West Africa Built Environment Research (WABER) Conference
10th Anniversary Conference, 5-7 August 2019, Accra, Ghana
Proceedings Edited by Laryea, S. and Essah, E.
ISBN: 978 – 9988 – 2– 6010 – 1
DOI: https://doi.org/10.33796/waberconference2019.71

SUSTAINABLE BUILDING PRACTICE: AN ASSESSMENT TOOL FOR GHANA

James Tito Ako-Adjei[1] and Humphrey Danso[2]
[1,2]Department of Construction & Wood Technology, University of Education Winneba
P. O. Box 1277, Kumasi-Ghana

The emergence of sustainable building practices has promoted the development of sustainable building assessment tools. The study aims at analyzing the existing sustainable assessment tools and develop one for the Ghanaian construction industry. It also seeks to assess sustainability policies and challenges for effective delivering of sustainable buildings in Ghana. Data was collected from 146 construction professionals with questionnaire and interview guide. The questionnaire consisted of both closed-ended (with 4-point Likert scale) and opened-ended questions. The study revealed that policies backing sustainable building construction in Ghana are inadequate. The key challenges identified with sustainable buildings include: high initial and operational cost, lack of government support and financial incentives, lack of certification, inadequate skill training, and minimal commitment level and research. The study further revealed that the rating tool most used in Ghana is the Green Star Eco Homes which was adopted from Green Star Australia (GS A-v1) and South Africa (GS SA-v1). On the functions of assessment tools use in Ghana, it was observed that the rated tool needs to be updated or changed, the rating tool for office and commercial buildings should be different from that of a residential facility, and the tool should be modified to reflect conditions in Ghana. "Green Rating & Measurement System for Ghana (GRMSG)" was developed and proposed to be employed for use in Ghana, which comprises of 9 main categories, 40 criteria, 150 total accrued points, and 4 certification levels (Bronze, Silver, Gold and Diamond). The study therefore, concludes that policies on sustainable construction practices in Ghana are insufficient, there are key challenges that government need to address and the rating tool used should be modified to reflect conditions in Ghana. Ghana Green Building Council (GHGBC) should consider the adoption of GAMS for assessing and certifying green buildings in Ghana.

Keywords: Ghanaian construction industry, green rating tools, sustainable assessment tools, sustainable building practices, sustainability policies

INTRODUCTION

The built environment industry in Ghana is undeniably one of the most vibrant and significant sectors of the country's economy. According to the Ghana Statistical Service (2013), it contributes an average of 12.6% of the Gross Domestic Product

[1] jakoadjei@gmail.com
[2] hdanso@uew.edu.gh

James Tito Ako-Adjei and Humphrey Danso (2019) Sustainable building practice: an assessment tool for Ghana In: Laryea, S. and Essah, E. (Eds) Procs West Africa Built Environment Research (WABER) Conference, 5-7 August 2019, Accra, Ghana, 987-1004

(GDP) and employs about 2.8% of the economically active population. Ahadzie, Proverb, Olomolaiye, and Ankrah (2009) opine that the building industry in Ghana contributes meaningfully to the national socio-economic development by providing significant employment opportunities. However, the industry put lots of stress on the environment due to the consumption of substantial natural resources such as non-renewable resources such as energy, timber, water, farmlands etc. thereby contributing to the climate change. Climate change arguably has become the greatest contemporary global threat and the risks associated with it will become more severe overtime (Yaro, 2010). This has given birth to the concept of sustainable development which simply means the ability of the present generation meeting their needs without compromising the ability of the future generations to meet their own needs. Sustainable building also known as high performance building or green building has been champion in the construction industry all over the world since the 1960s. This involves the kind of building that enhances the quality of life to the occupants as well as the environment, i.e. allowing people to live in a healthy environment, with improved social, economic and environmental conditions (Danso, 2018a; Ortiz et al., 2009). A building is said to be sustainable if the processes of designing, construction, renovation or maintenance, operation or reuse conforms to environmental friendly and resource efficient manner.

Buildings are certified as meeting sustainability principles through a rating system or with an assessment tool. The rating tool is a major part of the green building assessment process. According to Chehrzad, Pooshideh, Hosseini and Majrouhi Sardroud (2016) it demonstrates the result of calculation from decision tools and also includes many criteria in different categories which reflect priorities in various regions. The rating tools can be adaptable and flexible, meaning that the criteria are able to be adjusted, changed or tailored depending on the conditions which the rating tool is being utilized. Projects earn points for satisfying specific green building criteria set under the assessment tool, the number of points the project earns, determines whether the project will be certified as being sustainable or meeting sustainability principle. Rating systems or tools of various kinds have been developed in some advanced countries to measure the application of sustainable principles in buildings based on the economic, environmental and social situations of those countries. Popular amongst them is the Leadership in Energy and Environmental Design (LEED) for the United States of America, the Building Research Establishment Environmental Assessment Method (BREEAM) for the United Kingdom, also there is the Compressive Assessment System for Built Environment Efficiency (CASBEE) for Japan, among others.

Studies have been conducted indicating that sustainable development is therefore the surest way in minimizing, if not eradicating the effects or impacts construction activities has on the environment. To ascertain the sustainability of a building, there is a need for what is known as a rating system or assessment tool. According to Chehrzad et al. (2016) rating systems are developed to assess the sustainability of a building in accordance with the economic, cultural and ecological environment they are being used in. Therefore, rating systems may define sustainability differently based on the economic, cultural or social and ecological as well as the environmental situations and allocate diverse weight factors or scores to each category. Rating systems are the interface of green or sustainable buildings. They include different categories and criteria for allocation of point and assessment which are based on the prevailing conditions of its application (Chehrzad et al., 2016).

