Contribute to knowledge about risks in implementing green building projects in developing countries: a case of Vietnam

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Abstract. In recent years there has been significant interest in investigating risks linked to the implementation of Green Building (GB) projects that are in line with the developing trend of sustainable construction over the world. In an attempt to contribute to GB risks literature, this study explored risk factors that GB projects frequently confront in Vietnam. This study firstly conducted a comprehensive literature review to generate a preliminary list of risk factors. These risk factors were then confirmed and complemented by interviewing ten experts in the field. After that, the research assessed the risk factors by surveying 119 construction professionals to discover the most critical GB risks. Notably, this paper considered the effect on the risk assessment process of GB experience and project roles. Results showed that "The owner lacks determination," "Late involvement of GB consultants," and "Project evaluation result did not reach the expected GB standard" were the top three critical risks in GB projects. The statistical analysis also revealed that the assessment of GB risk negatively correlated with participants' GB practical experience. Furthermore, hierarchical moderated regression analysis exposed differences in the risk assessment between various project roles, though these differences were relatively small and not statistically significant. By investigating GB projects' main risks, this paper may become a useful reference guide within the construction sector. This research also enriches the literature by contributing empirical evidence of risk assessment in GB projects in a developing country.

1. Introduction

Construction and operation of buildings always impact considerably on a country's economy and society. However, they are also significant contributors to greenhouse gas emissions and other environmental pollutants worldwide [1]. In that context, Green Buildings (GBs) have emerged as a solution for the construction industry to reduce the impact on the environment while still meeting the demanded function of construction buildings [2]. In general, GBs are different from conventional buildings through the emphasis on environmental and social aspects [3]. The last several years have witnessed significant growth in the development of GBs over the world. As such, sustainable construction practices have attracted considerable interest over the world and, more so in some developing countries [4]. A recent report also revealed that emerging economies experienced a strong GB growth, and this was expected to grow faster in the forthcoming years [5].
Although GBs have attracted wide attention, the development of GBs still suffers many kinds of obstacles [6]. In particular, the presence of risks in implementing GB projects has emerged as a significant obstacle and received more attention from both academics and practitioners in recent years [3]. "No construction project is risk-free" [7]. Indeed, construction projects always confront different issues, such as financial problems, technical problems, and natural disasters. Some researchers also supposed that GB projects' risks are even higher than in conventional buildings [8]. Additionally, some studies emphasized that risks should be managed efficiently for achieving success in construction projects [9, 10]. Therefore, these findings revealed that risk management is crucial in GB projects. In recent years there has been growing interest in the GB risk topic. However, previous studies have almost only been limited to some developed countries such as Singapore, Australia, The US, and somewhat in China. To date, there are very few studies in developing countries. Unlike in developed countries, GBs were relatively new concepts in developing countries in general, and in Vietnam, in particular [11]. This phenomenon might imply that GB risks in developing countries are even higher in developed countries. As far as we know, there is very little information about GB risks in developing countries. Therefore, this finding highlights the need to investigate GB risks in developing countries, as such research can contribute to the knowledge of GB literature. As the first step in this journey, this research investigated risk factors that GB projects commonly have to endure in Vietnam.

2. Identification risk factors and hypotheses

2.1 Identification risk factors

In recent years, several studies attempted to examine risk factors in GB projects. Hwang et al. [8] identified risk factors in implementing green residential building construction projects in Singapore. The result has shown that "Complex procedure to obtain approval," "Overlooked high initial cost," "Unclear requirements of owners," "Employment constraint," and "Lack of availability of green material and equipment" are the five most essential risks in residential GB projects. Similarly, another research endeavored to identify and evaluate risk factors related to commercial GB projects in Singapore [12]. The outcome revealed the top five critical risk factors are "Inflation," "Currency and interest rate volatility worsened by the import of green materials," "Durability of green materials," "Damages caused by human error," and "Shortage of green materials." By comparing to traditional building projects, both studies indicated that GB projects are riskier than conventional ones. This finding is not surprising since GBs adopt high technology, innovative material, and a distinct construction procedure; thus, GBs are frequently more complicated than conventional buildings.

