Critical Barriers to Sustainability Attainment in Affordable Housing: International Construction Professionals' Perspective

Abstract

For a significant thrive towards sustainable development globally, sustainability attainment in affordable housing for low-income earners is fundamental. Identifying obstacles to sustainability attainment is primal to successful policy implementation. This study aims to identify critical barriers (CBs) to sustainable affordable housing (SAH) from an international perspective. To this end, 26 barriers were identified from comprehensive literature review and empirical questionnaire survey was conducted with 51 affordable housing experts from various countries around the world. Factor analysis on identified CBs revealed five components: green retrofit-related; land market-related; incentive-related; housing market-related and infrastructural-related barriers. Moreover, rank agreement analysis of the barriers components showed high agreement levels on 'incentive-related barriers' and 'housing market-related barriers' between experts from developing and developed countries. The research findings are relevant to policy-makers and practitioners in adopting tactical measures for worldwide SAH. Besides, the identified CBs serve as recommended set of barriers for further empirical study to unearth local variations and context specific barriers to SAH in most countries.

Keywords: Affordable Housing; Critical Barriers; Sustainable Housing; Affordability

1. Introduction

The good, the bad and the worse of housing! Housing provides an indispensable safety, security and shelter needs. It also guarantees other social and economic growth. Socially, housing plays a monumental role in tackling poverty, promoting social mobility and improving living conditions. For instance, a study in the United States revealed that declining public health was partly linked to increasing problems of inadequate access to affordable housing among potential households (Pollack et al., 2010). Accordingly, adequate housing could prevent extra expenditure by governments and policy-makers in providing health care facilities for diseases such as tuberculosis, meningitis and cholera which are common among slum dwellers (Penrose et al., 2010). Economically, housing could be a significant source of wealth to an individual and to a nation. It could be an asset as well as an economic activity with multiplier effects. Other sectors of an economy such as commerce, manufacturing and finance benefit once the housing sector is booming. Therefore, a booming housing sector reduces unemployment.

However, like any construction project, housing could have negative impacts. Generally, the construction industry is regarded as a resource-intensive business (Joglekar et al. 2018; Chan et al., 2018). About 70% and 25% of cement products and steel products, respectively, are consumed by the construction industry in many countries (Wang and Zhang, 2008). Specifically, the housing sector is the major energy consumer and contributor to the global greenhouse gas emissions. For example, heating and hot water provision among private households in Europe account for 40% of the total energy consumption and 30% greenhouse gas emission (Lechtenböhmer & Schüring, 2011). The resource consumption pattern and the associated emission of greenhouse gases have detrimental effects on the environment, the economy and the society. Left unbridled, the effects could be worse. High concentration of greenhouse gases causes global warming, urban heat islands, floods, degraded quality of air and health challenges (i.e. asthma or cardiovascular diseases).

Reactively, policy-makers have advocated for a global sustainable housing development because of its benefits. International organizations have often intervened in this regard with much focus on affordable housing for low-income earners. Typical of such interventions include the formulation of worldwide housing policies towards improving a broader access. For instance, previously, the World Bank recommended a universal policy of 'the market enabling strategy' to facilitate housing supply in developing countries (Keivani & Werna, 2001). Similarly, the launch of the 'Global Shelter Strategy' by the United Nations General Assembly introduced the enabling strategy into most housing policies (Ram & Needham, 2016). Furthermore, the global pursuit for sustainable housing is evinced in the United Nation (UN) policy goal. Target 11.1 of the Sustainable Development Goal II states: 'By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums' (UN, n.d.).

Moreover, in decision making for affordable housing, most low-income earners consider other influencing factors and criteria beyond price affordability (Adabre and Chan, 2018). This has often resulted in information asymmetry between developers (suppliers) and households (demanders) in the affordable housing market. Concerning information asymmetry, demanders have more information on housing requirements in their scale of preference beyond price while suppliers could narrowly be focusing on price affordability. The ripple effects of information asymmetry are the numerous housing overhangs as recorded in developing and developed countries such as China, Malaysia, Ghana, Nigeria and the United Kingdom (Yuan et al., 2018; Teck-Hong, 2012; Turok, 2016; Mulliner et al., 2013). Eventually, information asymmetry creates a quandary in which there are abundant housing supplies while the need for housing

and housing deficits continue to burgeon. Therefore, the negative effects of housing and the repercussion of information asymmetry buttress the need for housing facilities that are not only affordable but also sustainable.

A rule-of-thumb for affordable housing is that low-income households would spend no more than 30% of their income on housing (Friedman & Rosen, 2018). Such facilities could be sustainable when they are reasonably adequate in standard and location for a lower or middle-income household and do not cost so much that a household is unlikely to be able to meet other basic living costs on a sustainable basis (National Summit on Housing Affordable, 2006). Integrating the two concepts, sustainable affordable housing (SAH) is "housing that meets the needs and demands of the present generation without compromising the ability of future generations to meet their housing needs and demand" (Pullen et al., 2010 p. 13). Households need SAH for health benefits, comfort and economic benefits from energy and water efficient technologies and reduced commuting cost (Sullivan and Ward, 2012; Golubchikov and Badyina, 2012). Through sustainable practices, approximately 80% reduction in energy consumption could be achieved in buildings (Lechtenböhmer & Schüring, 2011). Despite these benefits, the global attainment of sustainable development in affordable housing is still low due to barriers. Therefore, to enhance the implementation of worldwide policies for SAH, it is fundamental to identify critical barriers to SAH from an international perspective.

In the light of the above background, the aim of this study is to investigate the critical barriers that impede sustainable affordable housing from the views of experts around the world. Notwithstanding the policy divergence and institutional arrangement among countries, the research findings from a comparative perspective could have practical implications on policy makers worldwide. The study findings and the suggested policies are integral to policy makers (such World Bank, United Nation) and practitioners who seek appropriate measures to mitigate barriers and thus foster SAH development for a sustainable society. This study adopts factor analysis with Pearson correlation and rank agreement analysis for an objective classification of the barriers and for assessing the level of agreement on the ranks of the barriers.

2. Literature Review

Based on the rule-of-thumb (no more 30% of household income on housing), affordable housing includes social housing, though there are some differences. According to Czischke & van Bortel (2018), rents are mostly related to costs or household income with regard to social housing. However, in terms of affordable housing, rents are mostly derived from, but below, the full-market rent. Thus, social housing accommodates people on very low income and those with special needs. Notwithstanding the differences, the literature review covers both schemes as housing for low-income earners.

Recently, initiatives are employed to make sustainable housing more broadly available for all income groups especially for low-income earners in both developing and developed countries (Sullivan and Ward, 2012). These initiatives are deployed to achieve the various goals of sustainability - social equity, environmental protection and economic development (Adabre and Chan, 2019). However, there are various impediments to the successful implementations of some of the initiatives. In subsequent sections, a literature review is conducted on various goals of sustainability and sustainability adoption barriers. This review culminates into the development of a conceptual framework of barriers to sustainable affordable housing as well as identification of the research knowledge gap.

2.1 Social Sustainability

Social sustainability in affordable housing development can be defined as "development that is compatible with the harmonious evolution of civil society, fostering an environment that encourages social integration, with improvements in the quality of life for all segments of the population" (Polèse and Stren, 2000 p. 15-16). Besides, social sustainability highlights the just distribution and consumption of housing resources (Trudeau, 2018). Bramley et al. (2006) indicated that it involves the overlapping concepts of social capital, social cohesion and social inclusion. Social capital includes the qualities of social organization such as networks, norms and trust which support co-operation for communal benefits. Social capital is essential for meeting the safety needs as well as preference and belonging needs of households (Trudeau, 2018). Concerning social cohesion, it refers to the need for a shared sense of morality and common purpose, social interaction within communities or families, a sense of belonging to a place and social solidarity and reductions in wealth disparities. Social inclusion ensures that individuals, families and neighbours have access to resources for efficient participation in the social, economic and political activities of a community.

The attainment of social sustainability in affordable housing is trammeled by various barriers. For instance, Trudeau (2018) and Nguyen et al. (2013) stated that 'community opposition to affordable housing projects' is one of the main barriers to its realisation. Similarly, in the UK, Sturzaker (2011) asserted that there is high community opposition to social housing. Besides, income segregation among households is a barrier that affects social cohesion and social inclusion (Massey et al., 2009). Furthermore, Bramley et al. (2006) indicated that lack of / inadequate infrastructure development is a noted cause of social exclusion. Moreover, the culture and attitude of a community could negatively affect the attainment of social sustainability (Sullivan and Ward, 2012). For instance, 'negative culture towards mortgage' (Sidawi & Meeran, 2011) and 'high mortgage default rates' (Boamah, 2010) do not broaden and strengthen participation by financial institutions for sustainable housing supply. Similarly, 'poor maintenance culture of existing affordable housing' could affect the quality of life of households and consequently lower one's needs of place belonging. Finally, Sulemana et al. (2019) identified income inequality as one of the fundamental barriers to affordable housing.

2.2 Economic sustainability

Enhancing housing affordability of low-income earners is one of the main objectives of affordable housing (Gan et al., 2017). Economic sustainability of affordable housing involves consideration of the price / rental cost, the cost of transportation and the house operation cost (e.g. energy bills) (Chan and Adabre, 2019). Reduced operation and transportation costs prevent tradeoff in the budget of households in meeting shelter needs to the detriment of attaining other basic needs (e.g. access to quality health care). Ultimately, for economic sustainable housing, households' residential take-up for such houses should be high (Pullen et al., 2010). Furthermore, economic sustainability should take into account developers' needs (Gan et al., 2017). Yet, there are challenges that could inhibit economic sustainability attainment in affordable housing projects.

Zhang et al. (2016) identified inadequate public funding as one of the barriers. In Huang et al. (2015) and Hwang et al. (2017), high cost of the factors of housing production such as high cost of serviced land and high cost of sustainable housing materials, respectively, were stated as the causes of the colossal housing prices. Furthermore, Love et al. (2011) identified inadequate government incentives as one of the main impediments to sustainable development (green building). Obeng-Odoom and Amedzo (2011) pointed out that high inflation rate of construction material and other factors of production was a key barrier to attaining economic sustainability in affordable housing. Moreover, Boamah (2010) stated that 'high interest rates'

and 'tight credit conditions' are some of the challenges that negatively affect the affordable housing market. On rental affordability, Obeng-Odoom (2010) contended that though rent control policies are important to control housing rent escalation, they could create a 'black market' leading to the paradox of higher rents. Similarly, Duvier et al. (2018a) and Duvier et al. (2018b) elaborated on how quality data could improve the quality of housing services offered to low-income earners. However, rent control policy was identified as one of the barriers that could lead to loss of revenue and subsequently affect investment on quality data among social housing owners (Duvier et al., 2018b).