According to Osae-Akonnor (2014) as cited by Ahmed, Hatira and Valva (2014), the Ghana Green Building Council (GHGBC) does not have its own building rating system but has however, adopted a building rating system in South Africa called the GS SA-v1 Building Rating System, which was adapted from the GS-v1 Building Rating Tool in Australia which was initially a system designed for South Africa. This therefore calls for thorough examination in the Ghanaian point of view to derive a suitable rating system based on the social, environmental and economic situation of the country. The aim of this study therefore, is to analyze the various assessment tools available and to determine the most suitable and efficient for Ghana. It also seeks to assess sustainability policies and challenges for effective delivering of sustainable buildings in Ghana. The objectives of the study are to: (1) examine existing polices on sustainable development in Ghana; (2) identify possible challenges that building practitioners face in applying building sustainability modules; (3) examine the existing sustainable assessment tool used in Ghana; and (4) develop a proposed sustainable building assessment tool or rating system for Ghana.

LITERATURE REVIEW

Components of Sustainability

Creating sustainable buildings starts with proper site selection, which includes the orientation of the building to maximize the use of natural light and air, reuse or rehabilitation of existing buildings must also be considered. A sustainable building should also use water efficiently, and reuse or recycle water for on-site use when feasible. Sustainable buildings are also constructed with materials that minimize life-cycle environmental impacts such as global warming, resource depletion, and human toxicity (Danso, 2018b). Environmentally friendly materials have a reduced effect on human health and contribute to improved worker safety and health, reduced liabilities, reduced disposal costs, and achievement of environmental goals (Muhwezi, Kiberu, Kyakula & Batambuze, 2012).

Bainbridge (2004) also stated that an ideal sustainable project should be inexpensive to build, last forever with modest maintenance, but return completely to the earth when abandoned. Sustainable construction ethos requires what is known as a 'cradle to grave' appraisal of project, this involves the management of serviceability of the project during its life-time and eventual deconstruction focusing on the economic aspect of sustainability (Wyatt, 1994). Thus a sustainable construction will aim at achieving set down principles. Kim and Rigdon (1998) mentioned that certain measures centered on the material life cycle can be used in defining sustainability of both structural and construction materials. The presence of some of these features in building materials make it sustainable, a production process that avoids pollution, materials that have high tendencies of being recycled, effort towards the reduction of embedded energy, the use of natural materials, materials that have the ability to prevent creation of a lot of waste during its installation, material that are locally available, energy efficient and renewable energy systems that can serve longer life spans (Danso, 2018b). The issue of reusability, recyclability and biodegradability is also important in determining the sustainability of a building. Kim et. al., (1998) came out with three main groupings of sustainable components or features of buildings and building materials as illustrated in the Figure 1.

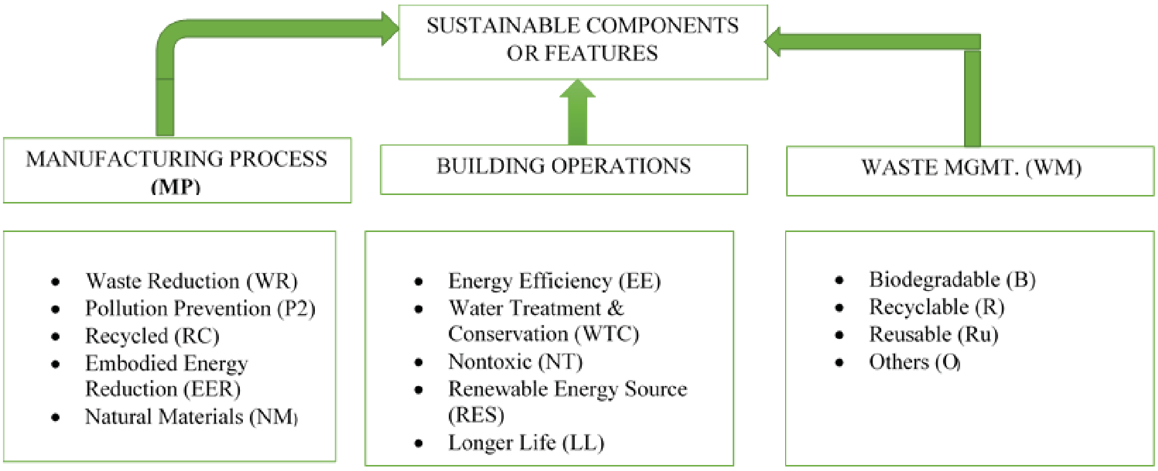

Figure 1: Sustainable components/features (Kim et al., 1998)

Sustainability Models

The three main concept of sustainability has resulted in the creation of sustainability models; these models include the 3-legged stool model, 3-overlapping-circle model, and 3-nested-dependencies model. The 3-legged stool model depicts the three dimensions of sustainability that are crucial for us to enjoy a high quality of life and shows that society is unbalanced if one of them is feeble (World Conservation Union IUCN, 2006). This model however draws the analogy that economic, environmental, and social dimensions are treated separately as shown in the Figure 2. The 3-overlapping-circles model of sustainability overlaps the economic, environmental, and social aspects of sustainability. With this model, the circles can be resized to indicate one of the dimensions more prevailing than the other depending on the interest (Newman & Kenworthy, 1999). This model seeks to communicate that some parts of the dimensions can exist on their own as shown in Figure 3. The 3-nested-dependencies model has resulted under the premise that there is a co-reliant reality. This indicates that the economy is a subset to the society and the society is a complete subset of the environment (Giannetti, 1993). This is to say that we cannot live without fresh clean air, a balance meal, portable water, productive soil, and other resources that nature provides and the society on the other hand created it economy as shown in Figure 4.