In China, the authors identified risk factors associated with GB projects based on the perspective of sustainability [13]. This research found that "Lack of experienced management in the operational phase" and "The public's satisfaction with the project is meager" are the two most significant risks. Likewise, another research aimed to assess risk factors of the life cycle of GBs in China and prioritize the importance level based on the probability of occurrence and degree of influence [14]. The result showed the differences in risk preference among stakeholders and provided fundamental knowledge for stakeholders to conduct risk management strategies according to their objectives. With the same approach, another research sought to investigate risk factors related to sustainable construction in Kuwait [15]. The result explicated that designers' and contractors' inexperience with GBs are the most severe risks. Other risks worth considering are "high initial cost for material" and "overall project cost." From a global perspective, Rafindadi et al. [16] examined risks in GB projects base on stakeholders' perceptions. The in-depth review above provided a solid basis for the identification of risk factors in GB projects. Based on the result, an initial list of 90 risk factors was established and classified according to three phases of a construction project: feasibility & design, construction, and hand-over & operation phase. These original risk factors were then reviewed and refined by ten professionals experienced in GBs through interviews and brainstorming. These ten professionals had at least 15 years of experience in the construction industry and five years in GBs. Each expert was provided with the list of risk factors and asked to choose the factors that have significantly influenced GB projects based on his/her
experience. In this process, while the ten professionals quickly agreed on many factors, several factors were chosen by some professionals, but not all. Therefore, we organized a meeting, and the experts discussed these factors to finalize the list. As a result of the brainstorming process, a total of 48 risk factors were collectively chosen by the ten professionals.

Additionally, the professionals suggested adding five new factors that can be considered distinctive features of developing countries like Vietnam. The new factors included "Late involvement of Green building consultant into the design process"; "Owner lacks determination when implementing GBs projects"; "Lack of reliable quantitative and simulation tools to support the decision making"; "Unrealistic requirements due to excessive creativity of green design compared to conventional design"; and "No general standards for testing the quality and origin of green materials." As a result, the final list consisted of 53 risk factors.

2.2 Hypotheses

The construction industry is considered a robust experience-oriented sector due to its complicated nature. This phenomenon implies that practitioners in the construction industry usually consult their prior experience to make decisions in various tasks (e.g., schedule estimation, cost evaluation, and dealing with onsite problems) [17]. Over time, practitioners can accumulate more skills and knowledge as dealing with diverse work requirements. Therefore, participants' practical experience of GB may affect their assessment of risks in GB projects. The experienced practitioners are frequently aware of the risky of GB projects better and more confident about their capacity. Thus, they may assess risks lower than those with less GB experience.

Besides, to succeed in construction projects requires the involvement of stakeholders with different roles and responsibilities. Some risk studies have supposed that the viewpoints on practitioners' risks often differ significantly depending on their specific roles in construction projects [18, 19]. However, some other research revealed the opposing result [16]. Therefore this is still a matter of ongoing debate. Even though previous studies have suggested the possible effect of various participants' characteristics on the risk assessment, there is still a lack of empirical evidence to confirm these relationships, especially in GB projects. Therefore, this study aims to contribute to the literature by quantitatively examining the influence and interactive effect of participants' GB experience and project roles on the risk assessment in GB projects in Vietnam. In particular, this research aims to quantitatively test the following hypotheses:

- H1: Participants' GB practical experience (GBEx) is negatively related to the risk assessment in GB projects (RA).
- H2: Participants' roles (Role) moderate the relationship between participants' GB practical experience (GBEx) and risk assessment (RA).