2.3 Environmental sustainability

Environmental sustainability ensures land use efficiency, energy efficiency, effective utilization of resources and reduction of greenhouse gas emissions from housing facilities (Chan et al., 2017; Gan et al., 2017). Nevertheless, its attainment is beset with various barriers. Obeng- Odoom (2010) indicated that inadequate access to secure land is among the barriers. Furthermore, zoning restrictions on land for affordable housing projects (such as restriction on multifamily housing and compact development) and low-rise affordable housing do not ensure efficient utilization of land for sustainable affordable housing (Mondal & Das, 2018). Moreover, Winston (2010) stated that the sitting and construction of new affordable housing units in outskirts of towns and cities encourages sprawl development which leads to a faster use-up of land. Consequently, longer commuting has negative economic implication on household income and could also lead to the emission of more greenhouse gases.

2.4 Institutional sustainability

It is predominantly argued that any analysis of sustainability issues needs to be connected to broader themes such as social, economic and environmental sustainability. However, by solely focusing on these three themes, the institutional / regulatory structure that is fundamental for the attainment of the three themes is often neglected. Therefore, the development of SAH requires a more holistic understanding and convergent policy approaches along social, economic, environmental and institutional / regulatory goals (Sullivan and Ward, 2012). Institutional / regulatory sustainability entails policy actions that ensure sensitive planning controls and zoning that will encourage commitment to and involvement in sustainable housing practices. Thus, while there are barriers related to social, economic and environment sustainability, these barriers could result from an inefficient institutional / regulatory structure (Sullivan and Ward, 2012).

Upon reviewing the literature, some institutional / regulatory barriers to SAH were identified. According to Alam et al. (2019), lengthy planning and approval process is among the barriers to sustainable construction practices. Besides, Winston (2010) identified inadequate skilled labor as one of the barriers that hinder sustainable housing development. In Agyemang and Morrison (2018), 'weak enforcement of planning system control on land development'; 'inadequate affordable housing policy / guidelines' and 'inadequate autonomy of local authorities due to high central government interference or conflicting policies between local authorities and central government on planning' were identified as barriers that can affect the operation of an institution for affordable housing supply. Similarly, Czischke & van Bortel (2018) and Bardhan et al. (2018) identified 'inadequate policy / guidelines' as a barrier to affordable housing or slum redevelopment for sustainable housing to low-income earners. According to Boamah (2010), 'inadequate mortgage institution' is one of the main barriers that affect financing of housing projects. Twumasi-Ampofo et al. (2014) and Gooding (2016) identified 'abandoned management of public housing facilities or projects by government' as a barrier that hinders housing development.

Table 1: List of Potential Barriers to Sustainable Affordable Housing with References and Country/ Economy of Study

Code	Barriers	References*	Countries / Jurisdictions
B01	Inadequate affordable housing policy / guidelines	[1]; [2]; [46]; [47]; [50]	Ghana; Dublin; Malaysia; United Kingdom; India
B02	Inadequate public funding	[3]; [4]; [5]; [47];	China; Australia; United Kingdom;
B03	Income inequality	[6]; [7]; [8]	Most Sub-Saharan African Countries; China;
B04	High cost of serviced land	[9]; [10]; [11]; [36]	Ghana; China; Hong Kong; Nigeria
B05	Income segregation	[12]; [13]; [32];	United States of America; Australia; South African
B06	Inadequate infrastructure development / supply	[14]; [15]; [32]; [51]; [56]	Ghana; South Africa; India
B07	Zoning restrictions on land for affordable housing projects	[17]; [18]	United States of America;
B08	Poor maintenance culture / inadequate retrofitting of existing housing facilities	[19]; [20]; [21]; [22]	Russia; Italy; Hong Kong; Australia;
B09	Delays in government approval process	[23]; [24]; [22]; [36]; [51]; [52]	Hong Kong; Australia; Ghana; Nigeria; India; Singapore
B10	Tight credit conditions	[25]; [21]; [22]	United Kingdom; Hong Kong; Australia;
B11	Inadequate access to land for housing	[2]; [26]; [36]; [49]; [51]; [53]; [55];	Ghana; Hong Kong; Nigeria; China; India; Mauritius; Latin American Countries
B12	High cost of sustainable building materials / technologies	[27]; [28]; [29]; [30]	Canada; United States of America; Australia; Ghana; Malaysia; Hong Kong; Singapore
B13	Lack of policies on land use planning system for housing supply	[2] ; [59]	Most Sub-Saharan African countries; Dubai
B14	Abandoned management of public housing facilities / projects by government	[31]; [32]; [53]	Ghana; Mauritius
B15	Community opposition to affordable housing projects	[33]; [34]; [35]; [53]; [58]	United States of America; Dublin; Mauritius; UK
B16	High approval cost due to high taxes and fees on developers	[36]; [51]	Nigeria; India
B17	Inadequate mortgage / financing institutions	[36]; [37]; [38]; [41]; [51]; [54]	Nigeria; Ghana; India; Most Latin American countries
B18	High interest rates	[25]; [36]; [39]	United Kingdom; Nigeria; Ghana
B19	Inadequate incentive for private investors	[40]; [41]; [45]; [47]; [48];	Ghana; United States of America; Canada; Australia; UK; Singapore;
B20	High inflation rate	[36]; [42]; [43]	Ghana; Nigeria
B21	Conflicting policies between local authorities and central government on planning	[2]; [22]; [56]	Ghana; Australia; New Zealand
B22	Rent control policies	[26] ; [44]	Ghana; United Kingdom
B23	Limited private partnership	[36]; [45]	Nigeria; Ghana
B24	Shortage of skilled labour	[15]; [22]; [23]	Dublin; Australia; Hong Kong
B25	High mortgage default rates by client	[37]	Ghana
B26	Negative culture towards mortgage	[39]	Kingdom of Saudi Arabia

*[1] Czischke & van Bortel (2018); [2] Agyemang and Morrison (2018); [3] Liu et al. (2015); [4] Zhang et al. (2016); [5] Hu & Qian (2017); [6] Chen et al. (2016); [7] Liddle (2017); [8] Sulemana et al. (2019); [9] Arku (2009); [10] Wen and Goodman (2013); [11] Huang et al. (2015); [12] Massey et al. (2009); [13] Randolph & Tice (2014); [14] Power (2008); [15] Winston (2010); [16] Oyebanji et al. (2017); [17] Hui & Soo (2002); [18] Mondal & Das (2018); [19] Paiho et al. (2015); [20] Gianfrate et al. (2017); [21] Tan et al. (2018); [22] Alam et al. (2019); [23] Lam et al. (2009); [24] Taylor (2011); [25] McKee (2012); [26] Obeng-Odoom (2010); [27] Ibem (2011); [28] Ahn et al. (2013); [29] Yang & Yang (2015); [30] Chan et al. (2018); [31] Twumasi-Ampofo et al. (2014); [32] Muringathuparambil et al. (2017); [33] Tighe (2010); [34] Winston (2010); [35] Trudeau (2018); [36] Makinde (2014); [37] Boamah (2010); [38] Bangdome-Dery et al. (2014); [39] Sidawi & Meeran (2011); [40] Susilawati and Armitage (2005); [41] Chan et al. (2018); [42] Marks & Sedgwick (2008); [43] Sulemana et al. (2019);

[44] Duvier et al. (2018b); [45] Kwofie et al. (2016); [46] Winston (2010); [47] Sourani & Sohail (2011); [48] Yin et al.(2018); [49] Hu and Qian (2017); [50] Bardhan et al. (2018); [51] Ram & Needham (2016); [52] Hwang & Ng (2013); [53] Gooding (2016); [54] Blanco et al.(2016); [55] Echeverry et al. (2007); [56] Murphy (2016); [57] Daniel & Hunt (2014).
[58] Sturzaker (2011); [59] Alawadi et al. (2018)

Table 1 shows the list of barriers identified from the literature review. In summary, the systematic literature review culminated into the development of a conceptual framework of barriers to sustainable affordable housing (as shown in Fig. 1). This framework shows that there exist relationships or associations among the barriers in each group. Thus, these barriers do not exist in isolation but could have effects on or are correlated with one another. The hypothetical relationships among the barriers are represented by the double-arrow curved lines that connect one group of barriers to another group of barriers.

From the literature review, it was found that prior studies were focused mainly on country-specific programs for sustainable housing or sustainable affordable housing. Besides, most of these studies concentrated on residential facilities of high-income earners while studies on sustainability attainment in affordable housing are insufficient. The notional reason is that sustainability and affordability are two diametric terms – one cannot be achieved without compromising on the other. Consequently, there is dearth empirical study from an international perspective on critical barriers for the gap between sustainable housing and affordable housing. Accordingly, an empirical investigation on these barriers from an international perspective could be germane considering that such study could benefit organizations such as the World Bank and the United Nation (UN) that could incorporate the findings into their international programs. Another impetus for this study is based on the fact that the largest area of residential development in most developing and developed countries are to be found in low-income settlements (Obeng-Odoom, 2010; Sullivan and Ward, 2012). Therefore, if significant achievement on sustainable housing is to be made in both developing and developed countries, it is vital to figure out strategies of making low-income residential facilities sustainable. This could be achieved by first identifying the critical barriers to sustainable affordable housing.

