

# INTEGRATION OF AFFORDABLE HOUSING AND GREEN RESIDENTIAL BUILDING DESIGN IN THE CONSTRUCTION SECTOR IN CAMBODIA

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## ABSTRACT

By 2030, the expected doubling of the urban population in Cambodia warns of housing shortage and under-supply of infrastructure. Cambodia adopted a national policy to promote the development of housing projects that need an additional 50,000 homes a year and 800,000 new affordable units to be built to meet the growing housing demand. The groups of population that urgently need affordable homes, low- to middle-income people, access fewer quality housing and well-being living opportunities and it is particularly difficult because of barriers associated to the construction sector. To this day, there are no guidelines and regulations for constructing affordable housing in the perspective of environmentally sustainable building design and adequate housing elements, nor a recognised standard of affordable housing practice and policy in the country. This study aims to define the compatible approaches and concepts of affordable housing and green building design in Cambodia. The study provides qualitative insights into contextual characteristics and definitions, construction cost, residential type, materials and technologies, main focus and implementation strategy of green affordable housing. The research method is conducted through semi-structured interviews following an exploratory interview and based on an interview guide and prepared hypotheses. The interviews aim to gather points of view and understandings on affordable housing and green residential building design from construction actors and decision makers. Forty professionals were selected in the survey and were categorised into four different groups based on their background and present work. The 40 participating professionals included (a) architects; (b) civil and construction engineers who have worked in the building construction field; (c) green building experts and practitioners; and (d) decision makers (ministry, municipality, founding director and chairman). According to the data interpretation and analysis, suitable approaches adapted to the green affordable housing and sustainable construction sector in Cambodia are finally found.

*Keywords: affordable housing, green building design, construction actors, Cambodia.*

## 1 INTRODUCTION

Urbanisation in developing countries has experienced dramatic growth because of rapid population and world economic growth. The UN estimates that the global population will reach 8.5 billion by 2030, almost 60% of which will be living in urban areas [1] and this will increase to 68% in 2050 [2]. By that time, the UN Population Division projected that about 64% of developing countries and 86% of developed countries will be urbanised [3]. The increasing speed and scale of urbanisation will bring challenges related to the fulfilment of the basic needs of the cities such as accelerated demand for housing, viable infrastructure including transportation, energy systems, basic services including education and health care, and jobs [2]. People moving from rural to urban areas to have better socio-economic status through employment and education has made providing sufficient and affordable housing a major challenge of urbanisation [4]. An estimated 3 billion people will need new adequate housing and basic urban infrastructure by 2030, and Cambodia is not deviating from this



challenge. Its capital city, Phnom Penh, is experiencing exponential growth and now has a population of 2.2 million, with numbers expected to continue rising.

In 2016, the World Bank Group upgraded Cambodia's status from a 'low-income country' to a 'lower-middle-income country' due to its significant poverty reduction and robust economic growth [5]. This reclassification coincided with a construction boom, particularly in the capital city. Building expansion is crucial as the Global Green Growth Institute and others predicted that the country's urban population will double by 2030, raising concerns about housing shortages and under-supply infrastructure. Cambodia adopted a national policy to promote the development of housing projects and the government forecasted that the capital city will demand some 800,000 new units to meet housing needs by 2030 [6].

The groups of population that urgently need affordable homes, low- to middle-income people, and vulnerable groups, access fewer quality housing and well-being living opportunities [7]. In Phnom Penh, the financialisation of the housing market through international investments has shifted housing construction to cater to foreign and elite groups instead of the local population. This makes housing access particularly difficult for the urban poor due to their low and unstable incomes and unenforceable land rights. Currently, most housing units are unaffordable for 60–70% of the population, presenting a significant challenge [8]. Besides the unaffordability challenge, the questions concerning the cost of construction, occupant health and comfort, and design standards of the building remain.