3. Research method and measures

A questionnaire survey was conducted to find the most critical risk factors and test the proposed hypotheses. The unit of analysis is an individual respondent. Survey respondents were asked to (1) provide their experience in GB projects and risk management; (2) rate the degree of importance of risk factors; (3) report their demographic information such as position in the company, industrial experience, and project role. The questionnaire was then sent (either by emails or hand-delivery) to 500 potential respondents. They have worked in the construction industry and experienced GB projects in Vietnam. The respondents were identified from the Vietnam Green Building Council and their members; GB consultants, Design consultants, and contractors. A total of 125 responses (i.e., 45 hard copies and 80 online forms) were received, with the response rate is about 25%. Among these responses, six responses were removed due to incomplete answers in the questionnaires, or the respondents have less than three years of experience or not familiar with GB projects. In the end, a total of 119 valid responses remained for further data analysis.

In this study, GB risks were measured by 53 risk factors according to the three phases of GB projects. In terms of the Feasibility and Design phase, these include 4 items in Law & Policies (D.Law), 5 in Financial/Cost (D.Fin), 5 in Management (D.Man), 4 in Human resource (D.Human), 5 in
Technical/Quality (D.Tech). In terms of the Construction phase, 3 items in Legal risk (C.Legal), 3 in Financial/cost (C.Fin), 3 in Management (C.Man), 5 in Technical/Quality (C.Tech), 4 in Human resource (C.Human), 3 in Safety environment (C.Safe), and 3 in material and equipment (C.Mate). In terms of the operation phase, 3 items in Management (O.Man), and 3 in Technical/Quality (O.Tech).

Survey participants were provided a questionnaire and were asked to rate "the importance of each risk factor" on a 5-point scale (1 = "not important"; 2 = "small importance"; 3 = "moderate importance"; 4 = "high importance"; 5 = "very high importance").

4. Results and discussions

4.1 Characteristics of respondents

Table 1 illustrates the demographic information of the respondents. The survey covered a diverse background of construction organizations comprising all relevant stakeholders. Table 1 shows that 66.84% of the respondents worked at the managerial or directorial levels, and over half of the respondents (51.26%) have worked for more than ten years. Their high positions and long working experience in the construction industry signified the validity and reliability of the responses.

These respondents were grouped into three categories: owner agencies, design/engineering/consulting firms, and contractors/subcontractors. In particular, 50 respondents (42.02%) were from owner agencies; 44 respondents (36.97%) were from design, engineering, or consulting firms; and 25 respondents (21.01%) were contractors or subcontractors. Regarding the GB experience and knowledge, 78.16% of the respondents have been engaged in GB projects more than 'rarely,' and over three-fourth (77.31%) of all respondents are 'familiar' or 'expert' GBs. This result implied that the participants have proper capacities to evaluate the questionnaires.

| Demographic characteristics | Frequency | Percent (%) |
|-----------------------------|-----------|-------------|
| Project roles               |           |             |
| Owners representatives      | 50        | 42.02       |
| Consultant                  | 44        | 36.97       |
| Contractors                 | 25        | 21.01       |
| Position in organization    |           |             |
| Directorial level           | 31        | 26.05       |
| Managerial level            | 48        | 40.34       |
| Expert level                | 33        | 27.73       |
| Other                       | 7         | 5.88        |
| Year of experience          |           |             |
| Less than 5 years           | 37        | 31.09       |
| 6-10 years                  | 21        | 17.65       |
| 11-15 years                 | 29        | 24.37       |
| More than 15 years          | 32        | 26.89       |
| GB knowledge                |           |             |
| Expert                      | 37        | 31.09       |
| Familiar                    | 55        | 46.22       |
| Somewhat familiar           | 27        | 22.69       |
| GB experience               |           |             |
| Often                       | 46        | 38.66       |
| Occasionally                | 47        | 39.50       |
| Rarely                      | 26        | 21.84       |

(n = 119)

4.2 The important of GB risk factors

Descriptive statistics were conducted firstly to evaluate the importance of risk factors. Table 2 presents the mean values and standard deviations of the ten most important risk factors. As shown in this table, seven out of ten highest-ranking items are related to the design phase, while the remaining three risk factors belong to the Construction (C16) and Operation phase (O1 and O4). This result is quite surprising because construction phases are regularly considered as the riskiest phase in construction projects. Thus this may imply that Design and Operation phases are also essential in GB projects and
require much attention from stakeholders. Table 2 shows that the mean values of all ten factors are higher than 4.00. This result signifies risks in GB projects are very high.

