and rich experience on green building to address occurred difficulties. Even on-site workers are also required to improve their knowledge and skills in execute green construction activities [8]. Besides, the planned schedule will be also a tough target for the green projects [15, 19]. Ineffective communication between relevant stakeholders is acknowledged as one of the significant challenges to delivering green building projects because this makes it to be more difficult to manage changes, mitigate risks, and contain costs with a holistic view of the project [18]. Additionally, green buildings not only affect their immediate users but also impact a broad range of other people; therefore, it is essential to treat the project team and all consultants, subcontractors, and others working onsite as part of the stakeholder group and they must be incorporated into the project earlier in the life cycle. Upon all challenges mentioned above, it is critical that all practitioners of an integrated process of the project delivery need to develop new skills that might not have been previously required in their professional work. Some of these new required skills to succeed include: critical thinking, analysis and questioning, teamwork, ability to collaborate with others on the team, good communication skills, and a deep understanding of natural processes [20].

In Vietnam, Nguyen, Skitmore [3] – a study on barriers to GB revealed that legislative and institutional barriers are widely perceived as the most challenging to GB in the country. Quangdung, Tien Toi [4] conducted a SWOT analysis of the market of GBTs and also discovered that “the system of technical codes, standards, guidelines is insufficient”; “green R&D activities are not paid appropriately attention by the industry”, and “it is lacking of competent contractors to execute green building projects” were the most critical challenges to the development of green building in Vietnam.

3. Research Methodology
3.1. Questionnaire design
First, a literature review was carried out and found a list of 30 potential challenges likely facing the contractors in executing green building projects. Next, based on the discussions of academia and consultants issued at the Website http://congtrinhxanhvietnam.vn/goc-nhin-chuyen-gia-c4, six challenges specific for the context of Vietnam were added to the list (see Table 1). Then, the
interviews with two construction managers and a senior lecturer that had much experience in the local construction industry and possessed relevant experience in green building activities were conducted to validate and refine the list of identified 36 potential challenges. They were asked to assess the questionnaire with regard to question construction, use of technical language/terms, whether the questionnaire covered all possible challenges as well as whether any factors could be added to, or deleted from the questionnaire. A few challenges were removed or merged; eventually the list of 31 potential challenges was adopted for a full survey questionnaire (Table 1). The first section of the instrument captured the respondent’s profile. The second listed the potential challenges that contractors may face during the construction phase of green buildings. The respondents were asked to rate the extent to which one factor was a critical challenge to managing green building projects using a 5-point Likert scale (1 = not critical; 2 = fairly critical; 3 = critical; 4 = very critical; and 5 = extremely critical). Before sending out the survey, a couple of pilot tests were carried out to determine the required time for its completion, to ensure that the questions and instructions were clear.

3.2. Data collection
The population of this study comprised the contractors’ managers or engineers who have knowledge and understanding of green construction activities in Vietnam. Since no sampling frame exists, the non-probability sampling technique can be utilized to acquire a representative sample. This is appropriate when the respondents can be selected on the basis of their willingness to take part into the research. A snowball sampling method was used to obtain a helpful sample size. This method was also used in many previous construction management studies [14]. Via personal introductions, five local contractors, which have been directly involved in the construction of green buildings in Hanoi, were firstly approached to identify the initial respondents. These initially identified respondents were asked to introduce and share information regarding other potential participants. Using this approach, out of a total of 215 survey questionnaires were administered via e-mail and in person, the 164 sets of questionnaires with completed responses were received and analyzed, yielding a rate of 76% responses. This sample size is acceptable for EFA based on the recommendation of Hair, 1998 [14]. Accordingly, the minimum sample size should be greater five times by the number of variables and not less than 50; this study has 31 variables, therefore the sample size should not less than 155.

3.3. Respondent profiles
Of the 164 completed responses, one contained over 30% missing critical data; therefore it was deleted – leaving 163 responses available for further analysis. Means is used to substitute missing values because this way is the most widely used method and considered appropriate for less than 10% missing data. Figure 1 shows the respondents’ profiles. This profile signifies the validity and reliability of the responses.