Figure 2: The 3-Legged Model of Sustainability (World Conservation Union IUCN, 2006)

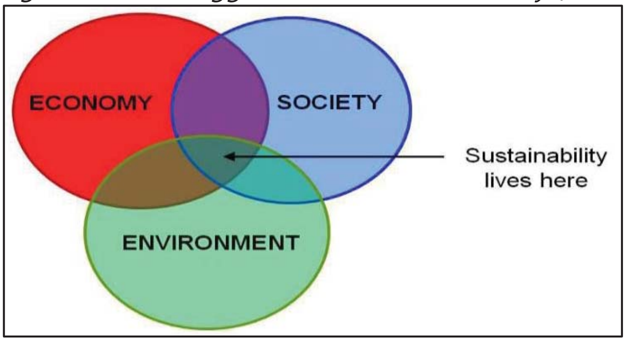

Figure 3: 3-Overlapping-Circle Model of Sustainability (Newman & Kenworthy, 1999 as cited by Kats, 2004)

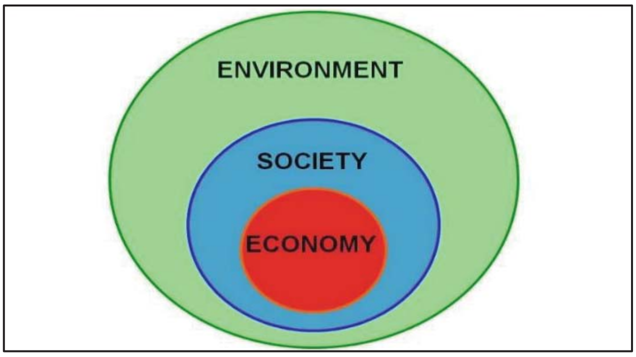

Figure 4: 3-Nested-Dependencies Model of Sustainability (Giannetti, 1993)

Sustainability Assessment Tools

The last couple of decade had seen tremendous growth of building sustainability assessment tools. The first recognized assessment tool emerged in the year 1990 and several others have emerged subsequently from different countries and backgrounds. Sinou and Kyvelou (2006) mentioned that the availability of assessment tool tends to differ from developers due to principles and concept of one tool developed and also it considers the criteria, items evaluation and data. One of the earliest and most profound assessment tools is the UK's Building Research Establishment Environment Assessment Method (BREEAM) developed in the year 1990. The main function of this assessment tools are primary on building specification evaluation including the design, construction and use. According to Ding (2008) the vast experience of BREAAM in building assessment has lead its methodology to be adopted as the foundation of the development of other building assessment tools in Canada, Hong Kong, Australia and many other countries.

The BREEM comprehensive assessment includes all criteria from energy to ecology, the main aspect of management processes, water use, health and wellbeing, transport, pollution and waste. Table 1 shows the rating benchmark of buildings for BREEAM certification. The rating has been identified as outstanding which a building has to obtain a score more than 85% and the lowest rated as unclassified at below 30%. The BREEAM weighting criteria for certification is up to 100 percent (100%) and it consist of nine (9) benchmark points of environmental aspect, energy, health and wellbeing, management, and materials aspects. It has also an additional slot for innovation which gives extra ten percent (10%). Table 2 presents the weighting of the criteria in BREEAM assessment system.

Table 1: BREEAM rating benchmarks

Rating	Score in percentage (%)
Outstanding	≥ 85
Excellent	≥ 70
Very Good	≥ 55
Good	≥ 45
Pass	≥ 30
Unclassified	< 30

Table 2: BREEAM environmental section weightings

Environmental Section	Weighting (%)
Management	12
Health & Wellbeing	15
Energy	19
Transport	8
Water	6
Material	12.5
Waste	7.5
Land Use & Ecology	10
Pollution	10
Total	100
Innovation (additional)	10

Leadership in Energy and Environmental Design (LEED), is the second oldest assessment tool developed, it has been available since the year 1998. This tool was developed by the United States Green Building Council (USGBC). LEED is also one of the earliest assessment tool which has serve as a model that is being adopted and modified according to one's country's environmental, social and economic nature (Reed et al., 2009). LEED is a third-party certification program and an internationally accepted benchmark for the design, construction and operation of high performance green buildings. LEED promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health (sustainable site development, water efficiency, energy efficiency, materials selection and indoor environmental quality). Certification is based on the total point score achieved, following an independent review. With four possible levels of certification (certified, silver, gold and platinum). LEED is flexible enough to accommodate a wide range of green building strategies that best fit the constraints and goals of particular projects. This tool has a wide range of coverage which include major renovation projects (LEED-NC), existing building operations (LEED-EB), commercial interiors projects (LEED-CI), core and shell projects (LEED-CS), homes (LEED-H) and neighborhood development (LEED-ND) (Sinou & Kyvelou, 2006). The required points for a building to be certified is 40 points and the highest rating is 80 or more to obtain platinum rated.