Table 2: Top ten risk factors

| Rank | Code | Risk factors                                                                 | Mean  | Std. Dev |
|------|------|------------------------------------------------------------------------------|-------|----------|
| 1    | D18  | The Owner lacks determination when implementing Green Buildings projects      | 4.39  | 0.78     |
| 2    | D13  | Late involvement of GB consultants/specialists into the design process       | 4.27  | 0.86     |
| 3    | D16  | Inefficient communication and coordination between parties, especially between GB consultant and other consultants | 4.13  | 0.88     |
| 4    | O1   | Project evaluation results did not reach the expected green building standard | 4.13  | 0.89     |
| 5    | D6   | Lack of accurate estimation of investment and long-term return in GB projects | 4.13  | 0.88     |
| 6    | D17  | Lack of experience of designers about GBs (Design-team inexperience)         | 4.05  | 0.87     |
| 7    | C16  | Lack professionals have experience and qualified about Green Building         | 4.04  | 0.95     |
| 8    | D15  | Project management consultants and/or project teams lack design management experience in GB projects | 4.03  | 0.90     |
| 9    | O4   | The performance of green solutions (e.g., energy and water savings) is not achieved as the original goal. | 4.02  | 0.95     |
| 10   | D19  | Unclear green requirements of Owners                                         | 4.00  | 0.93     |

The risk factor D18, "The owner lacks determination when implementing GB projects," occupied the top position in the risk ranking with a mean value of 4.39. This result reveals the crucial role of owners for the success of GB projects in the Vietnamese context. This factor's high ranking also implies that Owners are frequently not aware of GBs adequately and tend to give up when they confront obstacles in the implementation of GB projects. Therefore, complementing knowledge for Owners is essential and can help to enhance GB developments. The risk D13 "Late involvement of GB consultants/specialists into the design process" was ranked second with a mean value of 4.27. This is a distinct risk factor in Vietnam as Owners regularly let GB consultants join the project team quite late. Thus, in many situations, GB consultants do not have enough time to contribute the best for the project, or some crucial decisions were decided before they participate.

The risks D16, O1, and D6 were assessed at following successive positions with the same mean values 4.13. The risk D16, "Inefficient communication and coordination between parties, especially between GB consultant and other consultants," reveals that it is necessary to pay attention to the collaboration between stakeholders to accomplish the project goals. In reality, there have been many cases of failed projects due to a lack of communication between stakeholders. Especially in GB projects, the moderator role of GB consultants is crucial to achieving projects' goals. Therefore, the spirit and attitude of cooperation among stakeholders are always considered essential for successful projects.

The risk O1 "Project evaluation did not reach the expected GB standard" mentions the risk at the end of GB projects. Indeed, in several GB projects, the Owner spent much money getting high-rank GB certification to gain advantages in their business. However, the project team failed to achieve this goal; consequently, all stakeholders lost significantly because of this undesirable result. The risk D6, "Lack of accurate estimation of investment and long-term return in GB projects," implies that project teams do not adequately evaluate GB projects' real profit. As a result, they confront many difficulties in persuading Owners and stakeholders to implement GB projects.

The risks D17, C16, D15, O4, and D19 were assessed at successive positions with small differences in their mean values 4.05, 4.04, 4.03, 4.02, and 4.00, respectively. The risks D17 ("Lack of experience of designers about GBs"), C16 ("Lack professionals have experience and qualified about GBs"), and D15 ("Project management consultants lack design management experience in GB projects") consider to the role of professional practitioners for the success of GB project. Indeed, GB projects are a particular type of construction project with complicated technology, innovative material, and novel procedures.
Therefore, the participation of qualified professionals is necessary to achieve the success of GB projects. The risk O4, "The performance of green solutions are not achieved as the original goal," showed other problems related to GB projects' real performance. Specifically, this issue is somewhat related to ethical or capacity aspects of parties to projects. To mitigate this risk, the selection of GB consultants, designers, and contractors should be carefully executed and seek to prioritize the parties with high prestige, rather than only consider cost and technical aspects. Finally, the risk D19 "Unclear green requirements of Owners" confirm the crucial role of Owners once again. This factor particularly considers the knowledge of the Owner about GB in the Design phase. Although often overlooked, this risk factor is one of the definitive causes of GB projects' failure.