Even though the building sector is significant for economic growth, it should follow the principle of sustainable development [9] and it is crucial to make the city inclusive to everyone. The global green movement has prioritised green building due to its ability to meet building demands while mitigating the negative environmental impacts of the construction industry [10]. To address its development challenges, Cambodia must adopt green building practices as part of its strategy to achieve sustainable development. However, there are few activities and limited knowledge and awareness of sustainable buildings in the construction sector of Cambodia [5]. The construction boom in the capital city lacks attention to sustainability and this will have consequences in the near future. The construction laws and regulations include only quality, security, and safety of the building construction but they do not consider the performance of the building (for example: energy efficiency, human comfort, and low carbon emission), sustainability aspects, as well as green building criteria [11].

In the construction sector of Cambodia, there is still the requirement of guidelines and regulations for constructing affordable housing in the perspective of environmentally sustainable building design and adequate housing elements, and a recognised standard of affordable housing practice and policy. Meanwhile, the relevant sectors responsible for the affordable housing project development are facing a vague definition of affordable housing, unfixed sale price, not defined building typology, lack of standards and construction techniques, and missing the urban quality of life for people.

The objectives of this research are to define the characteristics and definition of affordable housing, green building, main focus for green affordable housing, construction cost and sale price, and residential type based on construction actors' points of view.

Furthermore, this article aims to address a research gap in the research and publication on affordable housing in Cambodia: unavailable access to data on the state of the housing sale market, no existing official categorisation of housing unit types, missing key stakeholders for interview research [12], and the lack of personal accounts from Cambodian critically analysing their situations [13]. Furthermore, the sustainable building construction and green building implementation are still very limited and in the process of ongoing discussions in developing countries such as Cambodia [5], [11]. Based on the mentioned problem and lack, this study will focus on a deeper understanding of concepts of affordable housing and green



building, as well as the implementation of green affordable housing design in the construction sector of Cambodia. Therefore, several research questions arise:

1. How are affordable housing and green buildings in the Cambodian context characterised and defined?
2. Which design, construction techniques, materials and strategy should be focused on in green affordable housing projects in Cambodia?
3. What is the recognised construction cost and sale price of affordable housing, green building and green affordable housing by Cambodian construction actors?
4. Which residential type of green affordable housing can be identified?

The research method is conducted through interviews to address these various questions. This article is structured into five sections. Section 1 introduces the literature review of housing challenges in the urbanisation and context of green building in the construction sector of Cambodia, problematic, research questions, and content. Section 2 explains the process of research methodology, interview questions, and participants' profiles. Section 3 illustrates the result of characteristics and definition, construction cost and sale price, and residential type of green affordable housing in Cambodia. Section 4 discusses the results. Finally, Section 5 presents the conclusion of the research findings and further work.

## 2 METHODOLOGY

The research method is to gather participants' points of view and understanding of affordable housing and green building design through semi-structured interviews following an exploratory interview and based on an interview guide and prepared hypotheses. Fig. 1 outlines the execution of the research procedure. The interview questions were designed and tested through three pre-experiments with a lecturer, a researcher, and a professor, to ensure the maximum possibility of collecting much relevant data and understanding of participants on the studied questions. The questions then were improved.

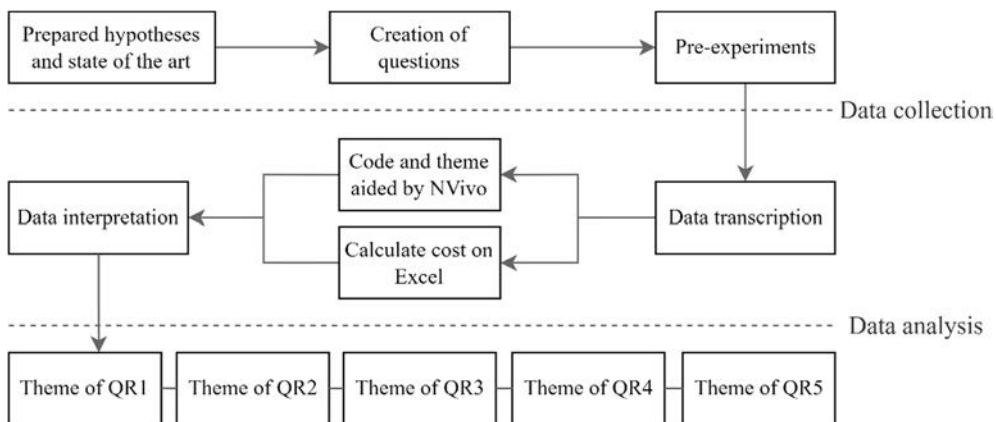


Figure 1: The detailed research procedure of the study.