Table 3: LEED rating system

Rating	Point
Platinum	≥ 80
Gold	79 - 60
Silver	59 - 50
Certified	49 - 40

Table 3 presents the rating and points, and Table 4 presents the criteria points for LEED tools.

Table 4: LEED criteria points

Criteria	Points
Sustainable sites	26
Water efficiency	10
Energy & atmosphere	35
Materials & resources	14
Indoor environmental quality credits	15
Innovation in Design	6
Regional Priority	4
Total	110

Japan has one of the most developed assessment tools in Asia, this is known as the Comprehensive Assessment System for Building Environment Efficiency (CASBEE) and it was developed in the year 2001. One of the first tools to emerged in the continent of Asian. The reliability of the tool has gained reputable status as the BREEAM and LEED. The rating tool is mainly focused in green building certification in Japan and Asia. The methodology which is applied during the CASBEE assessment tool usage differs greatly from other tools in existence. It applies the Building environmental efficiency (BEE) model. The Green Star is a sustainable rating tool for an environmental certification scheme. This tool was originally developed by the Green Building Council of Australia (GBCA). Green Star was then adopted by the Green Building Council of South Africa (GBCSA) for use in South Africa (Green Star SA) and has been adopted also by the Ghana Green Building Council (GhGBC) for use in Ghana (Alfris & Braune, 2016). The Green Building Council Australia certifies three levels of green building depending on the points a project achieved during the certification process. The three levels are: 4 Star, 5 Star and 6 Star, indicating "Best Practice", "Australian excellence" and "World leader" respectively.

METHODOLOGY

The study adopted descriptive design through cross sectional survey. The population consisted of architects, quantity surveyors and construction managers/engineers in the Greater Accra, Central, Ashanti and Brong-Ahafo Regions in Ghana. These construction experts were purposively chosen because of their knowledge and experience in sustainable building practices. Bernard (2002) described purposive sampling as a form of nonprobability sampling in which decisions concerning the individuals to be included in the sample are taken by the researcher, based upon a variety of criteria which may include specialist knowledge of the research issue, or capacity and willingness to participate in the research. The construction professionals were selected to provide useful information on the existing sustainable building rating tools as well as the criteria and weighting points of the proposed rating tool to be used in Ghana. A total of 195 practicing professionals were sampled from across the four regions and data collected. The instruments used for the collection of data were structured questionnaire and a semi-structured interview. A detailed survey questionnaire was designed and developed on the basis of a comprehensive literature review in the research area. To ensure validity, an initial draft of the questionnaire was subjected to critical review. The relevance of the variables to the purpose of the study was checked, clearly stated and confirmed to be capable of eliciting for the right responses from the respondents. It was shown to experts in the construction industry to review and their comments were used to revise the questionnaire.

The questionnaire consisted of both closed-ended and opened-ended questions. The 4-point Likert scale measuring from 'strongly disagree' to 'strongly agree' was adopted. According to Yin (2003), the Likert scale is easy to use and also decreases doubt, misunderstanding and error. Likert scale also lessens non-response rate and reduces respondents' fatigue. The questionnaire was structured into five main sections, which includes; respondents' background, policy level, application on sustainable construction, challenges that building practitioners face in applying sustainability modules and functionality of sustainable assessment or rating tools in Ghana. The respondents were asked to indicate their degree of agreement or disagreement on the Likert scale as: strongly agree (4); agree (3); disagree (2); and strongly disagree (1). A total of one hundred and forty-six (146) questionnaires were retrieved out of the 195 distributed, making a retrieval rate of seventy-four percent (74%). Data from the field were coded appropriately to make meaning out of them. Coding was done to facilitate data entering and ensure comprehensive analysis. Editing was also done with the aim of detecting and eliminating errors to ensure clean and reliable data. The Statistical Package for Social Science (SPSS) software version 21 was used for the data analysis. Descriptive statistical analysis factors like frequency tables, and percentages were generated to describe the data obtained on the field.

A semi-structured interview was also used to gather information from practicing professionals who are abreast with the sustainability concept or modules. The semi-structured interviews allowed the respondents freedom to express their views in their own terms and this provided reliable and comparative qualitative data (Malhotra & Birks, 2007). An interview guide was used to engage the practicing professionals in a formal interview. The interview guide was prepared based on the main themes that contributed to the developing of a new rating tool. These themes include the categories, the criteria that that makes up each category and comparison of some existing rating tools from literature. To generate the weights for the proposed rating tool, first the categories and criteria have to be decided. In order to do that, existing rating tools were studied and comparison were made and then, the categories and criteria which are suitable for Ghana were short listed. This then formed the basis of the interview with the professionals, the interview was for the professionals to verify the suitability of each category and its criteria. Once criteria have been verified, comparison between these criteria were made to generate weights according to the relative importance. In order to do that, the use the Analytic Hierarchy Process (AHP) technique was employed to make comparison between the criteria to form the basis for the development of a new rating tool for Ghana.

RESULTS AND DISCISSION

Characteristics of Respondents

The characteristics of the respondents were analyzed to ascertain their gender, highest educational level, years of professional practice, the number of works related to sustainable buildings they have worked on over the years and the region they practice their profession in Ghana. The results are presented in Table 5.