Table 3: Important degrees of risk factor groups

| Code  | Categories                        | All roles | Owners | Consultants | Contractors |
|-------|-----------------------------------|-----------|--------|-------------|-------------|
|       | Mean | Rank | Mean | Rank | Mean | Rank | Mean | Rank | Mean | Rank |
|       | Feasibility and Design Phase      | D.Law | 3.69 | 8 | 3.71 | 6 | 3.69 | 8 | 3.66 | 12 |
|       | D.Fin | 3.64 | 9 | 3.49 | 12 | 3.70 | 7 | 3.84 | 6 |
|       | D.Man | 3.82 | 5 | 3.71 | 5 | 3.90 | 5 | 3.90 | 5 |
|       | D.Human | 4.15 | 1 | 4.14 | 1 | 4.18 | 1 | 4.13 | 3 |
|       | D.Tech | 3.82 | 6 | 3.69 | 7 | 3.92 | 3 | 3.90 | 4 |
|       | Construction Phase                | C.Legal | 3.45 | 13 | 3.33 | 13 | 3.58 | 11 | 3.44 | 13 |
|       | C.Fin | 3.52 | 12 | 3.51 | 11 | 3.39 | 13 | 3.77 | 9 |
|       | C.Tech | 3.62 | 11 | 3.62 | 9 | 3.57 | 12 | 3.69 | 10 |
|       | C.Man | 3.64 | 10 | 3.56 | 10 | 3.64 | 10 | 3.79 | 8 |
|       | C.Human | 3.70 | 7 | 3.72 | 4 | 3.69 | 9 | 3.67 | 11 |
|       | C.Safe | 3.32 | 14 | 3.31 | 14 | 3.27 | 14 | 3.43 | 14 |
|       | C.Mate | 3.83 | 4 | 3.79 | 3 | 3.89 | 6 | 3.83 | 7 |
|       | Hand-over and Operation Phase     | O.Man | 3.90 | 3 | 3.68 | 8 | 4.00 | 2 | 4.15 | 2 |
|       | O.Tech | 3.92 | 2 | 3.79 | 2 | 3.92 | 4 | 4.17 | 1 |
|       | Overall | 3.72 | | 3.65 | | 3.75 | | 3.82 | |

Table 3 summarizes the assessment of the importance of risk groups according to each role in GB projects. There are some differences in risk assessment among the roles. The overall degree assessments of risk of the Owner, Consultants, and Contractors were 3.65, 3.75, and 3.82, respectively. In general, the Owners' assessment is lower than Consultants and Contractors across most of the risk groups. However, for risk groups Law & policies, Owners tend to evaluate higher than Consultants and Contractors. This reflects somewhat the responsibilities of stakeholders in construction projects in Vietnam, as legal issues take a lot of time to solve and are critical to Owners. Notably, the highest-ranking group across all roles is D.Human - the human resources in the Design phase. This phenomenon indicated that qualified human resource in the Design phase plays a pivotal role in GB projects. As expected, there are differences among the assessment across various roles though the differences are not much. Therefore, there is a need to test how the participant's roles and GB experience affect risk assessment. Such understandings may provide project stakeholders with the necessary knowledge to manage risk more effectively in future GB projects.