3.4. Data analysis techniques
3.4.1. Cronbach's alpha technique. The data were first tested statistically for their credibility and reliability for the current study using the Cronbach's alpha coefficient via the SPSS statistical package. Generally, a $\alpha$ value above 0.7 is considered acceptable. In this study, the $\alpha$ value for the 31 challenges in executing green building projects was 0.863, indicating a good reliability of the data at the 5%
significance level and thus the data collected can be treated as a whole, and to be suitable for further analyses.

3.4.2. Agreement analysis techniques. Different stakeholders may have different perception of challenges they may face in implementing green building projects. To examine whether different respondents within a certain group agreed on the ranking of the challenges, this study used the Kendall’s coefficient of concordance test (Kendall’s W) and the Chi-square test. The null hypothesis of the test is that “there is no agreement among the rankings given by the respondents within each group”. If the Kendall’s W value is at a low significance (significance level 0.001) then the null hypothesis can be rejected; and it can be said that there is some agreement among the rankings given by the respondents within each group. Chi square provides an approximate distribution with N-1 degrees of freedom (df) for determining the significance of an observed W. In addition to the Kendall’s W test, this study performed analysis of variance (ANOVA) test to check whether statistically significant differences in mean scores exist among respondents from different groups, namely Group 1 “execution or design departments’ managers”, Group 2 “superintendents” and Group 3 “field or office engineers”.

One-way ANOVA is a widely used method that is suitable for comparing the mean scores from three or more groups.

3.4.3. Mean score ranking technique. As a typical quantitative analysis method for ranking the relative importance/criticality of factors; the mean score ranking technique was used to rank the relative significance of the 31 challenges in executing green building projects as the respondents perceived. The mean score of the significance of a challenge is calculated using the following formula:

\[ B_i = \frac{\sum_j a_{ij}}{n} \] (1)

where \( n \) = the total number of respondents; \( a_{ij} \) = the significance of the challenge \( i \) rated by the respondent \( j \); and \( B_i \) = the mean score of the significance of the challenge \( i \).

Additionally, in order to ascertain whether each challenge was significantly important, statistical t-tests of the mean values against a test value of 3.5 were used at a significance level of 0.05. The null hypothesis, \( H_0 \), is that “the mean score is not statistically significant”, while the alternative hypothesis, \( H_1 \), is that “the mean score is statistically significant”. The null hypothesis for a challenge should be rejected if its p value is below 0.05.

4. Results and discussions

The results of Kendall’s coefficient of concordance, Chi square tests, and ANOVA are shown in Table 1. It can be seen that the coefficients of concordance are 0.321, 0.119 and 0.249 for the Group 1, Group 2 and Group 3, respectively. Also, the critical values of Chi-square for the three groups are observed to be 430.679, 302.898 and 224.271 (df = 31), respectively, with probabilities of occurrence under \( p < 0.001 \) (Asymp. Sig. = 0.000). These results indicate a good consensus exists among all the respondents from each the particular group regarding the ranking of the challenges in executing green building projects. Additionally, the ANOVA analysis shows the significance values of 31 challenges were greater than 0.05; on other words, the ANOVA result is insignificant at the 0.05 significance level (sig. > 0.05). The results together indicates that there were no statistically significant differences in the perceptions of the criticality of the challenges from execution or design departments’ managers, superintendents and field or office engineers. Regarding to the challenge C7, the differences in perceptions were statistically significant. The perception of the criticality of this challenge from the departments’ managers (mean = 4.47, rank 2) and the superintendents (mean = 4.65, rank 2) was higher than that from the field or office engineers (mean = 3.62, rank 19). This result is reasonably supported by the fact is that establishing a project team is responsible by departments’ managers and superintendents rather than field or office engineers who are at lower places in the companies. In general, the results indicate a good consensus between the respondents in expressing their opinions concerning the main challenges in executing green building projects.
Table 1 shows a list of challenges in executing green building projects with a ranked order that has been agreed by the respondents. The mean values range from 2.87 (for the challenge C11) to 4.54 (for the challenge C14). The results from t-test analysis verify that 30 out of the 31 challenges were statically significant in executing green building projects (C11 was not statistically significant). Challenges with normalized values not less than 0.50 are identified as critical challenges; here the result indicates 29 out of the 31 challenges deemed critical challenges (C11 and C6 were not critical).