Table 5: Characteristics of Respondents (n=146)

Characteristic	Responses	Frequency	Percent (%)
Gender	Male	113	77.4
	Female	33	22.6
Highest educational qualification	Bachelor's degree	93	63.7
	Master's degree	41	28.1
	Others	12	8.2
Work experience	< 2 years	8	5.5
	2 – 5 years	37	25.3
	6 – 10 years	86	58.9
	> 10 years	15	10.3
Number of works on sustainable building	Never	23	15.8
	1 - 10	62	42.5
	11 - 20	26	17.8
	> 20	35	23.9
Region of practice in Ghana	Greater Accra	67	45.8
	Central	23	15.8
	Ashanti	42	28.8
	Brong-Ahafo	14	9.6

Policy on sustainable development in Ghana

This section deals with the analysis on the policies on sustainable development in Ghana. This section seeks to determine from the respondents the relevance in employing policies and codes to regulate sustainable building practices in Ghana. Successively, respondents were asked to indicate their level of agreement from scale of 1 to 4, the need to have and apply formulated policies from government to guide sustainable building practice. Where 1=strongly disagree, 2=disagree, 3=agree, and 4=strongly agree. A mean value of 2.00 or greater is deemed to be a level of agreement. Table 6 presents the results obtained from the respondents.

Table 6: Policy on sustainable development in Ghana (n = 146)

Sustainable Policy	Frequency				Mean	SD
	SD	D	A	SA		
Sustainable development depends on Government policies	17	23	54	52	2.96	0.99
Policies in Ghana encourages sustainable practice	44	46	54	2	2.09	0.84
Policies are sufficient in building sustainable in Ghana	28	90	23	5	2.03	0.69
Policies should be amended	2	6	52	86	3.52	0.64
Policies should be obligatory	2	17	35	92	3.48	0.75
Policy co-ordination and regulations should be centralized in one body	0	37	71	38	3.00	0.71
Policies should regulate new buildings	7	47	51	41	2.86	0.88
Policies should apply to all kinds of structural development	0	8	53	85	3.52	0.60
Policies should factor in environmental, economic and social issues	2	3	52	89	3.56	0.60
Criteria for professional selection should include demonstrated knowledge of green building practices	6	4	88	48	3.21	0.68

SD=Strongly Disagree, D=Disagree, A=Agree, SA=Strongly Agree

All of the variables or items analyzed had mean values greater than 2.00 as can be seen in Table 6. The respondents rated policies should factor in environmental, economic and social issues highest with mean value of 3.56. This was followed by policies should apply to all kinds of structural development, policies should be amended, policies should be obligatory, criteria for professional selection should include demonstrated knowledge of green building practices and policy co-ordination and regulations should be centralized in one body with mean values 3.00 and above. Sustainable construction cliché is fast becoming a widespread phenomenon globally and among industry players. Djokoto et al. (2014) identify the lack of policy and codes to regulate the practice as the major barrier to sustainable building practice in Ghana. A sustainable policy seeks to drive forward the sustainable construction by providing clarity around the existing policy framework, signaling the future direction of Government policy and showing what can be done towards making sure they are enforced. The respondents indicated that policies should factor in environmental, economic and social issues of sustainability for the full balance of sustainable principles as also indicated by Ikediashi, Ogunlana and Ujene (2014) and Danso (2015). Schwartz and Raslan (2013) also identified that rating systems are developed to assess the sustainability of a building in accordance with the economic, cultural and ecological environment they are being used in, it was therefore of no surprise when the respondents also indicated that all the dimensions should be factored in the policies. The respondents also believed that policies should apply to all kinds of structural development, be amended, and be obligatory. Also the respondents demonstrated through their responses that professionalism is essential towards suitable sustainable practice so therefore professional selection should include demonstrated knowledge of green building practices as architects educated in green design better serve their clients by designing buildings that cost less to occupy and maintain as Kats (2003) propounded. Factors that determine a building's performance, such as site selection; orientation; foundation, walls, and roof; heating, cooling, and ventilation; and lighting, are either directly or indirectly influenced by the design decisions of the architect (Kats, 2003).

Challenges that building practitioners face in applying building sustainability modules in Ghana

This section analyses the challenges that practitioners face in applying sustainable building modules in Ghana. The respondents were therefore asked to indicate their views by ranking the challenges on a Likert scale of 1 to 4, where 1= strongly disagree, 2= disagree, 3=agree and 4= strongly agree. A mean value of 2.00 or greater is deemed to be a level of agreement. Table 7 presents the results obtained from the respondents.

All of the variables or items analyzed had mean values of 2.00 or greater as can be seen in Table 7. This therefore indicates that respondents largely agreed with the challenges of sustainable development in the construction industry in Ghana. The respondents rated initial and operational cost of sustainable buildings are very high as compare to the conventional buildings first with mean value of 3.19. This was followed by lack of government support and financial incentives in the industry, buildings that attain sustainable certification should be embossed with the certificate to encourage other building owners, learning and skills training on sustainable construction is inadequate in the country, commitment level of stakeholders in the industry is very minimal and not enough research has been carried out on sustainable development to ascertain its viability and practicality all recording mean values greater than 3.00. Rehm and Ade (2013) emphasis that green building construction costs is higher on average.