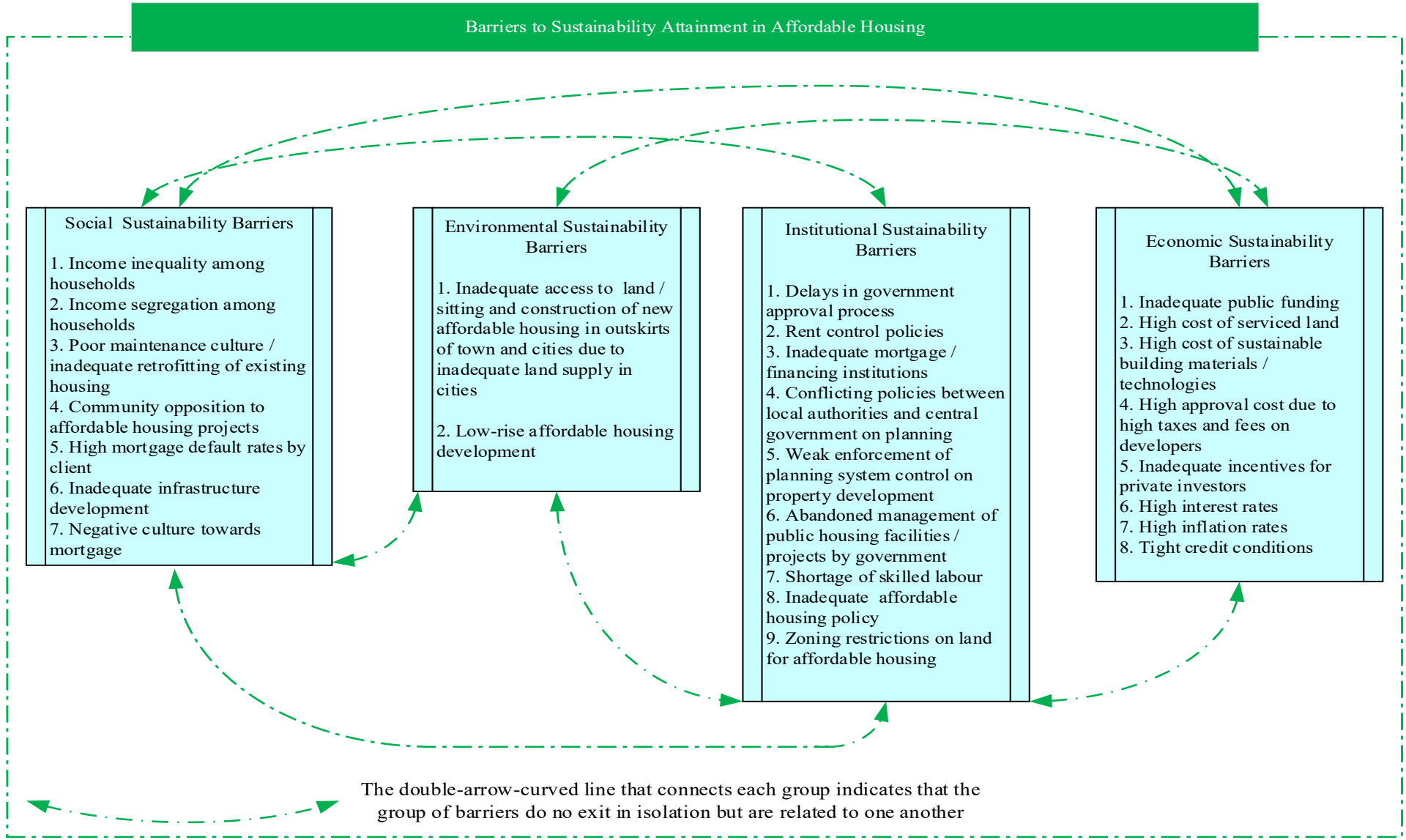

Fig. 1: A Conceptual Framework on Barriers to Sustainability Attainment in Affordable Housing

3. Research Methodology

3.1 Research Process

A six-stage research process was employed for this study (shown in Fig.2). The first stage involves a comprehensive review of the literature as detailed in section 2 of the study. This led to the problem identification, which forms stage 2 and detailed in section 1. Then, in stage 3, the barriers to SAH were identified from the literature review. Subsequently, a framework was developed from the list of barriers. Stage 4 entails questionnaire design from the list of barriers in Table 1. This stage also includes the techniques deployed for data analysis (i.e. factor analysis (FA) with Pearson correlation (PC) and rank agreement analysis (RAA)). The results of the analysis and suggested policies are reported in stage 5. Finally, stage 6 of the study contains the conclusions with recommendation. A summary of the various stages is shown in Fig. 2.

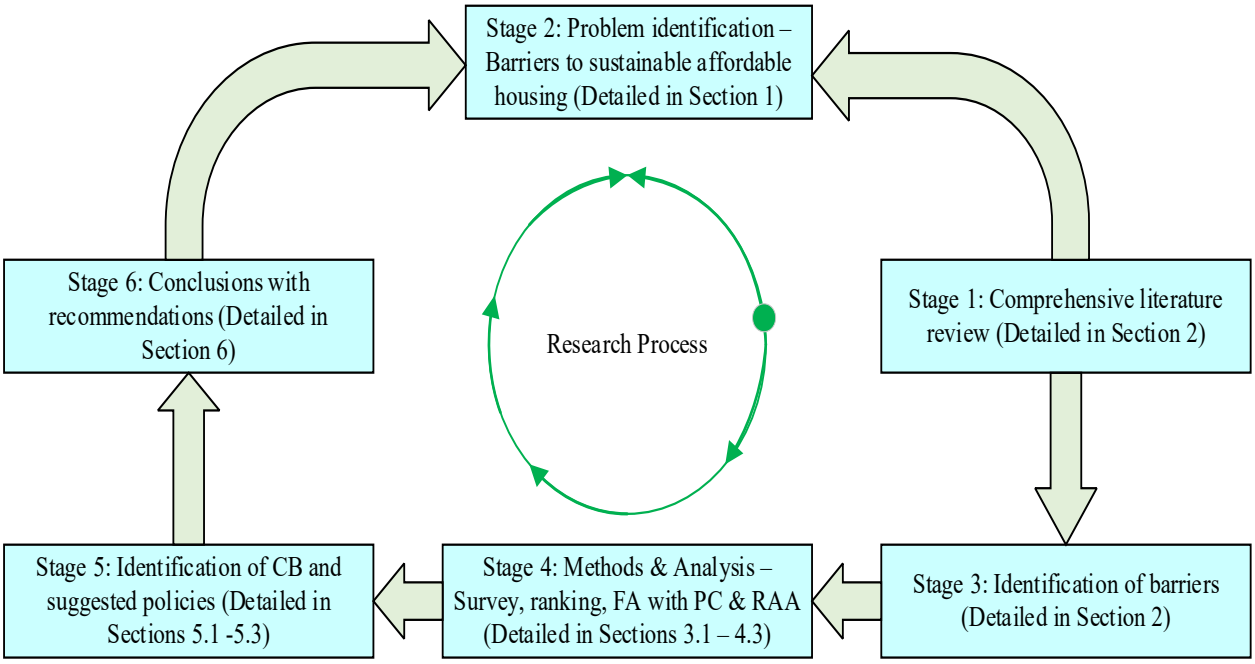

Fig. 2: Research Process for the Study

3.2 Identification of Potential Barriers to SAH

To identify the barriers to SAH, a comprehensive literature review was first conducted. The sources for this review are mainly secondary sources such as academic journals, government reports and technical literature on barriers to sustainable affordable housing. This compendium of materials was systematically reviewed for the identification of barriers to sustainable affordable housing in both developing and developed countries. Consequently, a set of 26 potential barriers was identified with their respective references and the countries / economy that the barriers were identified from (as shown in Table 1).

3.3 Pilot Study and Questionnaire Design

This study uses only questionnaire survey for data collection to achieve objective and quantifiable results. Prior to the actual questionnaire administration, the first draft of the questionnaire was piloted among two professors and two post-doctoral research associates who are experts in both sustainable housing and affordable housing. Essentially, the pilot study was conducted to eliminate ambiguities in the questions. Besides, the appropriateness of the technical terms and comprehensiveness of the list of barriers were checked. The questionnaire was finalized after receiving and implementing constructive comments from the pilot study participants. The final questionnaire consists of the 26 identified set of barriers (as shown in Table 1). The questionnaire

has two main sections. The first section contains questions that solicit for the demographic data of potential respondents while the second section includes questions on critical success criteria, critical success factors, barriers and risks to sustainable affordable housing. This paper reports the findings on the barriers. Potential respondents were requested to indicate their level of agreement on a 5-point Likert scale from 1 (Strongly disagree) to 5 (Strongly agree) with regard to the criticality of the barriers to SAH.

3.4 Data Collection

The questionnaire was administered through emails to affordable housing experts who are also knowledgeable in sustainable housing. The experts were mainly identified through journal publication and databases (membership directories e.g. Housing and Development Board and Hong Kong Housing Authority). Experts in both sustainable and affordable housing studies were identified based on the titles and content of their publications. Terms such as "sustainable" or "adequate" and "affordable" or "low-income" housing were identified from the titles or content of their publications. Emails with an attached Microsoft Word document of the questionnaire were then sent to experts. Additionally, a web link generated through Survey Monkey was included in the emails to provide an option for online response to the questionnaire. To enhance higher participation in the survey, potential respondents were invited to forward the questionnaire and web link to other experts whom they deemed appropriate, based on their industrial or academic experience, to provide the information as requested in the questionnaire. Approximately 200 questionnaires were administered.

A three-month period was allowed for data collection. Due to difficulties in soliciting the views of international experts (Osei-Kyei and Chan, 2017), 51 valid responses were received. The responses were received from experts from 18 different countries including developed countries (35 responses) and developing countries (16 responses). These two broad categories of countries are further classified into continents (as shown in Table 2). A challenge in this approach to questionnaire administration is the accurate estimation of the response rate since some of the questionnaires were possibly forwarded to other potential participants by some of the respondents. However, it is generally suggested and agreed among scholars that a minimum sample size of 30 could be used for analysis (Ott and Longnecker, 2015; Chan et al., 2017). Therefore, the 51 number of responses could be considered relatively high for the parametric analysis employed in this study. Yet, with a larger sample size, future study could use other robust analysis or test of significant difference between mean scores of the various barriers.

3.5 Respondents' Profile

Preliminary analysis of the data was conducted to determine the respondents' background information. This form of analysis is important to evaluate the reliability and credibility of the data (Chan et al., 2017). The preliminary analysis revealed that most of the respondents are professionals in housing-related disciplines. Constituents of the professionals include academics / researchers (55%), architects (18%), quantity surveyors (6%), project / construction managers (4%), engineers and other related disciplines (17%). Moreover, most of the respondents had extensive industrial and / or research experience in affordable housing projects. More than 60% respondents had above 10 years of working experience in at least one of the following housing types – social housing (40%), public housing (38%) and / or cooperative housing (15%).

Table 2: Respondents' Profession, Country, Years of Experience and Housing Type Handled

Profession, Country & Continent of respondent, Years of experience and housing type handled	Number of Responses	Percent	Cumulative Percent
Profession			

Academic / researcher	28	55	55
Architect	9	18	73
Quantity Surveyor	3	6	79
Project / Construction manager	2	4	83
Engineer	1	2	85
Others	8	15	100
Country of Origin of Respondents			
Developing Countries	16	31	31
Developed Countries	35	69	100
Continents of Countries			
North America	15	29	29
Asia	15	29	58
Europe	9	18	76
Oceania	8	16	92
Africa	3	6	98
South America	1	2	100
Years of Experience			
≤ 10 years	20	39	39
11-20 years	10	20	59
> 20 years	21	41	100
Housing Type Handled			
Social housing	37	40	40
Public housing	35	38	78
Cooperative housing	14	15	93
Others	6	7	100

4 Data Analysis

The Statistical Package for Social Science (SPSS version 20) was employed for data analysis. The analysis techniques include mean score, relative analysis of criticalities (normalization), Cronbach's alpha coefficient test, FA with PC and rank agreement analysis. In determining the relative criticalities of the barriers, the mean value was calculated for each barrier. Then, based on the calculated mean values, the normalization scores were computed for the barriers for both responses from developed and developing countries. Using the normalized scores, the criticality of a barrier was determined. Only barriers with normalized scores ≥ 0.5 were deemed critical barriers (Osei-Kyei and Chan, 2017). If two or more barriers have the same normalised scores, their standard deviations (SD) are used to rank them. Barriers with low standard deviations are ranked higher.

4.1 Cronbach's Alpha Coefficient

The Cronbach's Alpha (CA) is one of the often-used techniques for assessing the reliability of a scale. It measures the internal consistency among a list of items in a questionnaire to determine the reliability of the questionnaire (Chan et al., 2018). Fornell and Larcker (1981) provided ranges of values for an acceptable CA. Values ranging from 0.7 to 0.8 are acceptable while values above 0.8 are excellent. Therefore, with an estimated CA value of 0.82, it shows that there is an excellent internal consistency among the barriers. Consequently, FA was employed to identify the underlying components of barriers.

