Article

The Consensus Planning and Design Criteria for Sustainable Buildings in Cambodia

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Abstract: Buildings can generate heats, which are mostly generated from the machinery using inside the buildings, while these waste heats generally released into the atmosphere. Buildings can also block the wind flow by their canopies and trap the heat by using low albedo materials. These causes pointedly contribute to urban heat island and greenhouse effects. Likewise, urban development and building construction in Cambodia are growing rapidly. The construction has been recognized as a key development sector while thousands of buildings are being built and have been operated in the main cities. However, those buildings mostly have not been considered to incorporate sustainability concepts while the major final energy consumers in the country are buildings. The buildings' energy consumption is also projected to increase more than double until 2040. Hence, sustainable building promotion in Cambodia is necessary, and sustainable building criteria are completely required. This research aims to find out significant sustainable building criteria for Cambodia and focused on planning and design criteria because having proper planning and design is a smart start leading to achieving building sustainability in all stages. This research used the Delphi methods to validate the relevant sustainable building criteria available in the literature and then select the significant ones for Cambodia based on the Delphi consensus. The results showed that ninety-nine consensus planning and design criteria were found to be significant for sustainable buildings in Cambodia.

Keywords: Delphi methods; consensus decision analysis; building sustainability plan and design; Cambodia urban buildings; sustainable site selection; sustainable building shape design.

1. Introduction

By following the world trends on sustainable development, particularly global and regional trends on green growth, Cambodia developed a national policy, strategic plan, and roadmap on green growth to advise the win-win-win situation between economic, societal, and environmental sectors, aimed to realize constant economic growth, social inclusion, and environmental sustainability [1]. By following the United Nations 2030 Agenda for Sustainable Development, Cambodia established a National Council for Sustainable Development, aimed to promote sustainable development and to ensure the economic, social, and environmental balance in Cambodia, and green and sustainable city development is the key policy priority of this Council while the capital is the largest city (more than two million of population) and secondary cities are fast emerging [2].

Buildings normally have impacts more or less on public health and environments both during and after the construction, and these impacts are seen clearly in cities. This is because a large number of buildings located in cities. This situation can make the cities getting hotter from day to day, and the temperature goes up quickly at the day time, but goes down slowly at the night time. In this case, the buildings were revealed to be generated heats [3] while these heats were mostly generated from the machinery using inside the buildings. De Munck and her team in 2013 [4] showed that increasing the air conditioner uses and the system for cooling the buildings are largely emitting the waste heats to the atmosphere. The waste heats released by the air conditioners at the nighttime were found to be increased the city's temperature more than 1°C, reported by the Arizona State University scientists in 2014 [3,5]. Furthermore, when the urban temperature, especially in the urban center getting hotter than its surrounding areas is an urban heat island (UHI) effect. The buildings were found to be significant contributors to UHI effects because they have been blocking the wind and trapping the heat, as well as using low albedo materials. The uses of air conditioners are also increasing in order to keep the buildings cooler inside. Hence, the study discussing on environments, public health, and human gathering in cities, particularly UHI effect mitigation strategies is popular and widely recognized [6].

In most cities commonly have a limited number of natural areas and opened spaces because of the high density of buildings and constructions. In this case, planting more trees to cool the city or to reduce the urban heat is quite difficult. Constructing more water bodies or lakes in the city is also facing difficulties. Thus, optional strategies that we have are to (a) sustainably plan and design new buildings by following the sustainability and green concepts, (b) sustainably construct new buildings by using low-environmental impact materials, (c) sustainably operate and perform the functions of constructed buildings, and (d) sustainably renovate the existing low-performance or old buildings.

Nowadays, even though the sustainable building planning and design, construction, performance, and renovation concepts are generally used worldwide, still how to apply these concepts are different from one country to another country, especially they are very different between developed and developing countries [2,7]. Differences in the countries' contexts are among the main reasons, those particularly include the weather conditions. For example, the weather in the European countries is quite different from the weather in Asian countries; accordingly, sustainable building concepts for the European countries are also different from sustainable building concepts for Asian countries.

The context of Cambodia, an Asia's developing country, is also different from other developed countries while its urbanization is growing rapidly. The construction has been recognized as a key development sector while thousands of buildings in Phnom Penh, Siem Reap, Sihanoukville, and other major cities are being built and have been operated. These buildings, however, have not been considered to incorporate sustainability concepts [8] while the buildings are the major final energy consumers, with an estimated share of about 52 percent [9], especially commercial and residential buildings consume nearly 80 percent of the country's electricity, and these buildings' energy consumption is projected to increase more than double until 2040 [9,10]. Hence, sustainable building promotion in Cambodia is needed towards saving energy and reducing CO2 emission.