Table 7: Challenges of sustainable development in Ghana (n =146)

Challenge	Mean	SD	Rank
Initial and operational cost of sustainable buildings are very high as compare to the conventional buildings	3.19	0.65	1st
Sustainable buildings do not ensure value for money	2.00	0.69	10th
Professionals in the construction industry are not well versed in sustainable building practices	2.35	0.84	9th
Materials and technologies know-how are not readily available in Ghana	2.47	0.89	8th
Commitment level of stakeholders in the industry is very minimal	3.07	0.86	5th
Learning and skills training on sustainable construction is inadequate in the country	3.08	0.79	4th
Buildings that attain sustainable certification should be embossed with the certificate to encourage other building owners	3.10	0.70	3rd
No clear and consistent guidelines or framework for measuring sustainable construction	2.84	0.47	7th
Not enough research has been carried out on sustainable development to ascertain its viability and practicality	3.06	0.74	6th
Lack of Government support and financial incentives in the industry	3.13	0.78	2nd

Most of the respondents perceived sustainable construction to be expensive due to the varied new ideas, systems and components emanating frequently and which are considered expensive to acquire, install and operate. This therefore, leads to the general apathy attached to green building products (Kats, 2003). Governments have important role to promote green building development. Naturally for a developing country like Ghana, the need to have a government ready to lead in the provision of sustainable construction is vital and critical (Ofori, 2006). Physical visual inscription of sustainability status on buildings may serve as an incentive and awareness creation of the subject. According to Dzokoto et al. (2014), the Toronto Green Development Standard (TGDS) indicated that public awareness about green building was the most important component that led to high demand in Canada. Asamoah and Decardi-Nelson (2014) concluded that many of the construction projects in Ghana are becoming larger and more technical in sustainability and will require a higher quality of professional services and better control systems to meet the needs of the growing population. This therefore needs investment in training skills for the survival of the construction industry. Häkkinen and Belloni (2011) posited that sustainable building practice can be hindered by ignorance or a lack of common understanding about sustainability, and this therefore calls for adequate training and continuance skills development which most of the respondents agreed as lacking in the Ghanaian green building industry.

Sustainable assessment tools use in Ghana

In this section, the respondents were asked to indicate their knowledge on the existence and functions of assessment tools in Ghana. The respondents were asked to acknowledge whether or not they know or have heard of any sustainable building assessment tool used in Ghana and name them. Out of the 146 respondents, 83 representing 56.8% said "Yes" indicating they know of sustainability assessment tools use in Ghana, while 63 representing 43.2% said "No" as shown in Table 8. All the 43.2% that answered "No" did not give any name.19.1% of the respondents provided Green Star (Eco Homes) as the tool used in Ghana and 31.5% wrote "Others" ranging from BREEAM, LEED, Building Code etc. as the building assessment or rating tools they know of being use in Ghana. This implies that the knowledge does not match practice as noted by Nduka and Sotumbo (2014) and Abidin (2010) and perhaps, the Ghana Green Building Council, needs to engage in more of educational programs which will translate the awareness into practice.

Table 8: Sustainable building assessment tools use in Ghana

Responses	Frequencies	Percentage (%)
Yes	83	56.8
No	63	43.2
If "Yes" kindly name them:		
Not sure	9	6.2
Green star (Eco Homes)	28	19.1
Others (BREEAM, LEED, Building Code, etc)	46	31.5

On the functions of assessment tools use in Ghana, the respondents responded to the variables in the Table 9. All of the variables or items analyzed had mean values greater than 2.00. It can be observed that the respondents rated *tool used in assessing the sustainability of buildings in Ghana needs to be updated or changed* highest with mean value of 3.47. This was followed by rating tool for office and commercial buildings should be different from the *rating tool for a residential facility, the assessment tool used in Ghana should be or can be modified to reflect conditions in Ghana, and the rating criteria for office and commercial buildings should be different from the rating of residential facility*. All these variables obtained mean values greater than 3.00.

Table 9: Functional assessment of sustainable tools use in Ghana

Functional assessment	Mean	SD	Rank
Tool used in assessing the sustainability of buildings in Ghana is very efficient and effective	2.18	0.67	10th
Tool used in assessing the sustainability of buildings in Ghana needs to be updated or changed	3.47	0.52	1st
A single tool to rate all kinds of buildings is appropriate	2.38	0.91	9th
Tool used to assess sustainability of buildings in Ghana considers all aspects of sustainability dimensions	2.60	0.61	7th
A rating tool for office and commercial buildings should be different from the rating tool for a residential facility	3.35	0.48	2nd
The rating criteria for office and commercial buildings should be different from the rating of residential facility	3.17	0.48	4th
Measuring sustainability is relatively new in Ghana and so there is a lack of commonly accepted standard	2.95	0.70	5th
The tool used in assessing the sustainability of buildings in Ghana is very easy and simple to understand	2.15	0.65	11th
There is lack of assessment of building performance during operating stage with the current assessment tool used in Ghana	2.56	0.89	8th
The assessment tool focuses on social aspects of sustainability such as stakeholder engagement; health and safety performance	2.66	0.52	6th
The assessment tool used in Ghana should be or can be modified to reflect conditions in Ghana	3.27	0.70	3rd

The respondents were highly of the view that tools used in assessing the sustainability of buildings in Ghana need to be updated or changed, due to the fact that the tools found in the country were not design to meet the existing conditions in Ghana. This, therefore, suggests the need for the country to develop its own assessment tool which takes into consideration the existing conditions, instead of applying tools that were design for other countries. It is in light of this that the respondents agreed that assessment tool used in Ghana should be or can be modified to reflect conditions in Ghana. Ahmed et al. (2014) agreed with the respondents that, a single tool used to rate the sustainability status of all kinds of buildings is not appropriate, they identified a deficiency in the tools used in Ghana as failing to consider the interaction among different actions towards sustainability. This is in line with the respondents rating that a rating tool for office and commercial buildings should be different from the rating tool for a residential facility. Similarly, clearer building rating systems will result in more sustainable buildings and practices as espouse by Ahmed et al. (2014). Suopajarvi (2011) identified that an effective and efficient rating tool should include sustainability assessment indicators used for providing summaries and to focus and condense the complex surroundings into a form of manageable indicators. Building rating systems were developed as a means for the construction industry to meet the sustainability challenges.