4.2 Factor Analysis

Factor analysis (FA) is data reduction technique that is used for identifying a comparatively small number of factors (Adabre and Chan, 2019). It reduces and regroups large number of variables into smaller interrelated and critical groups of variables based on the scores of respondents (Li et al., 2011). These groups can be used to describe relationships among a list of many related variables (Pallant, 2010). Essentially, FA was employed in this study to provide an objective and

smaller interrelated classifications of barriers for the rank agreement analysis. Thus, through FA analysis, the four broad groups of barriers conceptualised from the literature review could be categorized into manageable interrelated groups. Prior to conducting FA, the appropriateness of the data was assessed. So, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were employed to examine the data appropriateness for FA. The KMO measures the sampling adequacy that represents the ratio of the squared correlation between the variables to the squared partial correlation between the variables. It ranges from 0 to 1, with 0.5 deemed appropriate for FA. The Bartlett's test of sphericity checks the presence of correlation among variables. It tests if the correlation matrix is an identity matrix, which would be an indication that the potential barriers are unrelated and therefore are not appropriate for FA. If the value for the Bartlett's test is large with an associated high level of significance (less than 0.05), then the correlation matrix of the population is not an identity matrix and therefore FA would be suitable (Pallant, 2010).

4.3 Rank Agreement Analysis on the Barriers

The results of the factor analysis were subsequently analyzed using rank agreement analysis. Similar analysis was employed in Okpala and Aniekwu (1988) to compare the views and consensus of three groups of respondents on the ranking of factors which cause high cost of construction in Nigeria. In this study, rank agreement analysis was conducted to determine the level of consensus between respondents from developing countries and developed countries on the ranking of the critical barriers. This is worthwhile in order to find out if there are groups of barriers which impede sustainable affordable housing in both developing and developed countries. The rank agreement analysis is a quantitative method that uses the "rank agreement factor" (RAF) (Zhang, 2005). The "RAF shows the average absolute difference in the ranking of factors between two groups" (Zhang, 2005 p. 11). Given the two groups of respondents – those from developing countries (Group 1) and those from developed countries (Group 2) – let the rank of a barrier within a component in group one be R_{i1} while the rank of the same barrier within the component of group two be R_{i2}, N is the number of barriers in each component and the number of groups (which in this case is two) is represented by k. Then, ($R_{i1} - R_{i2}$) of a barrier is the difference in ranks that are obtained from the two groups – developing and developed countries. R_i of a barrier is the sum of the ranks of the barrier from developing and developed countries. Using the following equations, as provided in Okpala and Aniekwu (1988), Zhang (2005) and Adabre and Chan (2019), the RAF could be determined as follows:

$$R_i = \sum_{i=1}^{N} (R_{ij}) \quad \text{equation (1)}$$

R_{ij} is the sum of the ranks given to a particular critical barrier by the two different groups

The mean value of the total ranks (R_{j2}) is given by

$$R_{j2} = \frac{1}{N} \sum_{i=1}^{N} (R_{ij}) \quad \text{equation (2)}$$

The RAF is defined as

$$RAF = \frac{\sum_{i=1}^{N} |R_{i1} - R_{i2}|}{N} \quad \text{equation (3)}$$

The maximum rank agreement factor (RAF_{max}) is given by

$$RAF_{max} = \frac{\sum_{i=1}^{N} |R_i - R_{j2}|}{N} \quad \text{equation (4)}$$

The percentage disagreement (PD) is given by

$$PD = \frac{\sum_{i=1}^{N} |R_{i1} - R_{i2}|}{\sum_{i=1}^{N} |R_i - R_{j2}|} \times 100 \quad \text{equation (5)}$$

The percentage agreement (PA) is given by

$$PA = 100 - PD \quad \text{.....equation (6)}$$

5. Results of the Survey

5.1 Ranking Analysis Results

The means, standard deviations (SD) and normalization scores for all the 26 barriers were computed for responses from both developing and developed countries (see, Table 3). Using the normalized scores, 18 barriers were identified as critical (barriers with normalization scores ≥ 0.50) from experts of developing countries. The top five critical barriers to sustainable affordable housing according to the normalized scores include: B04 – high cost of serviced land – was ranked first (score = 1.00). The second critical barrier is B06 – inadequate infrastructure development (score = 0.95) – followed by both B05 – income segregation (score = 0.90) and B18 – high interest rates (score = 0.90) while B13 – lack of policies / weak enforcement of policies on land use planning system for housing supply – ranked as the fifth critical barrier (score = 0.84). However, from the views of experts in developed countries, 15 critical barriers were identified. The top five critical barriers include: B01 – inadequate affordable housing policy – was ranked as the most critical barrier (score = 1.00). The second most critical barrier was B02 – inadequate public funding (mean = 0.95) followed by B03 – income inequality – as third (mean = 0.88) and then B05 – income segregation – as fourth (score = 0.85). Finally, B04 – high cost of serviced land – was ranked as the fifth critical barrier (mean = 0.84) (in Table 3).

Table 3: Ranking of Potential Critical Barriers to SAH

Code	Developing Countries				Developed Countries			
	Mean	SD	Normalization	Rank	Mean	SD	Normalization	Rank
B01	4.286	0.611	0.79[b]	12	4.333	0.802	1.00[b]	1
B02	4.357	0.929	0.84[b]	9	4.233	0.817	0.95[b]	2
B03	4.357	1.008	0.84[b]	10	4.100	0.923	0.88[b]	3
B04	4.571	0.851	1.00[b]	1	4.000	0.900	0.84[b]	5
B05	4.429	0.756	0.90[b]	3	4.033	1.159	0.85[b]	4
B06	4.500	0.760	0.95[b]	2	3.667	0.922	0.67[b]	8
B07	3.786	0.975	0.42	19	3.900	0.960	0.79[b]	6
B08	4.143	1.099	0.68[b]	15	3.548	1.091	0.61[b]	10
B09	4.143	0.893	0.68[b]	14	3.484	1.061	0.58[b]	13
B10	4.357	0.745	0.84[b]	6	3.533	0.973	0.61[b]	10
B11	4.071	0.917	0.63[b]	16	3.516	0.926	0.60[b]	12
B12	4.214	0.864	0.74[b]	13	3.567	0.898	0.62[b]	9
B13	4.357	0.633	0.84[b]	5	3.419	1.119	0.55[b]	15
B14	4.357	0.842	0.84[b]	8	3.452	1.207	0.57[b]	14
B15	3.357	1.447	0.11	25	3.800	1.157	0.74[b]	7
B16	4.357	0.842	0.84[b]	6	3.000	0.910	0.34	17
B17	4.214	0.802	0.74[b]	11	2.900	1.062	0.30	18
B18	4.429	0.756	0.90[b]	4	2.733	1.048	0.21	22
B19	4.000	0.961	0.58[b]	18	2.839	1.128	0.27	19
B20	4.000	0.679	0.58[b]	17	2.655	0.857	0.17	25
B21	3.786	0.975	0.42	19	2.742	1.210	0.22	20
B22	3.714	0.994	0.37	21	2.613	0.989	0.15	24
B23	3.429	1.222	0.16	24	2.690	1.004	0.19	23
B24	3.286	0.914	0.05	26	2.742	1.154	0.22	21
B25	3.500	1.224	0.21	23	2.567	1.000	0.13	26
B26	3.214	0.893	0.00	27	2.300	0.837	0.00	27

Note: SD = Standard deviation
Normalized score = (mean – minimum mean) / (maximum mean – minimum mean)
[b] The normalized value indicates that the barrier factor is critical (normalized ≥ 0.50)

5.2 Results of Factor Analysis (FA) with Pearson Correlation (PC)

Only barriers that were deemed critical from the perspective of developing or developed countries were considered for subsequent analysis. In all, 20 critical barriers were considered for FA and PC. PC was conducted for better interpretation of the results of the FA and to determine the associations among the barriers as postulated in the literature (shown in Fig. 1). Table 4 shows the correlations among the barriers. For FA, the KMO and Bartlett's test were conducted. The KMO obtained is 0.527. This value is acceptable since it satisfies the 0.50 threshold (Chan et al., 2018). The value of Bartlett's test of sphericity was large (600.551) with a high level of significance (0.000). Thus, the results of the KMO and the Bartlett's test give credence of the suitability of the data for FA. Consequently, the principal component analysis was selected with further selection of the varimax rotation to identify the underlying groups of barriers. Table 5 is a summary of the FA results with only 19 barriers successfully loaded (the loading of these barriers ≥ 0.50). Five underlying components were extracted, which explain 64.989% of variance. The variance compares approvingly with 62.82% of variance in a recent study (Chan et al., 2018). These five components explain the highest percentage (> 50) of variance. Therefore, a model with these five components can be used to satisfactorily represent the data from developing and developed countries. The components were named based on a common theme of their underlying barriers.

Table 4: Pearson Correlation (PC) Matrix of Critical Barriers

CODE		B01	B02	B03	B04	B05	B06	B07	B08	B09	B10	B11	B12	B13	B14	B15	B16	B18	B19	B20
B01	r	1.000																		
B02	r	.185	1.000																	
B03	r	.413**	.207	1.000																
B04	r	.223	.086	.160	1.000															
B05	r	.122	.086	.237	.044	1.000														
B06	r	.274	.013	.061	.263	.337*	1.000													
B07	r	.000	-.028	.243	.193	.141	.106	1.000												
B08	r	.205	.061	.331*	.193	.608**	.523**	.185	1.000											
B09	r	.241	.203	.296*	.015	-.007	-.168	.129	.169	1.000										
B10	r	.053	.215	.080	.231	.250	.305*	-.001	.385**	.141	1.000									
B11	r	.293*	.193	.032	.133	-.033	.098	.160	-.012	.609**	.329*	1.000								
B12	r	-.060	.218	-.210	-.059	-.107	-.151	.247	-.181	.398**	.111	.322*	1.000							
B13	r	.267	.029	.237	.293*	.390**	.502**	-.078	.400**	.131	.391**	.069	.159	1.000						
B14	r	.260	.214	.173	.104	.211	.333**	-.031	.422**	.185	.559**	.292*	.161	.500**	1.000					
B15	r	.349*	.123	.481**	.076	.007	-.014	.528**	.194	.289	.018	.119	.033	-.071	.103	1.000				
B16	r	-.109	.093	-.010	.095	.287	.592**	.242	.161	.256	.160	.078	.417**	.245	.152	-.173	1.000			
B18	r	-.078	-.031	-.060	.345*	.235	.503**	-.076	.303*	.191	.594**	.259	.230	.484**	.284	-.307*	.469**	1.000		
B19	r	-.025	-.106	.050	.270	-.090	.173	.048	.096	.522**	.235	.453**	.450**	.262	.100	-.105	.223	.363*	1.000	
B20	r	-.084	-.021	-.032	.228	.127	.358*	-.228	.235	.257	.492**	.242	.221	.514**	.420**	-.378**	.442**	.789**	.451**	1.000

r =Value for Pearson correlation.
p= Value of significance
*Correlation is significant at 0.05 level (2-tailed)
**Correlation is significant at 0.01 level (2-tailed)