4.3 Test the hypotheses

4.3.1 Effect of GB experience (H1). Based on the literature review, this research proposed that participants' practical experience of GB is negatively related to risk assessment. To test this hypothesis, the authors conducted an ANOVA-test to examine the relationship between participant's GB experience and risk assessment. The result showed that the differences in risk assessment between GB experience
groups were statistically significant across almost risk groups (Table 4). Only three risk groups were not statistically significant (D.Law, D.Man, and C.Safe), and the other three risk groups (C.Legal, C.Man, and O.Man) were significant at level p minus in this test. Notably, the overall risk assessment was significantly negatively related to GB experience (p-value = 0.009). H1 was thus supported.

Table 4: Result of ANOVA for testing hypothesis 1

| Code   | Risk categories         | F-value | P-value | Significant level |
|--------|-------------------------|---------|---------|-------------------|
|        | **Feasibility and Design Phase** |         |         |                   |
| D.Law  | Law & Policies          | 1.395   | 0.252   |                   |
| D.Fin  | Financial/Cost          | 5.764   | 0.004   | p+                |
| D.Man  | Management              | 0.818   | 0.444   |                   |
| D.Human| Human resource          | 4.768   | 0.010   | p+                |
| D.Tech | Technical/Quality       | 4.063   | 0.020   | p                 |
|        | **Construction Phase**  |         |         |                   |
| C.Legal| Legal risk              | 2.497   | 0.087   | p-                |
| C.Fin  | Financial/Cost          | 4.983   | 0.008   | p+                |
| C.Man  | Management              | 2.488   | 0.088   | p-                |
| C.Tech | Technical/Quality       | 3.747   | 0.026   | p                 |
| C.Human| Human resource          | 6.134   | 0.003   | p+                |
| C.Safe | Safety and environment risk | 1.082   | 0.342   |                   |
| C.Mate | Material and equipment problems | 3.856   | 0.024   | p                 |
|        | **Hand-over and Operation Phase** |        |         |                   |
| O.Man  | Management              | 2.964   | 0.056   | p-                |
| O.Tech | Technical/Quality       | 4.150   | 0.018   | p-                |
|        | **Overall**             | 4.950   | 0.009   | p+                |

Note: Significance level of 0.1 (p-), 0.05 (p), and 0.01 (p+).

Hypothesis H1 is further confirmed by examining the box plot using Seaborn in Python3. Figure 1 illustrates the box plot to compare GB experience groups across risk factor groups. However, in this figure, we only use the risk factor groups that were statistically significant tests (p-value ≤ 0.1); thus, we removed D.Law, D.Fin, and C.Safe. Firstly, we can see that all risk groups have a high-risk assessment, which implies that GB projects' risk is considered quite high. Secondly, the participant with GB experience 'Rarely' has a higher evaluation than the other two groups across all risk groups. Therefore, figure 1 shows the general trend that the higher GB experience of the participants, the lower their valuation. As a result, Hypothesis H1, which hypothesizes the significant negative correlation between GB experience and risk assessment, was supported. Figure 1 hence not only supports but also makes H1 more visual.

Figure 1: The effect of GB experience on risk assessment
4.3.2. **Moderator effect of project roles (H2).** Some authors have debated over the effect of project roles on risk assessment. Thus, this suggested a potential moderating effect of participants' roles on the relationship between GB experience and risk assessment, as hypothesized in H2. The interaction plot was firstly utilized to examine the moderator effect of participants' roles. As an example, figure 2 illustrates the interaction plot for overall risk. Figure 2 shows that the Owners have lower assessments compare to Contractors and Consultants. However, this difference is decreases as the participants' GB experience improves. This finding may imply that if the practitioners have enough GB experience, their risk assessment will be more accurate and converging regardless of their roles. Interestingly, figure 2 also indicates that the evaluation of Contractors and Consultants is almost equal, implying that Constructor and Consultant's risks are the same in GB projects. Nevertheless, there is no apparent difference in the risk assessment between role groups. Thus, we need an in-depth test to conclude the hypothesis H2.