The collected data from the semi-structured interviews were transcribed and summarised in a Microsoft Excel file. To proceed with data interpretation, the data then were coded and

categorised into specific themes on the NVivo platform, and the mean value of construction cost was calculated in Excel. The results were analysed corresponding to the guided questions of research.

The creation of the questions in the semi-structured interview was based on the objectives and exploration of defining characteristics of affordable housing, green building design, and their integration. The following questions were designed and used in the interviews to find themes of the guided questions of the research.

1. Affordable housing characteristic and definition
  - Please give us characteristics and/or keywords of terms ‘Affordable housing’ from your points of view.
2. Green building characteristic and definition
  - Please give us characteristics and/or keywords of terms ‘Green building design’ from your points of view.
3. Main focus for green affordable housing
  - Are the concepts of ‘Affordable housing’ and ‘Green building design’ compatible? If yes, what is your main focus and strategy to implement green building design to affordable housing?
4. Construction cost and sale price
  - Can you tell us what is the usual construction cost per built area of 1 m<sup>2</sup> in Cambodia?
  - Can you tell us what is the construction cost and sale price of an affordable housing per built and usable area of 1 m<sup>2</sup> in Cambodia?
  - Can you tell us what is the construction cost and sale price of a green building per built and usable area of 1 m<sup>2</sup> in Cambodia?
  - Can you tell us what is the construction cost and sale price of a green affordable housing per built and usable area of 1 m<sup>2</sup> in Cambodia?
5. Residential type
  - What type of residential housing do you think should be used to create affordable green housing in Cambodia? (For example: terraced house, semi-detached house, detached house, apartment, high-rise building, etc.)

The participants were categorised into four different groups: (a) architects (Arch); (b) civil and construction engineers (Eng); (c) green building experts and or practitioners (GB); and (d) decision-makers (DM). The details of the participant’s profiles are shown in Table 1. The criteria for selection are made according to architects who have experience at least in residential building design, civil and construction engineers who are working in building construction, green building experts, and or practitioners who are working related to green building design and in green building certification, decision-makers who are working in the field of construction and making policy about building construction and green building certification.



Table 1: Participant profiles.

No	ID	Designation	Years of experience
1	Arch1	Technical architect	2.5
2	Arch2	Senior architect	7
3	Arch3	Architect and urbanist	25
4	Arch4	Architectural designer	3.5
5	Arch5	Junior architect	0.5
6	Arch6	Site architect	0.5
7	Arch7	Senior architect	4.5
8	Arch8	Senior architect	6
9	Arch9	Architectural designer	4
10	Arch10	Architect	2.5
11	Eng1	Site engineer	7
12	Eng2	Quantity surveyor	4.5
13	Eng3	Site supervisor	4
14	Eng4	Senior structural engineer	5
15	Eng5	Site engineer	3
16	Eng6	Site engineer	7
17	Eng7	Technical manager	11
18	Eng8	Engineering advisory	5
19	Eng9	Structural and site engineer	5
20	Eng10	Technical designer and project manager	5
21	GB1	Design manager	11
22	GB2	Founder of architecture firm	5
23	GB3	Senior architect	7
24	GB4	Junior architect	2
25	GB5	Co-founder of architecture firm	4
26	GB6	Senior project engineer	3
27	GB7	Chairman and CEO	20
28	GB8	Senior architect	6
29	GB9	Director	9
30	GB10	Team leader	3
31	DM1	Architect and urbanist	23
32	DM2	Founding director	36
33	DM3	Ministry officer	7
34	DM4	Chairman	27
35	DM5	Deputy director	4
36	DM6	Founder and CEO	27
37	DM7	Urban environmentalist	3
38	DM8	Urbanist	31
39	DM9	General manager	8
40	DM10	Design manager and managing director	15



### 3 RESULTS

#### 3.1 Characteristics and definition of affordable housing, green building, and main focus for green affordable housing

The interviews were carried out with 40 construction actors in a total session of about 24 hours. The interview questions are divided into four sections. The first section was a self-introduction of the participant and they were asked about their current role and position in the company, years of experience working in the construction field, and type of building projects they mostly work on or design.