The proposed green building rating tool for Ghana [Green Rating & Measurement System for Ghana (GRMSG)]

The Analytic Hierarchy Process (AHP) method was employed to select a rating tool among the key ones analyzed in order to choose one that best measure indicators similar to the condition of Ghana. This criterion was then modified to suit the prevailing conditions in Ghana. Table 10 presents the AHP analyses in details.

Table 10: Analytic Hierarchy Process (AHP) method for the selection

	BREEAM	LEED	GBCS	GREEN STAR		
BREEAM	1.000	0.200	0.111	3.000		
LEED	5.000	1.000	0.142	5.000		
GBCS	9.000	7.000	1.000	0.111		
GREEN STAR	0.333	0.200	9.000	1.000		
SUM	15.333	8.400	10.253	9.111	WEIGHT	PERCENT
BREEAM	0.065	0.023	0.010	0.329	0.107	10.7%
LEED	0.326	0.119	0.013	0.548	0.251	25.2%
GBCS	0.586	0.833	0.097	0.012	0.382	38.3%
GREEN STAR	0.021	0.023	0.877	0.109	0.257	25.8%

A number building practitioners within the four regions under study were interviewed based on their experience in the construction industry through design to supervision of works. The interview was based on the outcome of the AHP analyses which projected the Green Building Certification System (GBCS) as the rating tool preferably to be modify to suit Ghana's condition. From Table 10, GBCS got the highest percentage (38.3%). The interview focused on the nine (9) main categories which comprises of the following: Land Development with 4 criteria, Transportation having 3 criteria, and Energy Efficiency, Materials Resources Efficiency, Water Efficiency containing 4, 8 and 5 criteria, respectively. The rest are Carbon Emissions reduction with 1 criterion, Maintenance / Innovation /Management having 3 criteria, Environment ecology and Indoor Environmental Quality (IEQ) with 4 and 8 criteria, respectively. The interview with the practitioners resulted in the above mentioned categories as being able to adequately measure sustainability of buildings in Ghana.

Table: 11: Propose "Green Rating & Measurement System for Ghana (GRMSG)"

Categories	Criteria	Benchmark Point (BMP)		
		Weight	TW	Possible Points
Land Development	Ecological Value of Site	1		
	Preservation of Existing Natural Resources	1	4	12
	Interference with Daylight to Adjacent Properties	1		
	Provision of Community Center and/or Facilities	1		
Transportation	Accessibility to Public Transportation	1		
	Installation of Bicycle Racks And Roads	0.5	2	6
	Easy Accessibility to City centers	0.5		
Energy Efficiency	Reduction of Annual Energy Consumption	1.5		
	Use of Alternative renewable Energy Sources such as solar etc.	2	6.5	19.5
	Use of motion and daylight sensors	2		
	Daylight & natural ventilation	1		
Materials Resources Efficiency	Application of Environmentally Friendly Construction Methods/Materials	3		
	Locally sourced materials	2		
	Built-In Furniture	1	14	42
	Installation of Recycling Containers	2		
	Installation of Food Waste Containers	2		
	Reuse-Nonstructural Elements	1		
	Use of Recycled-Content Materials	2		
	Reuse-Structural Elements	1		
Water Efficiency	Water Efficient Landscaping	1		
	Water Use Reduction	1		
	Installation of Storm water Reuse Systems	1	5	15
	Installation of Gray water Reuse Systems	1		
	Rain water harvesting	1		
Atmosphere/ Emissions	Reduction of CO_2 Emissions	3	3	9
Maintenance/ Innovation/ Management	Waste Management and Reduction Planning	1		
	Health and safety management planning	0.5		
	Provision of a Building Manager's Manual	0.5	2.5	7.5
	Provision of an Occupant's Operations and Maintenance Manual	0.5		
Ecological Environment	Consistent Green Space in the Complex	2		
	Application of Planned Landscaping	1		
	Improving the Local Ecological Environment	1.5	5	15
	Topsoil Reuse	0.5		
Indoor Environmental Quality	Use of Low-Emitting Materials	3		
	Installation and Controllability of thermal and cooling System	1		
	Noise Between Floors prevention	0.5	8	24
	Noise Between Walls prevention	0.5		
	Noise from Outside prevention	0.5		
	Accessibility for The Disabled and Elderly	1		
	Increased natural Ventilation	1.5		
Categories = 9	Criteria = 40	50	50	150

These categories and criteria were obtained by shortlisting from the existing rating tool that the AHP suggested as the most suitable for the Ghanaian industry. The weightings are based on the magnitude of the category and criteria's ability to impact on sustainability, it is also based on readily availability and cost of procurement as well as installation of the component. For example, installing bicycle rack is much cheaper than installing renewable source of energy such as solar systems or wind turbine, so the weight of the two varies in terms of the weighting points. Table 11 throws more highlight on the categories as well as the criteria with it respective weightings and possible points. The total weight (TW) is the sum of all the criteria weights whiles the Possible points of a category is obtained by multiplying the TW by the Benchmark point of three (3) for each category.