By realizing this need, the Ministry of Environment's General Directorate of Policy and Strategy is currently developing sustainable and green building criteria/guideline based on international experiences and systems. As we know building sustainability criteria developments are not easy tasks, especially while research outputs are currently limited in Cambodia. This shows a missed scientific contribution to criteria developments for sustainable building assessment in Cambodia while these are a lot in other developed countries around the world [11]. The lack of scientific results is considered missed an important input because the research generally provides useful information, including verifying the related context to the topic, which is completely useful to policy makers, as well as the government committee to use as evidence and baseline for making decision.

In order to fill the above gaps, this research aims to find out significant sustainable building criteria for Cambodia by applying Delphi consensus methods. This research will focus on sustainable building planning and design criteria because they are the early important criteria to take more consideration, especially when we prepare well during the planning and design stage will be a smart start leading to realizing building sustainability in all stages. Furthermore, most sustainable buildings have been registered and passed by their construction, so if the constructed building has not been passed, then we cannot help as it has already been built. Thus, preparing well by putting many efforts towards getting qualified from the starting points is completely a great decision.

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2. Materials and Methods

The materials used for this research are gathered data on planning and design criteria for sustainable buildings printed here [11] as data descriptor. There data were resulted from reviewing literature that are relevant and available. A literature review is quite helpful in summarizing the current literatures on the factor that influences the success of collaboration, and conducting a study based on available knowledge has also been considered as building block of all activities in academic research regardless of discipline [12,13]. The review results, however, need to be validated to fit with the country's context by using consensus methods, such as the Delphi technique [14,15]. This technique was found to be a useful tool to acquire correct information and identify the field that is a lack of established understanding and carry out complex problems that need further judgmental assessment [16–18]. Thus, this research applied this technique to validate the above gathered data of sustainable building planning and design criteria in order to find out the significant ones for the Cambodian context based on the Delphi consensus. In this sense, reviewing relevant sustainable building planning and design criteria from the existing literature is also significant (wildly known as pre-Delphi works) and covered many aspects.

The planning and design criteria for sustainable building assessment were found to be helpful for guiding a sustainable building project and for monitoring and assessing its progress to meet the sustainability requirement at the sustainable building planning and design stage. These criteria are also widely addressed in these two comprehensive guidebooks [19,20], even as guidelines and checklists. These criteria are normally needed for monitoring and assessing the building constructions toward attaining sustainable buildings after the constructions are completed. This means the planning and design criteria, aimed not only for attaining sustainable buildings in the planning and design stage, but also in the construction and operation stages. Therefore, effective planning and design are the sustainable building goals at the early stage towards reducing or eliminating environmental impacts. The gathered and reviewed sustainable building planning and design criteria, which were initially posted here [11], are summarily shown in Table 1.

Table 1. Reviewed sustainable building planning and design criteria.

Category	Criteria	Reference
Sustainable project orientation	Sustainability brainstorming; sustainability goal; sustainable project briefing; sustainable project baseline; code of behaviors; governing rule orientation; integrated key dimensions; stakeholder orientation; project cost intimation; incentive support provision; available material briefing	[20–24]
Sustainable project planning	Early engagement; design charrette; working together; inclusive documenting; commissioning process; whole-building design; perspective reflection; end-user reflection	[21,24,25]
Sustainable team formation	Sustainability qualification; competence qualification; individual qualification; integrated project team; sustainability missions; sustainability bureau; collaborative session; progress meetings	[19,21,22,24,26,27]
Potential stakeholder involvement	Lenders and investors; construction managers; sustainability coordinators; facility managers; local stakeholders; after-design stakeholders; civil engineers; mechanical engineers; electrical engineers; plumbing engineers; design professionals; interior designers; landscape architects; in-house employees; market representatives	[19,24,28–30]
Sustainable site selection	Environmental goals; retrofitting building; brownfield location; energy-saving location; geographic accessibility; environmental impacts; livable infrastructures; community connectivity; landscape connectivity; material availability; near basic services; urbanized location; mixed-use location; desirable location	[19,31–42]

Sustainable site design	Ecological preservation; smart outdoor lighting; clustering home design; passive solar design; surface-water design; irrigation system design; lower UHI effect design; site protection design; low emission design; compact building design; sustainable landscape design	[19,31–35,37,42–45]
Resource conservation plan	Land use conservation; material conservation; water conservation; energy conservation	[32,34,46–48]
Building cost reduction plan	Material cost saving; energy cost saving; productive worth; design cost saving; initial cost reduction; operation cost reduction; maintenance cost reduction; retrofitting cost planning	[32,49–53]
Sustainable building space design	Efficient building shape; lower building footprint; space utilization strategy; elimination of corridors; creating common spaces; multifunctional spaces; unnecessary item removal	[19,25,43,52,54–57]
Indoor environmental management	Indoor light control; thermal management; ventilation management; humidity control planning; indoor carbon reduction; noise pollution control; odor pollution control; value aesthetic decisions; hazardous risk mitigation; emitting pollutant prevention	[29,32,34,50,58,59]
Sustainable water management	Plumbing system management; dual plumbing installation plan; rainwater storage management; proper pressure reduction plan; water recirculation management	[23,32,60–62]
Sustainable energy management	Renewable energy plan; effective daylighting design; natural ventilation design; energy optimization plan; insulation use management; material choice-based design	[23,32,34,35]
Sustainable material use condition	No material pollution; no chemical pollution; local material promotion; Energy-efficient materials; efficient embodied energy; material durability; Integrated maintainability; material waste control; recycled material use	[32,34,35,61,63–68]