The second section of the interview was created to ask the participants about the characteristics and cost of affordable housing in the construction sector of Cambodia. The objective of the question was to investigate the participants' points of view on how and what they defined affordable housing, its construction cost, and the sale price per 1 m<sup>2</sup>. The interview results listed the following as the most to least mentioned: (1) architectural design and construction techniques; (2) affordable price; (3) enhance quality of life; (4) about location; (5) housing for low to middle-income people; (6) be comfortable; (7) materials choice; (8) housing for all; (9) energy consumption; (10) accessibility to public service and facility; and (11) be secure. To find specific characteristics, several themes must be divided into sub-themes. The analysed data were highlighted in themes and sub-themes in Table 2.

Table 2: Classified themes in the total list of characteristics and definition of affordable housing.

Themes	Sub-themes
1) Architectural design and construction (62)	<ul style="list-style-type: none"> <li>• Effective space arrangement and functional (8)</li> <li>• Ensure the quality of housing (6)</li> <li>• Minimal design and style (5)</li> <li>• Integrate community sense (3)</li> <li>• Adapt to local culture and vernacular architecture (2)</li> <li>• Sustainable building design (2)</li> </ul>
2) Affordable price (35)	
3) Enhance quality of life (24)	
4) Location (18)	<ul style="list-style-type: none"> <li>• Locate in suburbs (5)</li> <li>• Not be at a risky location (1)</li> </ul>
5) Housing for low to middle-income people (15)	
6) Be comfortable (14)	
7) Materials choice (12)	<ul style="list-style-type: none"> <li>• Affordable materials (4)</li> <li>• Local materials (1)</li> </ul>
8) Housing for all (7)	
9) Energy consumption (5)	<ul style="list-style-type: none"> <li>• Minimise energy consumption (2)</li> </ul>
10) Accessibility to public service and facility (4)	
11) Be secure (2)	



The third section of the interview was created to ask the participants about the characteristics and cost of green building in the construction sector of Cambodia. The objective of the question was to investigate the participants' points of view on how and what they defined green building, its construction cost, and sale price per 1 m<sup>2</sup>. The interview results listed the following as the most to least mentioned: (1) architectural design and construction techniques; (2) saving; (3) materials consumption; (4) bioclimatic design; (5) greenery; (6) occupants; (7) minimise impact to the environment; (8) renewable energy; (9) sustainable development pillars; (10) waste management; and (11) green building certification. The analysed data were highlighted in themes and sub-themes in Table 3.

Table 3: Classified themes in the total list of characteristics and definition of green building.

Themes	Sub-themes
1) Architectural design and construction techniques (48)	<ul style="list-style-type: none"> <li>• Sustainable building design (6)</li> <li>• Sustainable construction techniques (5)</li> <li>• Environmental and eco-friendly approach (4)</li> <li>• Practical and usable space design (2)</li> <li>• Site and surrounding integration (2)</li> <li>• Adapt to local culture, society, and people (1)</li> <li>• Feasible maintenance (1)</li> <li>• High-rise building (1)</li> <li>• Minimal design and style (1)</li> <li>• Protection against flood (1)</li> </ul>
2) Saving (47)	<ul style="list-style-type: none"> <li>• Saving energy (14)</li> <li>• Saving water (3)</li> <li>• Saving environment (2)</li> <li>• Saving materials consumption (2)</li> <li>• Saving cost (2)</li> <li>• Saving land use (1)</li> <li>• Saving maintenance (1)</li> </ul>
3) Materials consumption (40)	<ul style="list-style-type: none"> <li>• Reused and recycled materials (7)</li> <li>• Eco-friendly and low-carbon materials (6)</li> <li>• Local materials (2)</li> <li>• Natural products (2)</li> </ul>
4) Bioclimatic design (25)	
5) Greenery (23)	
6) Occupants (20)	<ul style="list-style-type: none"> <li>• Human comfort (3)</li> <li>• Social and community (2)</li> <li>• Well-being (2)</li> <li>• Security (1)</li> </ul>
7) Minimise impact to the environment (17)	
8) Renewable energy (5)	
9) Sustainable development pillars (3)	
10) Waste management (3)	
11) Green building certification (2)	



Table 4: Classified themes in the total list of characteristics and definition of green affordable housing.