The Top Five of the statistically significant challenges facing the contractors are across many aspects in terms of legislation, labor resources, and onsite technical operations. First of all, “lack of legal regulations and technical codes, standards, guidelines on green building” was perceived as the biggest challenge in executing green building projects by the construction contractors in Vietnam (C14, mean = 4.54). This finding is reasonable as at present there are just several green technical codes on non-baked building materials in the green industry sector in Vietnam. Until now, only the National Technical Regulation on Energy Efficiency Buildings QCVN 09:2017/BXD was issued; however it has been criticized as to be not complete, difficult to obey, and not fully enforced [21, 22]. The previous studies also explored that the system of legal documents and regulations on green building is not yet holistic and legal enforcement is considered to be weak in Vietnam [7, 23]. This result supports the empirical findings of the study of Nguyen, Skitmore [3]. They empirically revealed that “lack of a comprehensive technical code and policy package to guide action on sustainability” was one of the most influential barriers to implementing GBTs in Vietnam. This result is consistent with the empirical results of previous studies in different developing economies [1, 8, 9].

“More difficult to early establish a competent, integrated, multidisciplinary project team for green building projects” was considered as the second significant challenge by the contractors (C7, mean = 4.25). Regardless the type of design-build or design-bid-build green projects, the contractor needs to early establish a project team in order to effectively work with the owner, designer and other stakeholders during the planning and construction process. Such a project team should consist of project manager, architects, structural designers, superintendent, field engineers, sub-contractors, green consultants, even facility management team, and other members. According to [28], given having such a project team, it requires all team members must be equipped knowledge, skills, and experience on green construction issues. Green building projects are more complex in terms of technology, techniques and management; and therefore it requires a high level of green building competency of team members as well as more communication, coordination, and interaction among them. Additionally, many unforeseen circumstances in green building projects also require a competent and multidisciplinary level of the project team to response. For instance, convincing the owners to accept to use certain green building solutions undefined before or even to change a green goal, which was approved before, during construction process. All team members have to work closely together during the project’s design and construction stages to get a clear and holistic understanding of the defined green goals as well as to plan and implement the most effective practices to achieve those goals. Obviously, this really brings out the contractors a significant challenge to delivering green building projects [1, 9].

“More difficult for comprehending the owner’s green goals as well as the green specifications in the contract details and engineering documents” (C2, mean = 4.22) was found as a third challenge faced by the contractors. Construction of green buildings requires specified GBTs designed with more natural resources and more complex technical specifications. Furthermore, many issues such as financial and schedule parameters, social and environmental goals, maintenance and major renovation in future, etc. need to be considered as the whole. The owner’s green project requirements can be included in a variety of places in the project contract documents. It is a challenge that the contractor needs to conduct a thorough and detailed review of the owner’s request for bid and contract documents to well understand the requirements as well as conflicts on green specifications [15]. Green product criteria, certifications as well as codes and standards are constantly changing. Although the design team should be responsible to ensure that the specified product meets the required green criteria, it is best that the contractor verify that the product meets the required green criteria before bidding and
purchasing. It is worth noting that verifying whether or not the products purchased and installed do meet the defined criteria may save a lot of time, effort, and cost in resolving the issue, performing the necessary rework, and negotiating a change order [15].
### Table 1. The analysis result of data