(**B01**= Inadequate affordable housing policy / guidelines; **B02** = Inadequate public funding; **B03** = Income inequality; **B04** = High cost of serviced land; **B05** = Income segregation; **B06** = Inadequate infrastructure development; **B07** = Zoning restrictions on land for affordable housing projects; **B08** = Poor maintenance culture / inadequate retrofitting of existing housing facilities; **B09** = Delays in government approval process; **B10** = Tight credit conditions; **B11**= Inadequate access to land for housing; **B12** = High cost of sustainable building materials / technologies; **B13** = Lack of policies / weak enforcement of policies on land use planning system for housing supply; **B14** = Abandoned management of public housing facilities / projects by government; **B15** = Community opposition to affordable housing projects; **B16** = High approval cost due to high taxes and fees on developers; **B18** = High interest rates; **B19** = Inadequate incentive for private investors; **B20** = High inflation rate**)**

206 **Table 5:** Rotated Component Matrix

Codes	Barriers to Sustainable Affordable Housing	Components				
		1	2	3	4	5
Component 1	**Green retrofit -related Barriers**					
B14	Abandoned management of public housing facilities / projects by government	0.796	–	–	–	–
B10	Tight credit conditions	0.781	–	–	–	–
B08	Poor maintenance culture / inadequate retrofitting of housing facilities	0.639	–	–	–	–
B05	Income segregation	0.522	–	–	–	–
Component 2	**Land market-related Barriers**					
B13	Lack of policies / weak enforcement of policies on land use planning system for housing supply	–	0.707	–	–	–
B04	High cost of serviced land	–	0.636	–	–	–
B18	High interest rate	–	0.573	–	–	–
B20	High inflation rate	–	0.554	–	–	–
Component 3	**Incentive-related Barriers**					
B12	High cost of sustainable building materials / technologies	–	–	0.780	–	–
B09	Delays in government approval process	–	–	0.749	–	–
B11	Inadequate access to land	–	–	0.709	–	–
B19	Inadequate incentives for private investors	–	–	0.635	–	–
Component 4	**Housing market-related Barriers**					
B15	Community opposition to affordable housing projects	–	–	–	0.802	–
B03	Income inequality	–	–	–	0.716	–
B01	Inadequate affordable housing policy / guidelines	–	–	–	-0.555	–
Component 5	**Infrastructural-related Barriers**					
B07	Zoning restrictions on land for affordable housing projects	–	–	–	–	0.758
B16	High approval cost due to high taxes and fees on developers	–	–	–	–	0.736
B06	Inadequate infrastructural development	–	–	–	–	0.539
B02	Inadequate public funding	–	–	–	–	-0.779
Eigenvalue		7.172	3.049	2.444	1.632	1.299
Variance (%)		29.884	12.706	10.185	6.802	5.413
Cumulative variance (%)		29.884	42.589	52.775	59.576	64.989

207 **Extraction method**: Principal Component;
208 **Analysis Rotation method**: Varimax with Kaiser Normalization

5.2.1 Results and Discussion of Principal Component Analysis

5.2.1.1 Component 1: Green retrofit-related Barriers

The underlying barriers in this component emphasize the challenges associated with retrofitting or maintenance of affordable housing facilities. Accordingly, this component is named 'green retrofit-related barriers'; it is the most dominant among the five components and explains the highest level of variance (29.9%). The constituents of this component consist of four barriers. These barriers together with their loadings include: 'abandoned management of public housing facilities / projects by government' (79.6%); 'tight credit condition' (78.1%); 'poor maintenance culture / inadequate retrofitting of existing housing facilities' (63.9%) and 'income segregation' (52.2%) (see Table 5 for variance and loading values).

The correlation matrix (in Table 4) shows some significant relationships / associations among some of the critical barriers as postulated in Fig 1. For instance, there are significant correlations between 'abandoned management of public housing facilities / projects by governments' (B14, identified in Fig. 1 as an institutional sustainability barrier) and 'tight credit conditions' (an economic sustainability barrier) ($r= 0.559$, $p =0.01$); between 'abandoned management of public housing facilities / projects by governments' (B14, an institutional sustainability barrier) and 'poor maintenance culture / inadequate retrofitting of housing facilities' (B08, a social sustainability barrier) ($r= 0.422$, $p =0.01$); between 'tight credit conditions' (B10, an economic sustainability barrier) and 'poor maintenance culture / inadequate retrofitting of housing facilities' (B08, a social sustainability barrier) ($r= 0.385$, $p =0.01$); and finally between 'poor maintenance culture / inadequate retrofitting of housing facilities' (B08) and 'income segregation' (B05) ($r = 0.608$, $p=0.01$), which were both identified in Fig. 1 from the literature view as social sustainability barriers.

There is an increasing trend of the proportion of aged residential buildings to the total number of buildings as observed in most countries (Tan et al., 2018; Power, 2008). Consequently, debates abound on whether to demolish or refurbish older housing facilities in order to achieve reduction in greenhouse gas emission as well as reduce energy consumption in homes. Power (2008) reckoned that refurbishing older housing facilities to high environmental standards is more feasible in achieving the stated goals in addition to a significant carbon reduction. For instance, an estimated 80% cut in energy used has been achieved in renovated homes in Germany (Power, 2008). Similarly, in Italy, the maintenance of low energy houses contributed to a saving of 26% - 35% residential energy consumptions (Blengini and Carlo, 2010). Moreover, refurbishment encourages façade retention, encourages neighborhood renewal, generates more employment opportunities than new housing construction and are socially more satisfactory with less environmental impact and reduction in fuel poverty.

Therefore, most existing affordable housing facilities can be made sustainable through retrofit or green retrofit (Tan et al., 2018; Curado & de Freitas, 2019; Casquero-Modrego & Goñi-Modrego, 2019). Retrofit is the replacement of elements or components of a building. In a broader perspective, the U.S. Green Building Council (USGBC) defined green retrofit as "any kind of upgrade at an existing building that is wholly or partially occupied to improve energy and environmental performance, reduce water use and improve comfort and quality of the space in terms of natural light, air quality and noise – all done in a way that it is financially beneficial to the owner." Green retrofit of aged affordable housing facilities could offer an alternative measure to reduce household energy consumption and greenhouse gas emissions (Tan et al., 2018). Besides, since retrofitted buildings provide more comfort to residents, they

enhance social sustainability in housing. Thus, it can improve environmental, social and economic sustainability of aged affordable housing facilities.

Yet, the rate of retrofit to upgrade existing affordable housing to sustainability standards is low (Chiang et al., 2015; Tan et al., 2018). Green retrofit implementation is plagued with some barriers, namely, 'abandoned management of public housing facilities / projects by government', 'tight credit conditions' and 'poor maintenance culture / inadequate retrofitting of housing facilities'. High upfront cost of retrofitting, limited budget and high fiscal burden on government have often resulted in the abandonment of public affordable housing or poor maintenance of aged affordable housing facilities (Liang et al., 2016). Liu et al. (2015) noted that public involvement in energy saving retrofitting of housing facilities is often neglected. Consequently, poor living environments are often associated with older buildings that exist without proper management and maintenance (Chiang et al., 2015). Furthermore, poor maintenance and abandonment of affordable housing facilities could lead to value decline of adjacent buildings in the neighborhood. Therefore, there can be a domino effect on the type of households who leave the neighborhood (increase in high-income household mobility rate) and low-income households who may have no option of affording other housing facilities except to stay in that neighborhood. This could eventually cause income segregation within a neighborhood.

Strategies could be implemented to ensure successful green retrofitting of aged affordable housing facilities. First, information dissemination programs and knowledge transfers from material suppliers and energy advisors could be initiated to inform households on the technologies and benefits of green retrofit. Then, directive-based policies should be implemented (Tan et al., 2018). This should include action plan and guidelines for green retrofit. Besides, regulation-based policies should be established. Such policies could make green retrofit mandatory for aged housing facilities that are not sustainable. Since succeeding governments could abandon management of housing facilities (Twumasi-Ampofo et al., 2014), an established routine maintenance of low-cost housing facilities could be made mandatory and monitored. This could be used to evaluate the performance of governments in meeting sustainable development goals in affordable housing facilities / low-cost housing. This would help accelerate the retrofitting of unsustainable housing facilities built in the past (Weherill et al., 2014).

Since 'tight credit condition' was identified as one of the critical barriers with a significant relationship with 'poor maintenance culture / inadequate retrofitting of housing facilities', the next form of required policy could be financial enabling policy. Some of which include low-interest or interest-free loans and financial subsidies for green retrofit. Subsidized upgrading of unsustainable and derelict affordable housing facilities could improve the sustainability of such housing facilities. Low-interest loans could be used to incentivize low-income households and real estate developers for housing energy renovation. For instance, in Singapore, the Building Retrofit Energy Efficiency Finance (BREEF) scheme is an incentive scheme that provides financing to building owners for energy retrofit (Tan et al., 2018). Through the provision of financial incentives, retrofit technologies could be adopted for sustainable affordable housing. Some of these technologies include grey water collection and re-use, daylight sensors, green material, building-integrated photovoltaics and green roofs / walls, window frames with thermal breaks (Wilkinson and Feitosa, 2015). Given its benefits of indoor temperature reduction and improvement in indoor air quality, financial subsidies for green roof / wall is considered an efficient method for green retrofit of existing building.

Finally, evaluation-based policies should be established for supervising and monitoring the performance of the implemented policies. Building assessment tools could be developed specifically for sustainable affordable housing or adopted from other assessment tools (i.e. Leadership in Energy and Environmental Design, LEED and Sustainable Building Assessment Tool, SBAT) for evaluation of sustainability performance of affordable housing facilities.

5.2.1.2 Component 2: Land market-related Barriers

This component consists of four barriers and it explains 12.06% of the total variance. The barriers and the percentage of their loadings in bracket include: 'lack of policies / weak enforcement of policies on land use planning system for housing supply' (70.7%); 'high cost of serviced land' (63.6%); 'high interest rates' (57.3%) and 'high inflation rate' (55.4%) (see, Table 5 for variance and loadings).

Some significant correlations exist among the barriers. For instance, (in Table 4), there are significant correlations between 'lack of policies / weak enforcement of policies on land use planning system for housing supply' (B13, an institutional sustainability barriers) and 'high interest rates' (B18, an economic sustainability barrier) ($r=0.484$, $p=0.01$); between 'lack of policies / weak enforcement of policies on land use planning system for housing supply' (B13) and 'high inflation rates' (B18, an economic sustainability barrier) ($r=0.514$, $p=0.01$); between 'lack of policies / weak enforcement of policies on land use planning system for housing supply' (B13) and 'high cost of serviced land' (B04, an economic sustainability barrier) ($r=0.293$, $p=0.05$); between 'high cost of serviced land' (B04) and 'high interest rate' (B18) ($r=0.345$, $p=0.05$); between 'high interest rate' (B18) and 'high inflation rate' (B20) ($r=0.789$, $p=0.01$), both identified in the literature as economic sustainability barriers. The significant correlations among these barriers indicate that they are directly or indirectly related to supply and demand of land. Therefore, this component is labelled as 'land market-related barriers'.