![Figure 2: Interaction between practitioners' roles and GB experience in risk assessment](image)

To further investigate the moderating effect of project roles, this study performed a hierarchical multiple regression analysis [20]. In Model 1, two variables comprised: the participants' GB experience (GBEx) and project role (Role). In Model 2, the multiplicative interaction terms were calculated by multiplying GBEx and Role and entered in the model. All risk factors were mean-centered by calculating the overall risk to reduce multicollinearity [21]. Table 5 presents the hierarchical multiple regression analyses' main results for the Overall risk (average of all risks). The research also tried to calculate the interactive effect according to each risk factor group. The analysis outcomes showed that most of the risk factor groups had similar results with the Overall risk.

| Table 5: Model summary in hierarchical moderated regression |
|----------------------------------|-----------------|------------------|------------------|------------------|
| Hypothesis | Study variable | Statistics | Model 1 | Model 2 |
| H2 | GB involvement(GBEx).Often | Coefficient | -0.094 | -0.205 |
| | (GBEx).Rarely | Coefficient | 0.327<sup>b</sup> | 0.256 |
| Project role (Role).Consultant | Coefficient | 0.471 | -0.035 |
| (Role).Owner | Coefficient | 0.009 | -0.181 |
| Interaction (GBEx.Often × Role.Consultant) | Coefficient | -0.100 | 0.085 |
| (GBEx. Rarely × Role.Consultant) | Coefficient | 0.076 | 0.181 |
| (GBEx. Often × Role.Owner) | Coefficient | 0.092 | 0.089 |
| (GBEx. Rarely × Role. Owner) | Coefficient | 0.086<sup>b</sup> | 0.089 |
| R² | 2.688<sup>b</sup> | 1.341 |

Notes: p<sup>a</sup> ≤ 0.1; p<sup>b</sup> ≤ 0.05; p<sup>c</sup> ≤ 0.01.

Regression Model 1 for testing H2 exposed that GB experience and project roles explain a small part of the variance (8.6%). However, this model is still statistically significant with F-statistic = 2.688, p-
value = .0067. Nevertheless, considering the interaction between participants' roles and GB experience, Model 2 did not explain significantly more variance than the model 1 with just "GBEx" and "Role" alone. The result of R2 change = .003, F = 1.341, p = .708 indicated no significant moderation between the GB experience and participants’ roles in risk assessment. Thus, H2 was not supported. Although there is seemingly a difference in the risk assessment between various project roles (Figure 2), these differences were not statistically significant.

5. Conclusions
Increasing the popularity of GBs is imperative to reduce negative environmental impacts due to the construction industry's activities. However, GB projects frequently have to face many risks in the implementation process, so the practitioners need more knowledge on how to manage risk more effectively in GB projects. This is a challenging task due to the lack of knowledge about GB risk in the construction industry, especially in developing countries. Therefore, this study identified and empirically examined the main risks GB projects frequently encounter according to the three phases of projects. Additionally, the relationship between participants' GB experience and the risk assessment was investigated. Besides, this study also tested the moderating effect of the participants' roles in this relationship.

The research revealed the ten most significant risk factors during project development processes. So these findings may be useful for practitioners to manage risks in GB projects. Additionally, the results confirmed a negative relationship between the participants' practical GB experience and the level of risk assessment. These findings highlight the importance of having qualified participants with rich experience to manage risks in GB projects in fast-growing emerging economies like Vietnam. In the current situation, as the number of GB experts are somewhat limited, the priority should be to implement risk management training programs based on empirical studies. Besides, the result revealed that Owners have lower risk evaluations compared to Contractors and Consultants. However, this difference is not statistically significant and decreases as the participants' experience increases.

Although some prior studies have investigated issues related to GB risks, a lack of research examined risks in GB projects in emerging economies. As far as we know, very few researchers have provided empirical evidence on the effect of project participants’ GB experience and project roles on the risk assessment in GB projects. Hence, this study offered important theoretical contributions and opened the door to more future research on the interface between human factors and risk management in GB projects, especially in developing countries' contexts. The findings may help to enhance risk management and to achieve success in GB projects in emerging economies. Despite the focus on the Vietnamese building industry, the research methods and implications can be applied to other countries, especially emerging markets.

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