In qualitative research and assessment, using a decision support tool with relevant stakeholders, specialists, or experts was found to be popular and is usually considered important [69,70]. It helps the qualitative research and assessment in making decision while taking concerned criteria into account for helping groups or individuals exploring a decision or providing a solution. Hence, the multi-criteria decision analysis (MCDA) is getting popular recently and widely used in the fields related to qualitative validation and/or assessments [71–76]. The MCDA techniques, such as TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution), ANP (Analytic Network Process) and AHP (Analytic Hierarchy Process) were found to be significant for their application to select and/or prioritize policies, criteria, and indicators in many studies [77–81]. Furthermore, these techniques have also been used as combined methods with another development, validation, and/or consensus technique, namely Delphi [81–85]. The Delphi technique is essential to develop or validate criteria by identifying and confirming the level of importance and usually uses the 5-point Likert-type scale. This technique has also been widely used in qualitative research and assessments, particularly in the construction and related fields [86–91]. By reviewing the Delphi applications in many studies, Sourani and Sohail [14] figured out the important role and useful functions of Delphi as follows: (a) to acquire precise information that is not yet available; (b) to handle multipart problems that need more judgmental investigation; (c) to define areas where there is a lack of developed understanding; (d) to allow for joining disconnected viewpoints into a shared knowledge; (e) to model a actual phenomenon concerning a range of perspectives and for which there is slightly recognized quantifiable evidence; and (f) to feature areas of concern and judge uncertainty in a measurable manner [92–101]. Therefore, this research took Delphi methods to validate sustainable building planning and design criteria and select the significant ones for Cambodia. A summary of the research procedure is shown in Figure 1.

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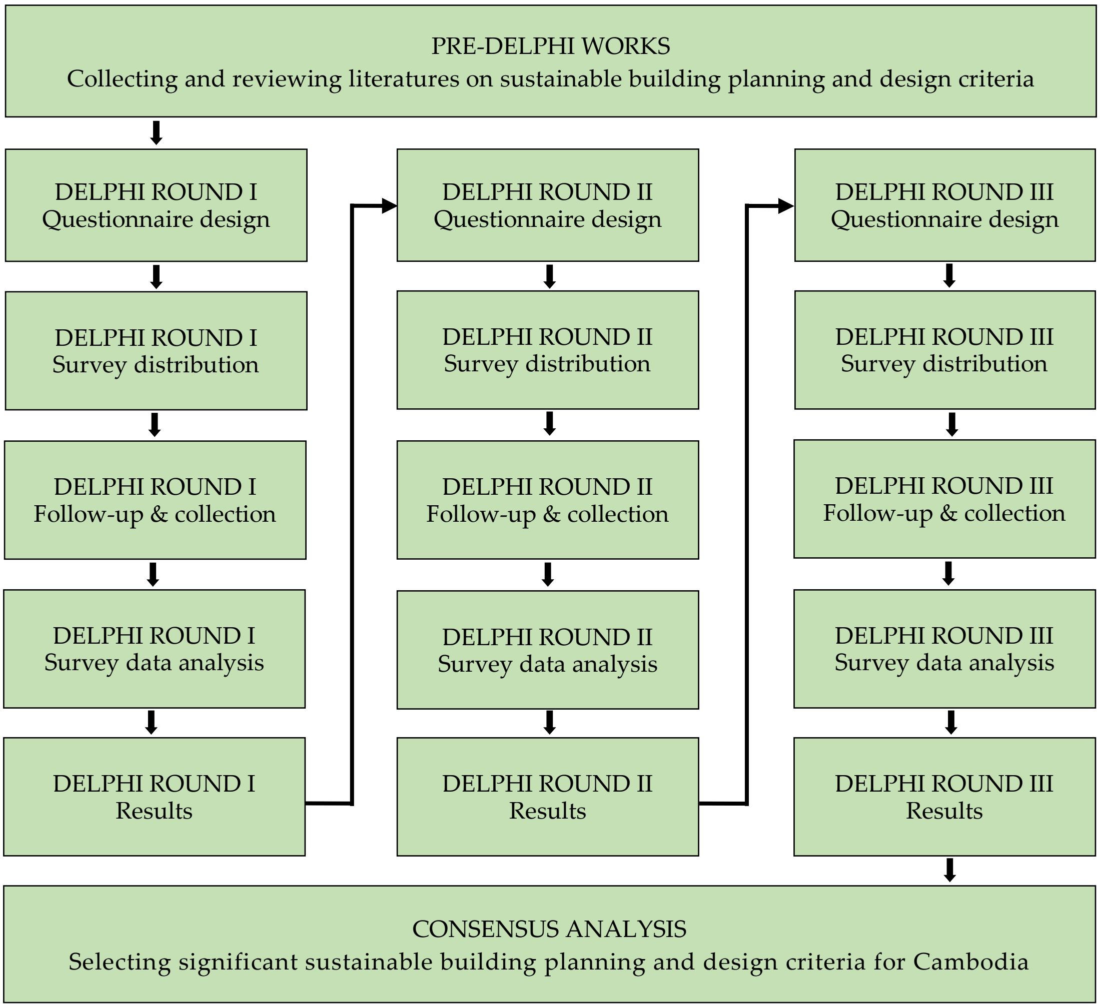