'Lack of policies / weak enforcement of policies on land use planning system for housing supply' could lead to land price escalation (Agyemang and Morrison, 2018). Infrastructure supply within a community reduces the land available for housing development while increasing the desire among potential households to live in that community. This increases demand for land thereby increasing prices of land. The increase in the land price / value could be attributed to the infrastructure supply, mostly provided by the state. Without adequate planning control, increase in land price / value is freely captured by land owners and developers. According to Agyemang and Morrison (2018 p.2640), there is an "opportunity cost in not attempting to extract some form of economic rent from private investors for affordable housing provision". Due to lack of policies / weak policies enforcement of planning control on infrastructural development, the uplift in land value leads to an upsurge in land prices. Consequently, 'lack of policies / weak enforcement of policies on land use planning system for housing supply' leads to high cost of serviced land. Besides, general inflation rate of a country is one of the macroeconomic variables that affect land prices. The relative price of land is positively linked to the expected inflation rate, as shown in the positive correlation between them ($r=0.514$, $p=0.01$). An increase in the expected inflation rate triggers an instant increase in the relative price of such 'store of value' real assets (i.e. land) (Feldstein, 1980).

Furthermore, high cost of serviced land impedes sustainable affordable housing development. For example, Huang et al. (2015) concluded that housing deficit and high housing prices in Hong Kong are due to high cost of land. Besides, the findings of Huang et al. (2015) revealed that land in areas of high land prices will experience longer holding periods than land in areas with low prices. The effect of high cost of serviced land is the postponement of housing

development which leads to inflations in the prices of existing housing or supply of housing at high prices. Consequently, supplied houses may not be economically sustainable in terms of price affordability. Besides, at high cost of serviced land, developers may borrow from financial institutions for land purchase. On borrowed capital for land purchase, the effect is high cost of financing. This ultimately increases the overall land price and the cost of housing development. For example, Wen and Goodman (2013) found a direct positive relationship between housing price and land price. Though they concluded that housing price has a greater influence (0.7109 elasticity of housing price) on land price than land price does on price of housing, the elasticity of land price was estimated at 0.1698 which means the increment is 4.19 times that of land price on housing price.

To overcome some of the barriers in the land market, governments could provide land as equity to developers. In developing countries (i.e. most African countries) where customary land tenure system is dominant, collaboration could be established between private investors and individual owners of land. In this form of collaboration, land owners provide land to developers as equity for housing development. The adoption and implementation of such policy could prevent private developers from incurring the initial land cost and high interest rates on borrowed funds. Essentially, the developer could rather channel these sums of money, mostly dedicated to the land purchase, to earlier start of the project and the adoption of sustainable technologies and materials for sustainable housing. At the completion of such projects, a number of housing units could be allocated to the land owners based on an agreement between the parties. With this strategy, it is expected that the land cost, high interest rates on borrowed funds for land purchase and the bureaucratic procedure of land acquisition could be obviated. Thus, the supplied sustainable houses could be price affordable. If the land is provided by the government, the number of houses given to the government could be allocated to low-income earners. This could be a strategy for ensuring mixed-income housing. Therefore, social sustainability could be achieved while the adoption of sustainable technologies will lead to environmental and economic sustainability attainment.

5.2.1.3 Component 3: Incentive-Related Barriers

The total variance accounted by this component is 10.2%. The underlying barriers and their percentage factor loadings include: 'high cost of sustainable building materials / technologies' (78.0%); 'delays in government approval process' (74.9%); 'inadequate access to land' (70.9%) and 'inadequate incentives for private investors' (63.5%) (shown in Table 5).

In Table 4, there exist statistical significant correlations between 'high cost of sustainable building materials' (B12, an economic sustainability barrier) and 'inadequate incentives for private investors' (B20, an economic sustainability barrier) ($r=0.450$, $p=0.05$); between 'inadequate incentives for private investors' (B20, an economic sustainability barrier) and 'delays in government approval process' (B09, an institutional sustainability barrier) ($r=0.522$, $p=0.01$); between 'inadequate incentives for private investors' (B20, an economic sustainability barrier) and 'inadequate access to land' (B11, an environmental sustainability barrier) ($r=0.453$, $p=0.01$); between 'high cost of sustainable building materials' (B12, an economic related barrier) and 'delays in government approval process' (B09, an institutional-related barrier) ($r=0.398$, $p=0.01$) and between 'high cost of sustainable building materials' (B12, an economic sustainability barrier) and 'inadequate access to land' ($r=0.322$, $p=0.01$).

The significant correlations among these barriers are coherent since they measure the same problem. This component is labelled as 'incentive-related barriers'. Studies have shown that developers are trammeled by barriers to sustainable affordable housing. For instance, in the

USA higher cost of sustainable building materials (green products) and inadequate government incentives were identified as some of the barriers that thwart sustainable development (Ahn et al., 2013 and Chan et al., 2016). In the case of UK, Parsons et al. (2010) highlighted some importance of rainwater and storm water collection for a sustainable resource utilization. However, findings of their study revealed a substantial shortage of interest in installing rainwater harvesting system in most houses. Attributable to the shortage of interest were financial and economic constraints of which the absence of incentives was significant.

Similarly, Chan et al. (2018) identified higher initial cost as among the barriers to the adoption of green building technologies among developing and developed countries. Elaborating on the cost, Van Bueren and Priemus (2002) stated that strategies for sustainable affordable housing mostly require few raw materials and more labor than conventional modes of construction of affordable housing. For example, it is estimated that depending on the project site, sustainable practices could increase the cost of the initial design, extra design services, certain green features and commission as much as 2-7% (Alwaer and Clements-Croome, 2010). Though some sustainable housing technologies (such as passive water heaters, energy efficient lighting, reflecting foil on exposed windows to reduce solar gains and shading devices / overhang) could be achieved at a minimal cost of two-figure sum in dollars, other sustainable materials / technologies could be expensive. For example, photovoltaic (solar) panels which can reduce household energy consumption by 80 percent can be costly (Sullivan and Ward, 2012). Therefore, integrating some of these technologies into housing facilities could make the housing facilities unaffordable to low-income earners.

Furthermore, delays in project approval is one of the identified barriers to sustainable affordable housing. Taylor (2011) estimated that review and approval procedure for development could be 18 months duration. So, the implementation of sustainable technologies in affordable housing may increase the complexity of construction because there could be additional submissions and approvals as compared to traditional form of construction (Lam et al., 2009). For example, in Singapore and Hong Kong, lengthy preconstruction process or delays caused by green requirements was identified as one of the barriers that affect the successful implementation of green construction (Hwang and Ng, 2013; Lam et al., 2009). As direct construction cost is linked to time, any delay in work flow due to review and approval would have economic effects (Lam et al., 2009).

Strategies could be implemented to curtail some of these barriers. Adequate financial incentives (such as tax incentives, direct grants and rebates) could be offered to developers to reduce the high cost of purchasing and adoption of sustainable housing materials or technologies (DuBose et al., 2007). For example, tax exemptions could be offered to developers who integrate sustainable technologies (green features) into affordable housing projects (Nguyen et al., 2017). Besides, since 'delay in approval' is positively correlated to inadequate incentives for private investors ($r=0.522$, $p=0.01$, see, Table 4), non-financial incentive such as expedited permitting could significantly save developers time and cost in permit approval process. This could be done in exchange for developers committing to the integration of stated sustainable materials or technologies into affordable housing projects (Perkins and McDonagh, 2012; Choi, 2009). Integrating affordable housing schemes and green building (GB) schemes through green procurement, such as requiring green features at the tendering stage, would encourage sustainable affordable housing development (Perkins and McDonagh, 2012). With regard to the barrier – inadequate access to land, land allotment to developers can be used as an incentive to ensure sustainable affordable housing. This will eliminate delays in land registration and cost of financing on developers' borrowed capital.

5.2.1.4 Component 4: Housing market-related Barriers

The extracted barriers with their factor loadings include 'community opposition to affordable' (80.2%); 'income inequality' (71.6%) and 'inadequate affordable housing policy / framework' (55.5%). This cluster explains 6.8% of the total variance (shown in Table 5) and is named 'housing market-related barriers'.

The correlation matrix shows some statistical significant associations among the barriers. There are significant correlations between 'community opposition to affordable housing projects' (B15, a social sustainability barrier) and 'income inequality' (B03, a social sustainability barrier) (r=0.481, p=0.01); between 'community opposition to affordable housing projects' (B15, a social sustainability barrier) and 'inadequate affordable housing policy' (B01, an institutional sustainability barrier) (r=0.349, p=0.05) and between 'income inequality' (B03, a social sustainability barrier) and 'inadequate affordable housing policy / guidelines' (B01, an institutional sustainability barrier) (r=0.413, p=0.01) (shown in Table 4).

'Inadequate affordable housing policy / guidelines' as a critical barrier could result from fiscal burden on the budget of most governments. Due to pressure on budgets of governments, the scarce resources are often allocated for the provision of other basic needs. Thus, housing provision could be relegated to the market. In a typical market-dominant model, housing is commodified and provided to those who are willing and able to pay (Drudy and Punch, 2002). Considering the incremental cost of adopting sustainable technologies and the predominance of the market-model, supplied sustainable housing are often beyond the income capacity of most low-income earners, without governments' intervention. The consequence of the dominance of a market model is an inadequate affordable housing policy / guidelines for low-income earners. This could lead to 'income inequality' and 'community opposition to affordable housing'.

The market-dominance model has various outcomes with regard to efficiency, quality and equity. For instance, since housing could be a consumption good and an investment, high-income earners could purchase more houses in anticipation of making profit in the near future (Drudy and Punch, 2002). As high-income earners earn profit from such investments, from the perspective of partial equilibrium, there is an outward shift in their demand curve with a corresponding increase in their demand for more housing, *ceteris paribus*. If supply is inelastic, the market equilibrium price increases correspondingly. This heightens the income inequality (gap) between high-income earners and low-income households. Thus, 'inadequate affordable housing policy' is associated with income inequality (r=0.413, p=0.01, as shown in Table 4). Income inequality could lead to rent increase, decrease housing consumption and decrease residual income of low-income households (Dewilde and Lancee, 2013). For instance, an increase in the market equilibrium price results in a decrease in the quantity of housing consumed among low-income earners. A study by Matlack and Vigdor (2008) revealed a continual significant relationship between inequality and crowding among low-income households. This is because low-income tenants respond to increasing inequality by reducing consumption to the point where expenditures on housing remain roughly steady. It was suggested in Matlack and Vigdor (2008) that allowing for product differentiation in housing could possibly alter the effects of income inequality. However, product differentiation could lead to community opposition depending on the "degree of product differentiation in the housing market".

"Opposition to affordable housing is often motivated by homeowners' fear that their property values will decline" (Nguyen, 2005 p. 15). Reasons for opposition to affordable housing

include low quality designs of affordable housing facilities, which are often linked to the fear of declining property values of neighbouring facilities. Upon a critical review of hedonic price studies, Nguyen (2005) concluded that proximally located affordable housing can negatively affect neighbouring property values. This could be attributed to inadequate affordable housing development policy such as low-quality design and poor management and maintenance; low compatibility between affordable housing and residential facilities of the host neighbourhood and high concentration of affordable housing within a specific area. Community opposition causes spatial segregation of low-income residential facilities, which leads to homogenous community development. This does not encourage social mx – a requirement for social sustainability.