Themes	Sub-themes
1) Architectural design and construction techniques (71)	<ul style="list-style-type: none"> <li>• Integrate community and common space (9)</li> <li>• Apply green, sustainable, and environmental design (8)</li> <li>• Minimal design and style (5)</li> <li>• Using design standards and construction techniques (4)</li> <li>• Maximise the space (3)</li> <li>• Adapt to affordable housing and green design (1)</li> <li>• Ensure quality of building (1)</li> <li>• Good accessibility in the building (1)</li> </ul>
2) Materials choice (60)	<ul style="list-style-type: none"> <li>• Local materials (7)</li> <li>• Reused, recycled, and recyclable materials (7)</li> <li>• Affordable materials (6)</li> <li>• Natural materials (6)</li> <li>• Eco-friendly materials (3)</li> <li>• Green labelled materials (1)</li> </ul>
3) Bioclimatic design (49)	
4) Quality of life (33)	<ul style="list-style-type: none"> <li>• Human comfort (4)</li> <li>• Social and community relationship (4)</li> <li>• Appropriate living space and shelter (3)</li> <li>• Environmental-friendly (2)</li> <li>• Accessible (1)</li> <li>• Entertainment (1)</li> <li>• Good ambiance and atmosphere (1)</li> <li>• Improve lifestyle (1)</li> </ul>
5) Saving (33)	<ul style="list-style-type: none"> <li>• Saving energy (9)</li> <li>• Saving materials (3)</li> <li>• Saving cost (2)</li> <li>• Saving water (2)</li> <li>• Saving construction techniques (1)</li> </ul>
6) Greenery (20)	
7) Be affordable (8)	
8) Minimise impact to the environment (4)	
9) Renewable energy (4)	
10) Rain harvesting (3)	
11) Waste management (3)	
12) Minimise construction cost (1)	





The fourth section of the interview was created to ask the participants if affordable housing and green building design are compatible and if they said yes, we would continue with the main focus on green affordable housing in the construction sector of Cambodia. The objective of the question was to investigate the participants' points of view on priority criteria, potential implementation, and integration of these two concepts. The interview results listed the following as the most to least mentioned: (1) architectural design and construction techniques; (2) materials choice; (3) bioclimatic design; (4) quality of life; (5) saving; (6) greenery; (7) be affordable; (8) minimise impact to the environment; (9) renewable energy; (10) rain harvesting; (11) waste management; and (12) minimise construction cost. The analysed data were highlighted in themes and sub-themes in Table 4.

The characteristics and definition displayed in Tables 2–4 present themes and sub-themes followed by the number of frequencies of each characteristic being mentioned by the participants.

### 3.2 Construction cost and sale price

In each section, the participants were asked about the current usual cost of the building, expressed in construction cost and sale price, respectively of affordable housing, green building, and green affordable housing in the construction sector of Cambodia. The objective of the interview section was to investigate the construction cost per built area of 1 m<sup>2</sup> and the sale price based on the participants' points of view, knowledge, and experience. The construction cost per built area of 1 m<sup>2</sup> and the sale price were given by the mean value of the different participant groups and then it was calculated to a final mean value.

The result of the usual construction cost given by the participants is \$356 per built area of 1 m<sup>2</sup>. For affordable housing, the construction cost is \$329 per built area of 1 m<sup>2</sup> and the sale price is \$758 per 1 m<sup>2</sup>. For green buildings, the construction cost is \$460 per built area of 1 m<sup>2</sup> and the sale price is \$1,322 per 1 m<sup>2</sup>. For green affordable housing, the construction cost is \$414 per built area of 1 m<sup>2</sup> and the sale price is \$904 per 1 m<sup>2</sup> (Table 5).