Figure 1. Summary of the research procedure.

2.1. Pre-Delphi Works

In this research, the major assignments comprise of the pre-Delphi works, Delphi round-one survey, Delphi round-two survey, Delphi round-three survey, and consensus analysis as shown in the above figure. The pre-Delphi works consist of two connected activities: brainstorming/gathering and reviewing literature. The brainstorming was to come up with the ideas of sustainable building planning and design criteria. As they are all specialized in relevant fields, such as construction, architectural, urban, and civil engineering, this brainstorming session has not taken a long hour. The brainstorming was based on a comprehensive guidebook of sustainable buildings [19] in order to make sure that everyone could be widely recognized and quite familiar with sustainable building planning and design concepts. Moreover, they were asked to preliminarily review on the sustainable building planning and design criteria as a practice. One week later, after finding out everyone has quite familiar with the sustainability concepts and planning/design criteria for sustainable buildings, they were all asked to provide a review on literatures related to sustainable building planning and design criteria, particularly descripting how those criteria are important for sustainable building planning and design. This review took two weeks and then their reviewed outputs were combined and categorized by classifying into categories. This combination and categorization process, including additional review on insufficient criteria's descriptions and improvements, took almost one month to finalize the reviewed outputs. As shown in Table 1, the finalized reviewed criteria for sustainable building planning and design were 116 in total and classified by 13 categories. The descriptions of these criteria were posted here [11] as Data Descriptor.

2.2. Delphi 3-Round Survey

A survey for Delphi research is generally called a panel survey. The sizes of the panel are various according to the research type, purpose, and/or concerned areas. Weidman et al. [89] does not indicate the particular number of panelists but suggested a minimum of at least 7 or 8. Similarly, Mitchell and McGoldrick [92] stated that the number of panelists should be at least from 8 to 10. In research of Hallowell and Gambatese [88] by applying the Delphi technique in construction-related fields showed that most of the Delphi studies use a panel size from 8 to 16 panelists. Following these recommendations, as well as to obtain a significant level of accuracy in applying Delphi, this research decided that the number of panelists to be involved should be at least 16. Therefore, this research invited 25 panelists, nine more than the determined number in order to prevent some of them dropped in any round, to participate in the Delphi three-round surveys. They specialized in architectural and civil engineering, sustainable urban and construction management, and engineering. Due to the Covid-19 pandemic situation in Cambodia, the surveys were conducted online and distributed, followed up, and gathered through email.

In Delphi studies, number of rounds is varied and should be based on the purposes of the study [14,90]. According to Gunhan and Arditi [91], most changes in the Delphi studies took place in round one and two. Quite interesting and getting clear with a research of Hallowell and Gambatese [88] that demonstrated that using Delphi in three rounds has the advantage to facilitate the responses from round two and report them in round three. Based on these applications, this research accordingly conducted the Delphi surveys in three rounds. The first round was to get the feedback from all panelists on the reviewed outputs—to understand the importance of the criteria by frequency. The second round was to pre-validate the criteria (to identify the level of importance) by using a 5-point Likert-type scale. The third round was to finally validate the criteria (to confirm the level of importance) by assessing based on statistical evidence (average/mean value) obtained from the Delphi round two. The numbers of panelists participated in this panel surveys in Delphi round one, two, and three were 25, 25, and 23, respectively.

During the survey, panelists were explained the research purposes in the email and briefed on how to complete the questionnaires at the top of the questionnaire. In round one, the questionnaire was designed with the reviewed outputs and distributed to the panelists. As mentioned earlier, this round was to get feedback from all panelists on the reviewed outputs and to understand the importance of the criteria by frequency. Therefore, all panelists were asked to check and select only the criteria considered important/ necessary for Cambodia and submit the results within a week. In round two, questionnaires were developed by using a 5-point Likert-type scale: 1 (not important), 2 (less important), 3 (important), 4 (very important), and 5 (extremely important). All panelists were required to identify the level of importance (pre-validation) of the criteria and submit within a week. In round three, questionnaires were developed by adding round-two mean values in front of the 5-point Likert-type scale. The panelists were required to confirm the level of importance (final validation) of the criteria and submit within a week.