For social sustainability attainment, income inequality must be controlled for fair distribution and consumption of housing resources. This can be achieved by using vertical equity (Chiu, 2003). Vertical equity is based on "fairness" notion of government taxation. It is an unequal treatment of people whose positions (i.e. income) are unequal. The main aim of vertical equity is for redistribution of wealth or income mostly through taxations. Through vertical equity policies (taxation), revenues realised could be used to subsidize the purchase of sustainable technologies for retrofitting of existing unsustainable affordable or low-cost housing. Such revenues could also be channelled into green housing construction for low-income earners. Moreover, they could be used to improve the design, quality, management and maintenance of affordable housing as well as improve on the compatibility between new affordable housing facilities and neighbouring housing facilities. This could reduce community opposition to affordable housing and thus improve on social sustainability attainment.

Another strategy to avoid community opposition to affordable housing is diversity. Diversity of income categories at a very low scale within a residential community could lead to an effective mixed neighborhood (Van Kempen and Bolt, 2009). Mixed neighborhood could eliminate the negative neighborhood effects associated with segregation due to community opposition to affordable housing. Besides, it improves social cohesion, liveability and neighborhood reputation. Moreover, it offers low-income earners an opportunity to extend their social networks by interacting with middle and high-income earners who could act as role models (Costarelli et al., 2019).

5.2.1.5 Component 5: Infrastructural-related Barriers

Lastly, component 5 consists of four barriers: 'zoning restrictions on land for affordable housing projects' (75.8%); 'high approval cost due to high taxes and fees on developers' (73.6%); 'inadequate infrastructural development' (53.9%) and 'inadequate public funding' (77.9%) (in Table 5). This component explains 5.4% of the total variance and is named 'infrastructural-related barriers'. The correlation matrix (in Table 4) shows only one significant association between 'high approval cost due to high taxes and fees on developers' (B16, an economic sustainability barrier) and 'inadequate infrastructure development' (B06, a social sustainability barrier) ($r=0.592$, $p=0.01$).

Owing to zoning restrictions on land, most affordable housing facilities are constructed in outskirts of towns and cities (Winston, 2010). Consequently, infrastructure such as roads are required to provide transport link among the housing facilities and social amenities. However, key infrastructure frequently arrives after affordable housing development and occasionally not at all. Funding is mostly reduced in large scale building programs on account of cost overruns and construction variations which may alter the end product usually far from the initial proposal (Power, 2008). Subsequently, inadequate transport link among infrastructure could increase commuting distance and cost. This makes affordable housing projects not

economically and environmentally sustainable due to high greenhouse gas emissions that could be linked to longer commuting distance (Power, 2008).

Besides, inadequate infrastructural supply could be a barrier to the sitting and construction of affordable housing within cities. For instance, one of the main reasons for zoning restrictions on land for affordable housing projects is to avoid possible congestion on existing limited social amenities (Tighe, 2010). Due to tight budget, most governments try to resolve the problem of inadequate infrastructure by increasing taxes and approval fees on developers so that the realised revenue could be used to augment infrastructure provision. However, when developers incur high taxes and permit fees for housing development, the taxes and permit fees are invariably transferred onto potential households in the form of higher house prices, thus making housing prices very high and economically unsustainable.

To avoid the problems of inadequate infrastructural supply, high-density development and mixed-land use are crucial. These developments encourage proximity to infrastructure. Proximity to infrastructure and services has relevant outcomes such as vehicle emission reduction and the wellbeing of citizens. These forms of development are key elements for an efficient access to local services and for promoting fairer transport models. They promote a walkable and cycling community. These alternatives of transport are considered as fundamental ingredients in an integrated, intermodal transportation system and they offer households transportation options and provide continuity from home to destination (Southworth, 2005). Walking and cycling gain merits as sustainable means of transport since they are "energy efficient and low pollutant" (Marquet and Miralles-Guasch, 2015). Besides, communal facilities should be provided in addition to housing facilities to promote social contact (Winston, 2010).

Although high-density development is important, Turok (2016) noted that extreme high-density development could have detrimental effects. High-density development could increase traffic congestion. Consequently, this could increase the travelling time of households and associated difficulties in pedestrian movement which could discourage brief walking trips (walking trips that take no more than 10 minutes). Similarly, a study conducted by Marquet and Miralles-Guasch, (2015 p.263) revealed that "as density increases from the more dispersed areas to the denser ones, so does the use of the neighborhood for brief trips. However, once a certain density threshold is surpassed, proximity utilization no longer varies significantly. For areas above the 35.00 inh / km^2, density ceases to be found as significant for proximity use."

5.3 Results of Rank Agreement Analysis on the Critical Barriers

The results of the FA were subsequently used for the rank agreement analysis to determine the level of agreement between experts from developing and developed countries. Using the equations as provided in subsection 4.3 on rank agreement analysis, the percentage disagreement (PD) was first calculated before estimating for the percentage agreement (PA) of each component. Recall eqn (5), the percentage disagreement (PD) is given by

$$PD = \frac{\sum_{i=1}^{N} |R_{i1} - R_{i2}|}{\sum_{i=1}^{N} |R_i - R_{j2}|} \text{ x } 100 \quad \text{..... eqn (5)}$$

For **green retrofit-related barriers**, using the figures as shown in Table 6, PD = $\frac{4}{6}$ x 100 = 67%

Therefore, PA is given by, recall eqn (6)

$$PA = 100 - PD \quad \text{.....eqn (6)}$$

$$PA = 33\ \%$$

Similarly, using the values shown in Table 6 for **land market-related barriers**, with a PD of 67% (PD = $\frac{4}{6}$ x 100), the PA is given by

$$PA = 100 - PD$$

$$PA = 33\ \%$$

Using the same approach, the PD for **incentive-related barriers** was estimated as PD = $\frac{2}{6}$ x 100 = 33%

Therefore, the percentage agreement (PA) is given by $PA = 100 - PD = 67\%$.

For **housing market-related barriers** (using the figures as shown in Table 6), the PA is estimated at 50% while the percentage agreement for **infrastructural-related barriers** was estimated at 0%.

Results of the rank agreement analysis between experts from developing and developed countries are shown in Table 6. With regard to 'green retrofit-related barriers', 'income segregation' was the highest ranked barrier by both groups. However, with a mean score of 4.357, 'tight credit condition' ranks second among experts from developing countries, followed by 'abandoned management of public housing facilities or projects' (4.357) and then 'poor maintenance culture / inadequate retrofitting of housing facilities' (4.143). Among experts from developed countries, 'poor maintenance culture / inadequate retrofitting of housing facilities' ranks second with a relatively low mean score (3.548), followed by 'tight credit conditions' with a comparatively low mean score (3.533) and then 'abandoned management of public housing facilities' with a mean score of 3.452. As a result of the high differences in rankings of the various barriers under 'green retrofit-related barriers', a relatively low rank agreement level of 33% was calculated (as shown in Table 6 and in eqn. 5 & 6).

From the rank agreement analysis on 'land market-related barriers', 'high cost of serviced land' was the highest ranked barrier between experts from developing and developed countries with mean scores of 4.571 and 4.000, respectively. However, on subsequent rankings of barriers from the perspective of experts from developing countries, 'high interest rates' ranks second with a relatively high mean score (4.429). The third ranked barrier is 'lack of policies / weak enforcement of policies on land use planning system for housing supply' with a mean score of 4.357. Finally, 'high inflation rate' ranks fourth with a high mean score of 4.000. Among experts from developed countries, 'lack of policies / weak enforcement of policies on land use planning system for housing supply' ranks second with a relatively lower mean score (3.419). The third ranked barrier is 'high interest rate' albeit a lower mean score (2.733) and finally, 'high inflation rate' with a mean score of 2.655. Therefore, aside the barrier 'high cost of serviced land' that is ranked highest and equally from both groups of experts, the other barriers were ranked differently. Consequently, a rank agreement level of 33% was estimated between experts from developing and developed countries (as shown in Table 6).

646 **Table 6:** Rank Agreement Analysis of Barriers to SAH

Barriers to Sustainable Affordable Housing	Developing Countries			Developed Countries			Agreement Analysis		
	Mean	SD	Rank	Mean	SD	Rank	R_i	$(R_{i1} - R_{i2})$	$\lvert (R_i - R_{j2}) \rvert$
Component 1: Green retrofit-related Barriers									
B14: Abandoned management of public housing facilities / projects by governments	4.357	0.842	3	3.452	1.207	4	7	1	2
B10: Tight credit conditions	4.357	0.745	2	3.533	0.973	3	5	1	0
B08: Poor maintenance culture / inadequate retrofitting of housing facilities	4.143	1.099	4	3.548	1.091	2	6	2	1
B05: Income segregations	4.429	0.756	1	4.033	1.159	1	2	0	3
							$R_{i2}= 5$	Sum = 4	Sum =6
Component 2: Land market-related Barriers									
B13: Lack of policies / weak enforcement of policies on land use planning system for housing supply	4.357	0.633	3	3.419	1.119	2	5	1	0
B04: High cost of serviced land	4.571	0.851	1	4.000	0.910	1	2	0	3
B18: High interest rates	4.429	0.756	2	2.733	1.048	3	5	2	0
B20: High inflation rate	4.000	0.679	4	2.655	0.857	4	8	1	3
							$R_{i2}= 5$	Sum = 4	Sum = 6
Component 3: Incentive-related Barriers									
B12: High cost of sustainable building materials	4.214	0.864	1	3.567	0.898	1	2	0	3
B09: Delays in government approval process	4.143	0.893	2	3.484	1.061	3	5	1	0
B11: Inadequate access to land	4.071	0.917	3	3.516	0.926	2	5	1	0
B19: Inadequate incentives for private investors	4.000	0.961	4	2.839	1.128	4	8	0	3
							$R_{i2}= 5$	Sum = 2	Sum = 6
Component 4: Housing Market-related Barriers									
B15: Community opposition to affordable housing	3.357	1.447	3	3.800	1.157	3	6	0	2
B03: Income inequality	4.357	1.008	1	4.100	0.923	2	3	1	1
B01: Inadequate affordable housing policy / guidelines	4.286	0.611	2	4.333	0.802	1	3	1	1
							$R_{i2}= 4$	Sum = 2	Sum =4
Component 5: Infrastructural -related Barriers									
B07: Zoning restrictions on affordable housing	3.786	0.975	4	3.900	0.960	2	6	1	1
B16: High approval cost due to high taxes and fees	4.357	0.842	2	3.000	0.910	4	6	1	1
B06: Inadequate infrastructural development	4.500	0.760	1	3.667	0.922	3	4	1	1
B02: Inadequate public funding	4.357	0.929	3	4.233	0.817	1	4	1	1
							$R_{i2}= 5$	Sum = 4	Sum = 4

647

Concerning 'incentive-related barriers', one of its underlying barriers - 'high cost of sustainable building materials' - was ranked the highest barrier to SAH by experts from both developing and developed countries with mean scores of 4.214 and 3.567, respectively. Among experts from developing countries, 'delays in government approval process' ranks second followed by 'inadequate access to land' and then 'inadequate incentive for private investors'. However, among experts from developed countries, 'inadequate access to land' ranks second with a mean score of 3.516. The third and fourth ranked barriers are 'delays in government approval process' and 'inadequate incentives for private investors', respectively. Due to the closeness and similarities in the ranks of the underlying barriers, a rank agreement level of 67% was estimated.