| Code | Challenges faced in executing green building projects under the view of contractors | Total sample | Group1 | Group2 | Group3 | ANOV A<sup>a</sup> | Sources |
|------|--------------------------------------------------------------------------------|------------|--------|--------|--------|---------------------|---------|
|      |                                                                                | M         | R      | N      | M      | R      | M      | R      | M      | R      |                      |         |
| **Planning activities-related challenges (6)** |                                                                                     |           |        |        |        |        |        |        |        |        |                      |         |
| C1   | More difficult to build an effective quality management system with specific features for green building project | 3.76      | 18     | 0.59   | 3.76   | 10     | 3.72   | 18     | 3.80   | 18     | 0.22                | [1, 3, 8, 15, 23] |
| C2   | More difficult for comprehending the green specifications in the contract details and engineering documents | 4.22      | 3      | 0.91   | 4.26   | 1      | 4.17   | 4      | 4.23   | 3      | 0.31                | [8, 18, 24] [10-13] |
| C3   | More difficult to prepare a good plan on testing and quality assessment, monitoring and surveying of technical parameter of the works | 3.85      | 10     | 0.65   | 3.50   | 20     | 3.95   | 6      | 4.05   | 5      | 0.32                | Experts added |
| C4   | More difficult to design a good method of quality control and inspection for materials, products, structural components and equipment used | 3.84      | 11     | 0.65   | 3.54   | 23     | 3.94   | 7      | 4.04   | 6      | 0.19                | [1, 8, 14, 16, 23, 25] |
| C5   | More difficult to design construction technique methods ensuring safety of human, machinery, equipment and the construction work | 3.65      | 25     | 0.59   | 3.46   | 10     | 3.72   | 18     | 3.70   | 17     | 0.22                | Experts added |
| C6   | More difficult to design a good plan on inspection and acceptance for building tasks, and acceptance for the completion of the work/work items | 3.29<sup>*</sup> | 28   | 0.25<sup>a</sup> | 3.34<sup>*</sup> | 28 | 2.99<sup>*</sup> | 29 | 3.04<sup>*</sup> | 28 | 0.15                | [14, 16, 25] |
| **Organization activities-related challenges (7)** |                                                                                     |           |        |        |        |        |        |        |        |        |                      |         |
| C7   | More difficult to early establish a competent, integrated, multidisciplinary project team for green building projects | 4.25      | 2      | 0.93   | 3.62   | 19     | 4.47   | 2      | 4.65   | 2      | 0.21                | [1, 2, 8, 9, 16, 18, 26, 27] |
| C8   | Lack of competent project managers, superintendents, and engineers with knowledge, experience, and skills | 3.76      | 18     | 0.59   | 3.76   | 10     | 3.72   | 18     | 3.80   | 18     | 0.22                | Experts added |
| C9   | Lack of workers with good technical skills and familiar with green building technologies and techniques | 3.78      | 16     | 0.60   | 3.72   | 12     | 3.74   | 17     | 3.88   | 12     | 0.37                | Experts added |
| C10  | Lack of appropriate tools or equipments specific for installing green building materials, products, technologies | 3.78      | 16     | 0.60   | 3.60   | 17     | 3.88   | 10     | 3.86   | 13     | 0.17                | Experts added |
| C11  | Lack of appropriate plants, machineries, tools or equipments to conduct construction activities onsite ensuring the defined green performance | 2.94      | 29     | 0.00<sup>a</sup> | 2.84   | 29     | 3.00   | 28     | 3.02   | 29     | 0.41                | [1, 16, 23] |
| C12  | Lack of appropriate tools, laboratories specific for testing, assessing, measuring, and inspecting the green performance of green building technologies used | 3.89      | 6      | 0.59   | 3.89   | 7      | 3.80   | 14     | 3.98   | 8      | 0.09                | [1, 8, 10-13] |
| C13  | Require a good plan of financial resource for green projects | 3.64      | 27     | 0.50   | 3.37   | 27     | 3.25   | 27     | 3.70   | 27     | 0.17                | [1, 16, 23] |
| **Onsite management and control activities-related challenges (9)** |                                                                                     |           |        |        |        |        |        |        |        |        |                      |         |
| C14  | Lack of legal regulations and technical codes, standards, | 4.34      | 1      | 1.00   | 4.25   | 2      | 4.50   | 1      | 4.72   | 1      | 0.41                | [1, 8, 10-13] |
### Challenges faced in executing green building projects under the view of contractors