2.3. Consensus Analysis

The consensus, panel agreement, was analyzed after the criteria were validated (the level of importance was confirmed). Referring to Hughes [100], a consensus analysis is important to measure how the panelists agreed on a given issue. Through a comprehensive review and use of the Delphi methods in a study related to construction management, Sourani and Sohail [14] proposed that for each criterion, a consensus should base on the average (mean value), SD (standard deviation), and percentage of panelists agreed on the criterion. Similarly, Chan and Lee [99] analyzed a Delphi consensus based on the mean value at first and percentage of panelist agreed on the criterion at last. On a 5-point Likert scale, a consensus is measured by (i) an average (mean value) is above/equal to 3.00, and (ii) a percentage of panelists agreed on the criterion is above/equal to 75.00% [14,99].

Therefore, this research accordingly measured the Delphi panel consensus as follows: The first condition was the average/mean value (confirmed level of importance of criteria) is above/equal to 3.00. The last condition was the percentage of panelists who agreed on validated criteria from 3 (important) to 5 (extremely important) is above/equal to 75.00%. Finally, the validated criteria that fulfilled these two conditions were proven significant sustainable building planning and design criteria for Cambodia.

3. Results and Discussion

The sustainable building planning and design criteria were provided feedback and commented on the list by individual panelists in Delphi round one (reflection). Later, all criteria were identified the level of importance in Delphi round two (pre-validation) and then confirmed their level of importance in Delphi round three (final validation). After the criteria were validated, the consensus rates, panel agreement, were analyzed. These results of the Delphi three rounds and consensus rates are shown in the next pages.

Some criteria were commented to remove from the list by some individual panelists in Delphi round one. Though, the summed-up results from all panelists showed that the criteria, reviewed outputs, were all given back, just some given more by the panelists and some given less by the panelists. For example, sustainability brainstorming in sustainable project orientation was given back (remained on the list) by 24 panelists, which is equal to 96.00%, whereas incentive support provision was given back by only 14 panelists, which is equal to 56.00%. Similarly, indoor light control in indoor environmental management was given by 21 panelists, which is equal to 84.00%, whereas indoor carbon reduction was given by only 11 panelists, which is equal to 44.00%. More importantly, as shown in Figure 2, almost all criteria were considered acceptable from more than half (50%) of the panelists, and only 4 of 116 criteria have acceptable rates less than 50%.

Through a pre-validation process in Delphi round two, many criteria were considered most important criteria, such as civil engineer involvement (mean value = 4.72), mechanical engineer involvement (mean value = 4.36), electrical engineer involvement (mean value = 4.32), and design professional involvement (mean value = 4.28). Furthermore, as shown in Figure 3, almost all criteria were considered important (mean value is above/ equal to 3.00), and only 3 of 116 criteria were considered not-important (mean value is less than 3.00). They are code of behaviors (mean value = 2.84) in sustainable project orientation, mixed-use location (mean value = 2.92) in sustainable site selection, and elimination of corridors (mean value = 2.76) in sustainable building space design.

After confirming the level of importance of criteria (final validation) in Delphi round three, the above not-important criteria were remained not-important. Moreover, 14 other criteria were also found to be ‘not important’. Those 14 criteria are integrated key dimensions (mean value = 2.91) in sustainable project orientation, perspective reflection (mean value = 2.83) in sustainable project planning, collaborative session (mean value = 2.74) in sustainable team formation, in-house employees (mean value = 2.96) in sustainable stakeholder involvement, retrofitting building (mean value = 2.96) and desirable location (mean value = 2.78) in sustainable site selection, ecological preservation (mean value = 2.91) in sustainable site design, retrofitting cost planning (mean value = 2.70) in building cost reduction plan, unnecessary item removal (mean value = 2.74) in sustainable building space design, indoor carbon reduction (mean value = 2.70) in indoor environmental management, dual pumping installation plan (mean value = 2.87) and proper pressure reduction plan (mean value = 2.91) in sustainable water management, and material choice-based design (mean value = 2.87) in sustainable energy management. As shown in Figure 4, many criteria were found to be the most important criteria, such as sustainability qualification (mean value = 4.00), competence qualification (mean value = 4.17), construction manager involvement (mean value = 4.35), civil engineer involvement (mean value = 4.74), mechanical engineer involvement (mean value = 4.30), electrical engineer involvement (mean value = 4.17), pumping engineer (mean value = 4.04), design professional involvement (mean value = 4.30), and interior designer involvement (mean value = 4.13).