Table 5: Construction cost and sale price (by mean value) per 1 m<sup>2</sup> of affordable housing, green building, and green affordable housing.

Participant group	Arch	Eng	GB	DM	Mean value (\$)
Usual construction cost per 1 m <sup>2</sup> (\$)	235	319	374	496	356
<b>Affordable housing</b>					
Construction cost per 1 m <sup>2</sup> (\$)	425	275	275	342	329
Sale price per 1 m <sup>2</sup> (\$)	883	529	766	855	758
<b>Green building</b>					
Construction cost per 1 m <sup>2</sup> (\$)	378	344	626	490	460
Sale price per 1 m <sup>2</sup> (\$)	1,521	1,094	1,309	1,363	1,322
<b>Green affordable housing</b>					
Construction cost per 1 m <sup>2</sup> (\$)	506	293	414	441	414
Sale price per 1 m <sup>2</sup> (\$)	993	783	917	922	904

### 3.3 Residential type

In the fourth section of the interview, the participants were asked a question about the ideal residential type of green affordable housing in the construction sector of Cambodia. The



objective of the question was to investigate the participants' perspectives and ideas on the type of green affordable housing that they believed it was well adapted and should be constructed in the context of the case study.

The most mentioned responses from the participants are high-rise apartment (9 or more storeys) and followed by medium-rise apartment (4–8 storeys), detached house, shophouse (linked house), and low-rise apartment (1–3 storeys) (Table 6).

Table 6: Residential type by frequency.

<b>Residential type</b>	<b>Frequency</b>
High-rise apartment (9 or more storeys)	15
Medium-rise apartment (4–8 storeys)	10
Detached house	9
Shophouse	4
Low-rise apartment (1–3 storeys)	2

#### 4 DISCUSSION

In this section, we briefly discuss the findings of this study with the first questions that guided this research. The findings of this study show that the construction actors and decision-makers give various definitions of affordable housing and some give recommendations and requirements that need to be taken into account in affordable housing projects. The affordable price, to enhance the quality of life, be comfortable, housing for all and low to middle-income people, and be secure proved to be the most recognised and defined characteristics among construction actors and decision-makers in Cambodia. When related to architectural design and construction techniques, location, materials choice, energy consumption, and accessibility to public service and facility, they precise the specific criteria and guidance, based on the results in Table 2. A particular response given by a participant covered almost the finding results, the participant Arch3 mentioned the principles included in affordable housing such as accessibility to materials and public, acceptable price to construct and buy the house, belief, and culture involved vernacular architecture, not in the risky location, and enhancing economy of living. Given that this participant has been working in the field of slum community upgrading and affordable housing construction for about 25 years, thus this participant understands the field and study context very well. However, the words 'housing for all' to define affordable housing in Cambodia are not certainly acceptable and should be excluded because of their global and general purpose. Still, it is more relevant by the words 'housing for poor and low to middle-income people' reported by Seng [4] and Kol and Brugman [7] in the context. Therefore, the results show that all the above-mentioned definitions, recommendations, and study criteria for affordable housing in Cambodia could be baseline standards and provisions for future affordable housing projects and these definitions and characteristics could be familiar and identified to other construction actors and relevant sectors in the country.

In the interview, the participants defined and described green building based on their understanding, experience, and knowledge. The participants provided all the principles, strategies, and technologies of green building that are related to their practice and adapted to the construction sector in Cambodia and that did not follow the definition of any reference or theory. They agreed and mentioned that green buildings and their design in Cambodia cannot follow from A to Z of the worldwide green building key elements. They implemented green building design into their projects where and when it is feasible. Ragheb et al. summarised five key major elements of green building design such as sustainable site design,



water conservation and quality, energy and environment, indoor environmental quality, and conservation of materials and resources [14]. The participants shared many relevant elements of green building principles while they proposed other specific characteristics such as saving (cost, land use and maintenance), design of protecting against flood, and bioclimatic design (natural light and ventilation). However, one misunderstanding about green building in Cambodia concerns the building type. They believed that green buildings should only be high-rise buildings. A few high-rise buildings in Cambodia were certified as green buildings, so that is a reason the participants thought that only the high-rise building could achieve the green building objectives.