| Code | Challenges faced in executing green building projects | Total sample | Group1 | Group2 | Group3 | ANOV A<sup>2</sup> | Sources |
|------|------------------------------------------------------|-------------|--------|--------|--------|----------------|----------|
| C15  | Lack of green construction cost estimated norms      | M 3.87      | R 7    | N 0.68 |        | 0.23 [1, 3, 8, 15, 23] |
| C16  | Cost sensitive of GBTs and green building activities | M 3.68      | R 23   | N 0.53 |        | 0.20 [1, 16, 23] |
| C17  | More stakeholders and more conflict of interest among them in green building projects | M 3.73      | R 21   | N 0.57 |        | 0.29 [1, 3, 8, 15, 23] |
| C18  | More unforeseen circumstances in green building projects | M 3.71      | R 22   | N 0.55 |        | 0.31 [1, 3, 8, 15, 23] |
| C19  | More time is required to implement green construction practices onsite | M 3.76      | R 18   | N 0.59 |        | 0.22 [1, 16, 23] |
| C20  | More alteration and variation with the design during the construction process | M 3.74      | R 18   | N 0.57 |        | 0.13 [1, 16, 23] |
| C21  | More communications, meetings, more collaboration are required among project team members | M 3.87      | R 7    | N 0.68 |        | 0.11 [8, 18] |
| C22  | More difficult for preparing construction documents  | M 3.87      | R 12   | N 0.63 |        | 0.45 [1, 3, 8] |
| C23  | Government incentive policies are not clear, ineffective | M 3.66      | R 25   | N 0.51 |        | 0.26 [1, 3, 8, 15, 23] |
| C24  | Client’s budget plan                                 | M 3.66      | R 25   | N 0.51 |        | 0.32 [1, 3, 8] |
| C25  | Shortage of reliable green building methods, materials, technologies, and equipments in the market | M 4.05      | R 0.79 | N 4.12 |        | 0.7 Experts added |
| C26  | Lack of reliable suppliers of green products, materials, equipments in the market | M 3.82      | R 12   | N 0.63 |        | 0.45 [1, 3, 8] |
| C27  | Difficulty in the selection of competent subcontractors in providing green building services | M 4.18      | R 4    | N 0.88 |        | 0.44 Experts added |
| C28  | Low level of officials’ awareness of green building   | M 3.82      | R 12   | N 0.63 |        | 0.60 [14, 16, 25] |
| C29  | Low level of users and public’s awareness of green building | M 3.80      | R 14   | N 0.61 |        | 0.22 Experts added |
| C30  | Lack of financing schemes (e.g., bank loans, surety bonds) | M 3.80      | R 14   | N 0.61 |        | 0.19 [1, 16, 23] |
| C31  | Limited insurance or lack of insurance for green projects | M 3.68      | R 23   | N 0.53 |        | 0.16 [14, 16, 25] |

**Note:** Group 1: Field or office engineers; Group 2: Design or Execution Departments’ managers; Group 3: Superintendents; M: Mean; R: Ranking; N: Normalized value = (mean - minimum mean)/(maximum mean - minimum mean); ‘*’ Data with insignificant results of one-sample t-test (p > 0.05) (2-tailed); ‘**’ Kendall’s Coefficient of Concordance test on the challenges amongst the three respondent groups; (a) The normalized values indicate that the barriers are not a critical barrier (normalized value < 0.50); (b) The ANOVA result is insignificant at the 0.05 significance level (sig. > 0.05)
“Difficulty in the selection of competent subcontractors in providing green building services” was perceived as the fourth challenge in executing green building projects by the contractors in Vietnam (C27, mean = 4.18). Regards the construction subcontractors, they need to have a good capacity in terms of human, finance, management, and technology to design green-directed construction technical methods and conduct onsite green construction practices. Developing and maintaining a more collaborative teamwork between general contractor and subcontractors is considered as one of the most critical success factors for executing green building practices onsite [17]. The studies of [14], [25], and [20] also revealed that lack of awareness and knowledge of green building from contractors, subcontractors was the most critical barrier to implementing green building in the US, Malaysia, and China. For the consultant subcontractors, their services may be on many works, such as the selection of green materials, equipment, products, the selection of green building technical systems, the registration of green certification by third party, and the testing, assessing, measuring, and inspecting the green performance of green building technologies procured. However, presently the green construction industry in Vietnam is still at the infancy stage with a limited supply of competent employees as well as experienced construction consultant organizations on green building [3, 7, 23]. The qualitative study by Tran (2019) discovered the fact is that testing, assessing, measuring, and inspecting the green performance of almost green building technologies in Vietnam were conducted in foreign countries such as Singapore, the US due to lacking technical tools and equipment. Therefore, as a result, the subcontractor selection process becomes tougher and may take more time. This result is also supported by the empirical finding of [3] as revealed that “lack of methods to consistently define and measure green features” and “lack of a reliable tool to assess green performance” significantly hinder the adoption of green building in Vietnam.

“Shortage of reliable green building methods, materials, technologies, and equipments in the market” was found as the fifth significant challenge by the contractors (C25, mean =4.05). Contractors expressed concerns over the reliability of green materials and equipment as most of these new technologies do not have a proven track record. Unlike conventional building technologies, many new green materials may not be available locally and they may be imported for the foreign countries; in turn this may bring out many consequent concerns such as cost sensitiveness, legislation or extensive inspection of their green performance.