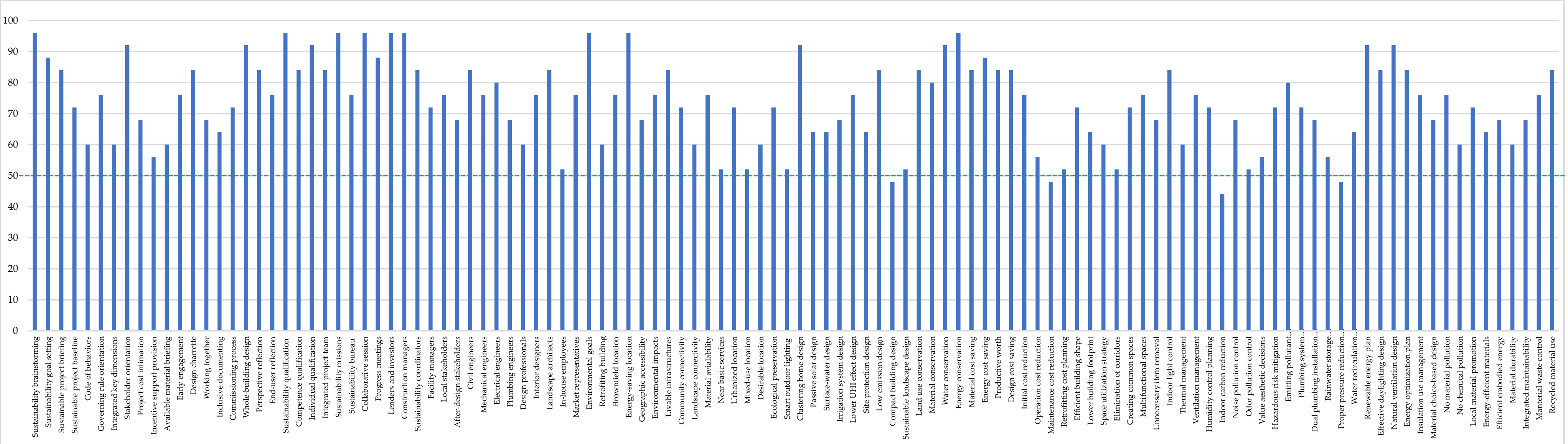

Figure 2. Results of Delphi round one.

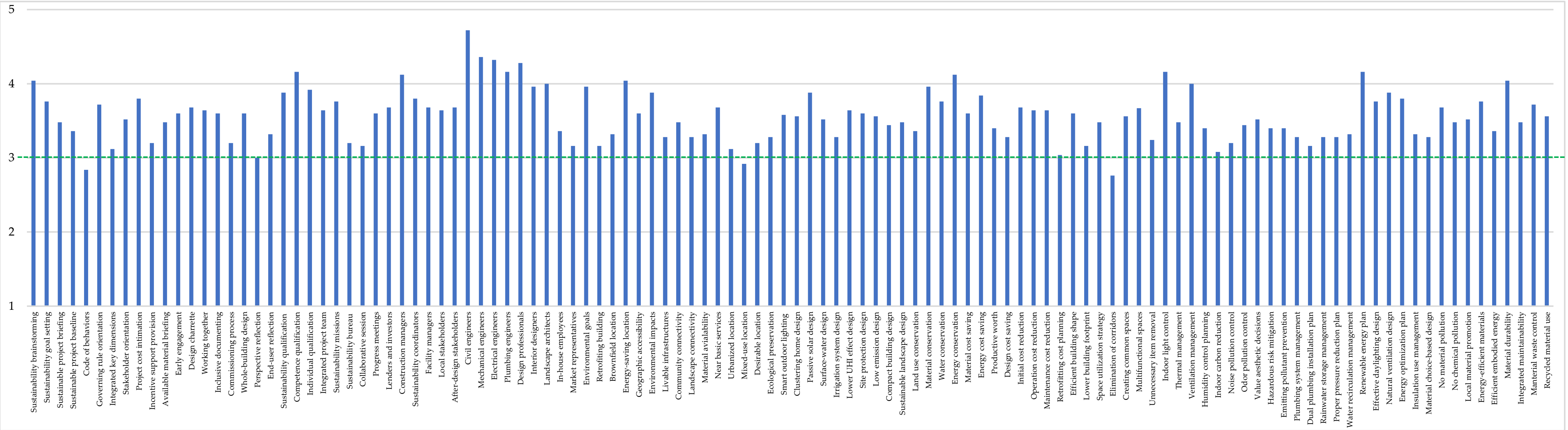

Figure 3. Results of Delphi round two.