The discussion of the main focus for green affordable housing in the construction sector of Cambodia received various impressions and inputs from the participants. The participants tried to find the middle line between affordable housing and green building. It was a bit challenging to give the answers at first because they believed that green building design is expensive while it must apply to housing that has to be costless and affordable to construct. On the other hand, some participants thought green building would not be expensive because they believed that we could build green affordable housing from the available local resources and practices, for example Khmer traditional house. The more feasible and adapted principles that could apply to green affordable housing in the country are given in Table 2.

The 2017 Policy on the Incentives and Establishment of National Program for Development of Affordable Housing in Cambodia introduced measures to encourage developers to build dwellings priced between \$15,000 and \$30,000 [8]. The sale price of green affordable housing found in this study, in the case of \$45,200 for 50 m<sup>2</sup>, shows that it is higher than the price suggested by the National Policy. However, based on the construction cost found in the study, \$414 per 1 m<sup>2</sup>, we can achieve the construction of green affordable housing in line with the National Program but the developers will be challenged with a slight benefit from the project. Therefore, it requires government intervention and non-government organisations' support to provide green affordable housing with an affordable price range.

For the residential building types of green affordable housing that were most suggested by the participants, high-rise apartment is the most cited, followed by medium-rise apartment and detached house. However, around a third of participants recommend high-rise buildings, a third medium- and low-rise buildings, and a third single-family houses. It therefore seems that several types of residential buildings can be suitable for green affordable housing. Currently, there is an affordable housing project constructed in the capital city that is a high-rise apartment building (20–24 storeys) and some others that are shophouses (terraced houses). The detached house type cannot be the ideal type because of the high land price in the city. Therefore, the apartment building and the shophouse could be identified as the main residential types of green affordable housing in the capital city of Cambodia.

## 5 CONCLUSION

The research developed based on interviews on the integration of green residential building and affordable housing in the construction sector of Cambodia received much interest from the participating construction actors and decision-makers, due to the lack and limited study in the field of architecture and sustainable building construction. Based on the participants' points of view and their current experience and practices in Cambodia, this research presents and characterises the main characteristics that affordable, green, and green and affordable buildings should incorporate into their design.

The construction of green affordable housing in Cambodia should consider: (1) architectural design and construction techniques that include community and common space, application of green and sustainable design, minimal design and decoration, using



standards, space maximisation, quality, and accessibility of the building; (2) recommended materials such as local, reused, recycled, recyclable, affordable, natural, eco-friendly and green-labelled materials; (3) bioclimatic design; (4) enhance quality of life through human comfort, social and community relationship, appropriate living space, good and environmentally-friendly ambiance, entertainment and improving lifestyle; (5) saving resources and cost; (6) using greenery; (7) minimising impact to the environment; (8) renewable energy implementation; (9) rain harvesting; and (10) waste management. The construction cost should be around \$414 per built area of 1 m<sup>2</sup> and the preferred building typology is the high-rise apartment building for building green affordable housing in the capital city, even if middle- and low-rise apartment buildings and shophouses can also be recommended.

The results of this research may lead to the feasible and adapted integration and recommendation of the main principles and criteria of green residential design and affordable housing among stakeholders in the construction sector of Cambodia and it could guide future research related to these topics and the context of the study. The findings elements and considerations on green affordable housing can also be used by architects, civil and construction engineers, green building designers, residential developers, and policymakers.

Future research should focus on construction costs and sale prices with key stakeholders in the affordable housing sector to precise a price suitable for affordable housing that meet green building design and is affordable for low to middle-income people. Moreover, the characteristics and definition found in this study will help future researchers move forward to the guidelines and regulations on green affordable housing projects in the country.

#### ACKNOWLEDGEMENTS

The authors thank and appreciate all the construction actors and decision-makers who participated in the interview, as well as ARES – COMBOdIA project for funding this research. This research is developed within two research laboratories: LEMA, ULiège and RIC, ITC.

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