5. Implications and conclusions
In order to promote GB development in Vietnam, this study investigated the critical challenges facing the contractors in executing green building projects. Given the limited empirical studies on issues influencing the success of delivering green building projects, the present study contributes to the body of knowledge. A wide of range of challenges in executing green building projects was identified and examined by using a combination of research methods, including literature review, in-depth interview, and a questionnaire survey. The challenges facing the contractors were further analyzed by using mean ranking technique, thus providing a clear understanding of the key issues that are worthwhile to pay more attention to improve the success of green building projects.

The data analysis result indicated that “lack of legal regulations and technical codes, standards, guidelines on green building”, “more difficult to early establish a competent, integrated, multidisciplinary project team for green building projects”, “more difficult for comprehending the owner’s green goals as well as the green specifications in the contract details and engineering documents”, “difficulty in the selection of competent subcontractors in providing green building services”, and “shortage of reliable green building materials, technologies, and equipments in the market” were the Top Five statically significant challenges facing the Vietnamese contractors in executing green building projects. It is worth noting that these top five challenges were spread across the different aspects in terms of legislation, techniques, human resource, and supply chain.

The findings of this study are expected to make the considerable practical contributions to improve the success of delivering green building projects in Vietnam. First of all, the government needs to speed up completing the system of legal regulations and technical codes, standards, guidelines on green building. The comprehensiveness and quality of the legal system are the key successful indicators for delivering green building projects in the context of Vietnam. In fact, most of existing building codes have not been upgraded for order to gain the goals of green building. Vietnam can learn international experience to establish future legal regulations and the new green codes. Secondly,
Vietnam needs to provide policies to promote the scientific research activities on GBTs as well as the transformation of the scientific research results into the practical solutions or marketable green products. The GBTs market is still very small and dependent very much on the imported technologies or products. Thirdly, incentive programs or schemes supported by government to improve the awareness and capacity on green building in domestic construction organizations, especially medium and small enterprises, which very often play a role as subcontractors, are also very important. Success of green building projects is dependent on the capacity of all stakeholders within its supply chain. Finally, for individual contractors, they are advised to pay special attention to formulating and implementing good strategies toward the market of green building; in which, the policies or schemes to improve the knowledge and skills on green building issues for all employees, from top managers to workers onsite should be highlighted.

Although the objectives of this study were achieved, there are some limitations may be drawn. Although the sample was adequate to statistical analyses, it is nevertheless a relatively small sample; it is nevertheless a relatively small sample. Besides, there might be some limitations on generalizations because the findings were mainly interpreted within the context of Vietnam.

Acknowledgements
This research is funded by Vietnam National Foundation for Science and Technology Development (NAFOSTED) under grant number 502.02-2018.39. The authors acknowledge the National University of Civil Engineering, Vietnam for funding this research under grant number 83-2020/KHXD. We are also grateful to the experts who participated in the questionnaire survey.