This value indicates a relatively high level of consensus between experts from both group of countries on the effects of the underlying barriers on SAH. Similarly, Chan et al., (2018) conducted a comparative study on the critical barriers to green construction in Ghana, USA, Canada and Australia. Findings of their study showed that 'high cost of sustainable building materials / technologies (green building technologies)' was the top barrier in these countries. Furthermore, 'inadequate incentives for private investors' was ranked among the top five barriers in both Ghana and USA. Moreover, 'delays in government approval process' is a common barrier for both traditional and sustainable affordable housing development in both developing and developed countries (Zhang et al., 2012; Lam et al., 2009).

With regard to 'housing market-related barriers', 'income inequality' is the highest ranked barrier with a mean score of 4.357 among experts from developing countries. 'Inadequate affordable housing policy / guidelines' ranks second (mean score of 4.286). With a mean score of 3.357, 'community opposition to affordable housing' ranks third. Among experts from developed countries, 'inadequate affordable housing policies / guidelines' is the highest ranked barrier (mean score of 4.333). 'Income inequality' ranks second with a mean score of 4.100. 'Community opposition to affordable housing' ranks third which is similar to the ranking among experts from developing countries, although its means value (3.800) is relatively high among experts from developed countries. As a result of the closeness in ranks among the barriers, a rank agreement level of 50% was estimated (as shown in Table 6 and in eqn. 5 & 6).

The relatively high rank agreement level on 'housing market-related barriers' between both groups of respondents is possibly due to the housing supply approach adopted in most developing and developed countries. Since 'inadequate affordable housing policy' ranks high in both cases, this could possibly be attributed to the dominance of the market model in housing supply among most countries. Fiscal austerity evinced in budgetary constraints among governments has often been stated as the influencing factor for this approach to housing supply (Drudy and Punch, 2002; Zhang et al., 2016). In the market model approach, housing supply is considered as a personal investment, profit-making or wealth generation. Besides, this model encourages speculative acquisition of land, hoarding, monopoly elements and segregation (Drudy and Punch, 2002). Corollary of the market-dominance model is income inequality. It is, therefore, not surprising that income inequality was also rated high by respondents from both developing and developed countries.

Concerning 'infrastructural-related barriers', there was a vast difference in the rankings of the underlying barriers between experts from developing and developed countries. Among experts from developing countries, 'inadequate infrastructural development', with a mean score of 4.500, is ranked the highest. 'High approval cost due to high taxes and fees on developers' ranks second with a mean score of 4.357. Third is 'Inadequate public funding' followed by

698 ‘zoning restrictions on affordable housing’ (mean score of 3.786). However, among experts in
699 developed countries, ‘inadequate public funding’ is first with a mean score of 4.233. Then,
700 ‘zoning restrictions on affordable housing’ ranks second with a relatively high mean score
701 (3.900). ‘Inadequate infrastructural development’ and ‘high approval cost due to high taxes
702 and fees’ rank third and fourth, respectively, with mean scores of 3.667 and 3.000. Although
703 the underlying barriers had high mean scores, they are ranked differently in both groups of
704 experts. For instance, while ‘zoning restriction on affordable housing’ was ranked high among
705 experts from developed countries, it was relatively ranked low among experts from developing
706 countries. Thus, the high differences in the ranks of the underlying barriers under this
707 component yielded a rank agreement level of zero (0), which indicates no consensus on the
708 ranks of the barriers.
709
710 In summary, the underlying barriers in “incentive-related barriers” and “housing market-
711 related barriers” are implicated in the inadequate sustainable affordable housing in most
712 developing and developed countries. Therefore, global policies on incentives for developers
713 (such as adequate supply of low-cost serviced land, expedited permitting and subsidies for low-
714 income household) are crucial for sustainability attainment in affordable housing or low-cost
715 housing. These incentives could enable developers and low-income households to purchase
716 energy efficient technologies and other sustainable housing technologies. Besides, given the
717 dominance of the market model in housing supply among most countries, governments need
718 to intervene. Through governments’ interventions, sustainable affordable housing could be
719 made available to low-income earners. The interventions could be in various forms such as
720 redistribution policies through taxation. Besides, effective public-private partnership could be
721 an efficient strategy in providing sustainable affordable housing to low-income earners.
722

Table 7: Summary on Barriers, Rank Agreement Level and Suggested Policies for Sustainability Attainment in Affordable Housing

Components of Barrier	Underlying Barriers	Rank Agreement Level	Suggested Policies for Sustainable Affordable Housing
Green retrofit -related Barriers	• Abandoned management of public housing facilities / projects by government • Tight credit conditions • Poor maintenance culture / inadequate retrofitting of housing facilities • Income segregation	33%	• Political will and commitment to low-cost housing • Financial enabling policies (i.e. low interest loans or interest free loans; revolving fund for retrofitting) • Regulation-based policies on routine maintenance / retrofitting of low-cost housing • Information dissemination programs; Knowledge transfers from material suppliers and energy advisors; directive based policies; regulation-based policies; evaluation-based policies • Inclusionary housing, mixed neighbourhood / diversity of income categories at a low scale within a residential community
Land market-related Barriers	• Lack of policies / weak enforcement of policies on land use planning system for housing supply • High cost of serviced land • High interest rate • High inflation rate	33%	• Taxation on property / capital gains on land for sustainable affordable housing supply • Land-use planning system for housing supply • Partnership between land owners and developers for housing supply; Governments' supply of land as equity for public-private partnership or providing land subsidy to developers • Limited holding periods of vacant land to prevent speculation of land prices • Availability of low interest rates financing schemes / mortgage; governments adopting long-term financing strategy such as bond-financed affordable housing delivery approach other than using short-term strategies such as treasury-bills • Taxation on property / capital gains on land for sustainable affordable housing supply • Long-term financing other than short-term financing strategies for sustainable affordable housing supply
Incentive-related Barriers	• High cost of sustainable building materials / technologies • Delays in government approval process	67%	• Access to low-interest loans; subsidies on cost of sustainable technologies • Non-financial incentives (i.e. expedited permitting approval

			on land acquisition and land titling)
	• Inadequate access to land • Inadequate incentives for private investors		• Land allotment as an incentive for public-private partnership • Providing financial incentives for developers (i.e. tax incentives, tax exemptions, direct grants and rebates)
Housing market-related Barriers	• Community opposition to affordable housing projects	50%	• Improve compatibility between low-cost housing and neighbouring facilities; improved design, quality, management and maintenance of affordable housing; mixed neighbourhood / diversity of income categories at a low scale within a residential community; bottom-up, community engagement approach to planning for affordable housing
	• Income inequality		• Vertical equity of government taxation for income redistribution; subsidies for energy retrofitting; horizontal equity i.e. transparent allocation of housing facilities • Government provision of subsidies to households
	• Inadequate affordable housing policy / guidelines		• Tailored building regulation or codes as standards for assessing sustainability in affordable housing
Infrastructural-related Barriers	• Zoning restrictions on land for affordable housing projects	Nil (0%)	• Mixed housing development and high-density development
	• High approval cost due to high taxes and fees on developers		• Tax exemption such as Low-income Housing Tax Credit (LIHTC)
	• Inadequate infrastructural development		• Compact housing development or high-density housing construction in urban areas • Siting low-cost housing within cities / towns • Providing infrastructural subsidy to developers • Land-use planning system for infrastructure supply
	• Inadequate public funding		• Linking commercial development approval to funding for housing / charging developers in towns and cities impact fees of development • Public-private partnership • Effective participation of “non-profit” developers

724

6. Conclusions

This study identified critical barriers that hinder sustainable affordable housing development. Through a questionnaire survey, data on barriers were collected from 51 affordable housing experts from various countries around the world. These experts are also knowledgeable in sustainable housing. The data were analysed using ranking analysis (mean and normalization scores), factor analysis with Pearson correlation and rank agreement analysis.

The research findings revealed that 19 critical barriers impede sustainable affordable housing in developing countries. The top five critical barriers include: 'high cost of serviced land' followed by 'inadequate infrastructural development', 'income segregation', 'high interest rates' and then 'lack of policies / weak enforcement of policies on land use planning system for housing supply'. However, from the perspective of respondents from developed countries, the top five critical barriers include: 'inadequate affordable housing policy', 'inadequate public funding', 'income inequality', 'income segregation' and 'high cost of serviced land'. Through factor analysis of the combined critical barriers from the perspective of developing and developed countries, five components were obtained, namely, green retrofit-related; land market-related; incentive-related; housing market-related and infrastructural-related barriers. Rank agreement analysis of the underlying barriers in the various components showed high rank agreement level between respondents from both developing countries and developed countries on 'incentive-related barriers' (rank agreement level of 67%) and 'housing market-related barriers' (rank agreement level of 50%). However, a low rank agreement level (33%) was obtained for 'green retrofit-related barriers' and 'land market-related barriers' with no agreement (0%) on infrastructural-related barriers.

This study has limitations worth stating with regard to the interpretation and generalization of its findings. First, the findings of the study rely on a relatively small sample size, which could affect their generalizability. Therefore, future study could use much larger sample size from both developing and developed countries for the rank agreement analysis. This could reveal much insight on the rank agreement analysis in this study. Besides, with larger sample size, other parametric analysis could be employed to test the significant difference among the barriers that impede sustainable affordable housing from developing and developed countries. Furthermore, the study reports on barriers to sustainable affordable housing from only the perspective of affordable housing experts. Future study could include the views of low-income residents by using additional data collection technique such as interviews to provide a broader and bias-free view on barriers to sustainable affordable housing.

Albeit the limitations, the research findings have significant practical and theoretical contributions worth stating. Practically, the research findings could enable policy makers and practitioners to adopt global pragmatic measure to promote sustainable affordable housing. Besides, in the light of the barriers identified, the study highlights the measures which are worth considering among international policymakers for sustainable affordable housing. Unlike previous studies, the present study proffers in-depth understanding of the barriers to sustainable affordable housing from an international perspective as well as recommendations for overcoming those barriers. As such, the findings of this study have practical implication for international organization such as the World Bank and the United Nations. These organizations could incorporate the findings and recommendations into their international programmes for promoting sustainable affordable housing across the globe. Promoting sustainable affordable housing across the globe would contribute to achieving the target 11.1 of the Sustainable Development Goal 11 of the United Nation, which highlights the need for Sustainable affordable housing for all by 2030. Theoretically, future study could investigate the

interrelationship between the identified critical barriers and critical success criteria towards developing a model for sustainable affordable housing. The identified barriers could also be employed for further study to unravel context specific barriers among developed and developing countries.

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