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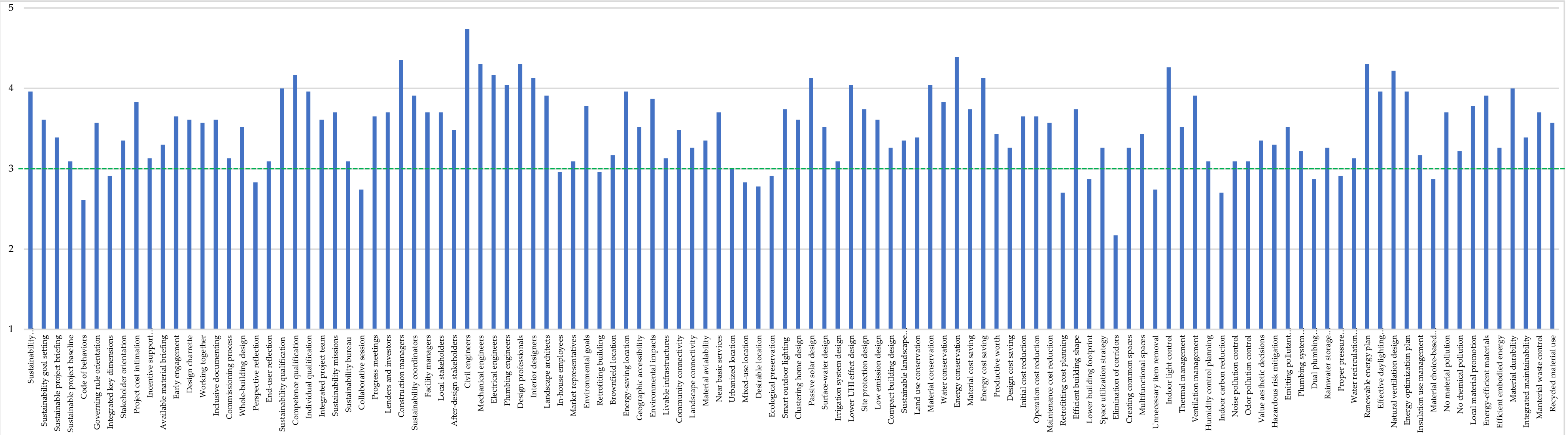

Figure 4. Results of Delphi round three.

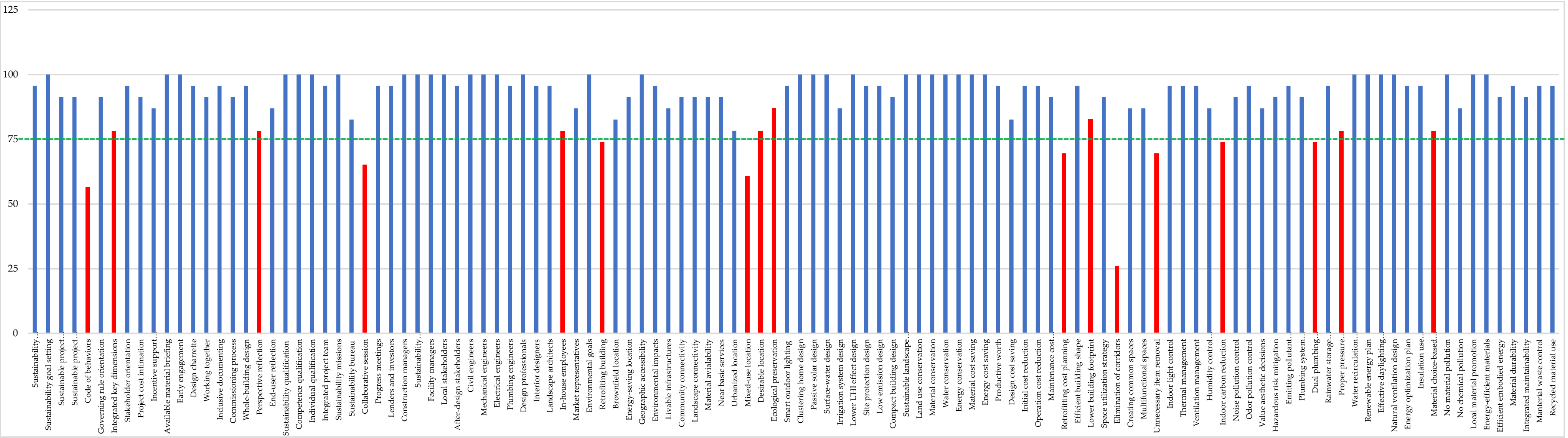

Figure 5. Results of consensus analysis.

Figure 6. The consensus planning and design criteria for sustainable buildings in Cambodia. An arrow direction shows the order of categorized sustainable building planning and design criteria from the first until the last criteria.

In this research, selecting significant sustainable building planning and design criteria for Cambodia is based on the Delphi consensus. It means that the significant criteria have to be fulfilled the consensus condition: (a) the confirmed level of importance is above or equal to 3.00; and (b) the percentage of panelists who agreed on the criteria from 3 to 5 reached 75% or above. As shown in Figure 5, there are 17 of 116 criteria failed to fulfil this condition; therefore, based on this Delphi research, a total of 99 criteria were found to be significant sustainable building planning and design criteria for Cambodia.