References
[1] Hwang, B.-G. and Ng, W. J. (2013). Project management knowledge and skills for green construction: Overcoming challenges. International Journal of Project Management. 31(2): 272-284.
[2] Hwang, B.-G., Zhao, X., and Tan, L. L. G. (2015). Green building projects: schedule performance, influential factors and solutions. Engineering, Construction and Architectural Management. 22(3): 327-346.
[3] Nguyen, H.-T., Skitmore, M., Gray, M., Zhang, X., and Olanipekun, A. O. (2017). Will green building development take off? An exploratory study of barriers to green building in Vietnam. Resources, Conservation and Recycling. 127: 8-20.
[4] Quangdung, T., Tien Toi, P., The Chinh, K., Phuong Nam, T., and Ngoc Thoan, N. (2019). A SWOT analysis of the market of green building technologies in Vietnam. Journal of Science and Technology. 13(2V): 76-85.
[5] Tran, Q., Huang, D., and Zhang, C. (2013). An assessment method of the integrated e-commerce readiness for construction organizations in developing countries. International Journal of E-Adoption (IJEA). 5(1): 37-51.
[6] Darko, A., Zhang, C., and Chan, A. P. (2017). Drivers for green building: A review of empirical studies. Habitat international. 60: 34-49.
[7] Nguyen, H.-T. and Gray, M. (2016). A Review on Green Building in Vietnam. Procedia Engineering. 142: 313-320.
[8] Hwang, B. G. and Tan, J. S. (2012). Green building project management: obstacles and solutions for sustainable development. Sustainable development. 20(5): 335-349.
[9] Mohammadi, S. and Birgonul, M. T. (2016). Preventing claims in green construction projects through investigating the components of contractual and legal risks. Journal of cleaner production. 139: 1078-1084.
[10] Zhang, J., Li, H., Olanipekun, A. O., and Bai, L. (2019). A successful delivery process of green buildings: the project owners’ view, motivation and commitment. Renewable energy. 138: 651-658.
[11] Bond, S. (2011). Barriers and drivers to green buildings in Australia and New Zealand. Journal of Property Investment & Finance. 29(4/5): 494-509.
[12] Dwaikat, L. N. and Ali, K. N. (2016). Green buildings cost premium: A review of empirical evidence. Energy and Buildings. 110: 396-403.
[13] Gou, Z., Lau, S. S.-Y., and Prasad, D. (2013). Market readiness and policy implications for green buildings: case study from Hong Kong. *Journal of Green Building*. 8(2): 162-173.

[14] Darko, A., Chan, A. P. C., Ameyaw, E. E., He, B.-J., and Olanipekun, A. O. (2017). Examining issues influencing green building technologies adoption: The United States green building experts’ perspectives. *Energy and Buildings*. 144: 320-332.

[15] Lam, P. T., Chan, E. H., Poon, C., Chau, C., and Chun, K. (2010). Factors affecting the implementation of green specifications in construction. *Journal of environmental management*. 91(3): 654-661.

[16] Li, Y. Y., Chen, P.-H., Chew, D. A. S., and Teo, C. C. (2014). Exploration of critical resources and capabilities of design firms for delivering green building projects: Empirical studies in Singapore. *Habitat International*. 41: 229-235.

[17] Li, Y. Y., Chen, P.-H., Chew, D. A. S., Teo, C. C., and Ding, R. G. (2011). Critical project management factors of AEC firms for delivering green building projects in Singapore. *Journal of construction engineering and management*. 137(12): 1153-1163.

[18] Robichaud, L. B. and Anantatmula, V. S. (2010). Greening project management practices for sustainable construction. *Journal of Management in Engineering*. 27(1): 48-57.

[19] Zhang, X., Shen, L., and Wu, Y. (2011). Green strategy for gaining competitive advantage in housing development: a China study. *Journal of Cleaner Production*. 19(2): 157-167.

[20] SamKubba, ed. *The Green Design and Construction Process*. Handbook of Green Building Design and Construction. 2017, Elsevier Inc.

[21] Tran, Q., Zhang, C., Sun, H., and Huang, D. (2014). Initial adoption versus institutionalization of e-procurement in construction firms: An empirical investigation in Vietnam. *Journal of Global Information Technology Management*. 17(2): 91-116.

[22] Quangdung, T., Dechun, H., and Drew, S. (2014). Assessment of internet-based e-commerce readiness in Vietnamese construction enterprises: Towards an industry-oriented framework and a context-specific instrument. *Information Technology Journal*. 13(2): 201.

[23] Pham, D. N. (2015). Developing green building in Vietnam - status quo and recommendations. *Journal of Vietnamese Architecture*.

[24] Khodadadzadeh, T. (2016). Green building project management: obstacles and solutions for sustainable development. *Journal of Project Management*. 1(1): 21-26.

[25] Isa, M., Rahman, M. M. G. M. A., Sipan, I., and Hwa, T. K. (2013). Factors affecting green office building investment in Malaysia. *Procedia-Social and Behavioral Sciences*. 105: 138-148.

[26] Mulligan, T. D., Mollaoglu-Korkmaz, S., Cotner, R., and Goldsberry, A. D. (2014). Public policy and impacts on adoption of sustainable built environments: Learning from the construction industry playmakers. *Journal of Green Building*. 9(2): 182-202.

[27] Shi, Q., Zuo, J., Huang, R., Huang, J., and Pullen, S. (2013). Identifying the critical factors for green construction—an empirical study in China. *Habitat international*. 40: 1-8.