Finally, this research found that 99 sustainable building planning and design criteria are consensually applicable for Cambodia. These criteria are classified by 13 categories as follows: sustainable project orientation; sustainable project planning; sustainable team formation; potential stakeholder involvement; sustainable site selection; sustainable site design; resource conservation plan; building cost reduction plan; sustainable building space design; indoor environmental management; sustainable water management; sustainable energy management; and sustainable material use condition. These categories also indicate the order of all criteria from the first to the last. As summarized in Figure 6, the early preparatory from the criteria in the first category (sustainable project orientation) until the criteria in the third category (sustainable team formation) were listed on the top of the drawn sustainable building model "Vattanac Capital" a Gold LEED certified tower in the capital of Cambodia. Other criteria in the more-technical categories were listed alongside the drawn sample with an arrow that goes across the building again and again to show that those criteria are required to reflect and check again and again as they are getting more technical for planning and designing a sustainable building. Finally, the last criteria in the last category (sustainable material use planning and condition) were positioned as the foundation of the building. Those criteria are "no material pollution; no chemical pollution; local material promotion; energy-efficient materials; efficient embodied energy; material durability; integrated maintainability; material waste control; and recycled material use". These criteria are also significant to maintain the long-term performance (operation) of the building after successfully constructed. This in-advance material use planning and condition will help in saving resources during the building construction, saving energy and reducing environmental impacts during the building operation, and securing the healthy and safe conditions to the people who are working and/or living inside the building toward increasing the productivity of the building.

The descriptions of the criteria, which were posted here [11] as Data Descriptor, are more important to understand how each of criteria is important and contributing to make a building sustainable. For example, the criteria in a category of 'sustainable project orientation' are important to assess the early preparation of a sustainable building project. Firstly, it is important to realize that sustainability principles were well introduced to all project team members which are significant to achieving a sustainable mission and major work outcomes. It is also important to make sure that the sustainability goals of the project were properly set since the beginning as it is crucial to make the project framework clear, especially in decision makings. Furthermore, it is important to check whether the proposed project was well briefed to the team to make them all understood before the project starts, which will lead to achieving sustainable building goals and cost-effectiveness. Moreover, these criteria are important to measure that the project baseline was properly included the sustainability aspects during defining project scope and charter, design drawing, management plan, and contract in order to select the best option to achieve the target of sustainability. It is also important to check that the project administration and rules were orientated because strong governing rules or effective monitoring principles, including the use of technology, are given advantages while the orientation of stakeholders is very important to a sustainability (multidimensional) project, and involving them has also encouraged them to experience sustainability benefits. More than that, these criteria are important to understand cost intimation of the project which the project director needs to prepare an actualized expense to the clients. Likewise, it is important to understand the incentive support provision as incentives play an important role in promoting sustainability. Incentives can be provided in terms of money or others to improve working performance. Last but not least, these criteria are important to briefly understand material sources, characteristics, and certification and essentially encouraged stakeholders to realize the availability of sustainable materials in the construction industry.

4. Conclusions

This research applied the Delphi methods to find out the significant planning and design criteria for sustainable buildings in Cambodia. Through the reflection and validation process, as well as the consensus analysis, a total of ninety-nine criteria were found to be consensually applicable for Cambodia. These criteria were classified by thirteen categories as follows. First of all, 'sustainable project orientation' is to assess the early preparation of a sustainable building project while 'sustainable project planning' is to properly plan a sustainable building project, and 'sustainable team formation' is to form an inclusive and integrated sustainability team. The 'potential stakeholder involvement' is to involve all potential stakeholders in sustainable building planning while 'sustainable site selection' is to assess the suitability of a sustainable building location, and 'sustainable site design' is to maintain proper site planning and design. A 'resource conservation plan' is to conserve resources and land use while a 'building cost reduction plan' is to reduce sustainable building costs and promote building cost-saving, and 'sustainable building space design' is to effectively plan and design a building shape and spaces. An 'indoor environmental management' is to plan and design for indoor environmental quality in advance while a 'sustainable water management plan' is to manage sustainable water supply and consumption for the building, and a 'sustainable energy management plan' is to manage sustainable energy consumption and production. Finally, sustainable material use condition is an important plan to maintain the right, safe, and sustainable use of materials. This research is limited to identifying and confirming the levels of importance to validate the criteria and to select the significant ones for Cambodia. Thus, these levels of importance could not be used as relative weights to prioritize these criteria. Future research using a pairwise comparison method, such as the AHP (analytic hierarchy process) technique, to analyze the relative weights of these criteria would be significantly contributing to the sustainable building criteria prioritization in Cambodia.

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