As there was an assigned benchmark point (BMP) of three (3) for each category, the weighting value accrued by a project by the BMP will form the accrued points for the proposed assessment tool. The total possible accrued point is one hundred and fifty (150) and a minimum accrued points for a certification is forty (40). Any building is therefore required to earn a minimum point to attain a certification. Buildings earning higher scores will be rewarded with different certification levels depending on the specific thresholds they reach. The proposed GRMSG will have four certification levels which include: Bronze (40-59 points), Silver (60-79 points), Gold (80 -105 points), and Diamond (106 – 150 points) as shown in Table 12.

Table 12: Certification levels

Rating	Score
Diamond	106 - 150
Gold	80 - 105
Silver	60 - 79
Bronze	40 - 59

SUMMARY AND CONCLUSION

The study aimed at analyzing the existing sustainable assessment tools and develop one for the Ghanaian construction industry. It also seeks to assess sustainability policies and challenges for effective delivering of sustainable buildings in Ghana. The study revealed that policies backing sustainable building construction in Ghana are inadequate and existing ones should: factor in environmental, economic and social issues; apply to all kinds of structural development; and be obligatory. The key challenges identified with sustainable buildings include: high initial and operational cost, lack of government support and financial incentives, lack of certification, inadequate skill training, and minimal commitment level and research. The study further revealed that the rating tool most used in Ghana is the Green Star Eco Homes which was adopted from Green Star Australia (GS A-v1) and South Africa (GS SA-v1), and most responded did not know the name of the rating tool used in Ghana. On the functions of assessment tools use in Ghana, it was observed that the rated tool needs to be updated or changed, the rating tool for office and commercial buildings should be different from that of a residential facility, and the tool should be modified to reflect conditions in Ghana. "Green Rating & Measurement System for Ghana (GRMSG)" was proposed to be employed for use in Ghana, which comprises of: nine (9) main categories, forty (40) criteria, one hundred and fifty (150) total possible accrued point, and four (4) certification levels (Bronze, Silver, Gold and Diamond). From the forgoing, the study concludes that policies on sustainable construction practices in Ghana are inadequate, there are key challenges that government need to address and the rating tool used should be modified to reflect conditions in Ghana. The study has proposed a rating tool for Ghana, known as the Green Rating &

Measurement System for Ghana (GAMS), and therefore, the Ghana Green Building Council (GHGBC) should consider its adoption for use in assessing and certifying green buildings in Ghana.

REFERENCES

Abidin, N. Z. (2010). Investigating the Awareness and Application of Sustainable Construction Concept by Malaysian Developers. Habitat International, 34(4), 421-426.

Ahadzie D.K., Proverbs D.G., Olomolaiye P.O. & Ankrah N.A. (2009). Competencies required by project managers for housing construction in Ghana: Implications for CPD agenda. Engineering, Construction and Architectural Management, 16(4), 353-375, https://doi.org/10.1108/09699980910970842

Alfris, M. & Braune, M. (2016). Applying Green Star SA to Ghana: Local Context Report (For the One Airport Square Project); GhGBC and GBCSA.

Ahmed K., Hatira, L. & Valva, P. (2014). The Construction Industry in Ghana, West Africa "How can the construction industry in Ghana become sustainable?" Master's Thesis, Department of Strategic Sustainable Development Blekinge Institute of Technology Karlskrona, Sweden.

Asamoah, R.O. & Decardi-Nelson, I. (2014). Promoting Trust and Confidence in the Construction Industry in Ghana through the Development and Enforcement of Ethics. Information and Knowledge, 3(4), 63-68.

Bainbridge D.A. (2004). Sustainable building as appropriate technology. In Building without Borders: Sustainable Construction for the Global Village; Kennedy, J., Ed.; New Society Publishers, Gabriola Island, Canada, 55–84.

Bernard, H.R. (2002). Research methods in anthropology: qualitative and quantitative approaches. 3rd alta mira press; walnut creek, CA.

Chehrzad M, Pooshideh S. M., Hosseini, A. J. & Majrouhi-Sardroud, J. (2016). A review on green building assessment tools: rating, calculation and decision-making" Department of Civil Engineering, Central Tehran Branch, Islamic Azad University, Iran

Danso, H. (2018a). Identification of Key Indicators for Sustainable Construction Materials. Advances in Materials Science and Engineering, 2018, 1-7. https://doi.org/10.1155/2018/6916258.

Danso, H. (2018b). Dimensions and Indicators for Sustainable Construction Materials: A Review. Research & Development in Material Science, 3(4), 1-9. DOI: RDMS.000568.2018.

Djokoto S.D., Dadzie, J. & Ohemeng-Ababio, E. (2014). Barriers to Sustainable Construction in the Ghanaian Construction Industry: Consultants Perspectives. Journal of Sustainable Development; 7(1), 134-143.

Danso, H. (2015). Use of agricultural waste fibres as enhancement of soil blocks for low-cost housing in Ghana. PhD Thesis, School of Civil Engineering and Surveying, University of Portsmouth, http://eprints.port.ac.uk/id/eprint/20762

Ding, G.K.C. (2008). Sustainable construction: the role of environmental assessment tools. Journal of Environmental Management, 86(3), 451–64.

Giannetti, E. (1993). Vícios Privados, Benefícios Públicos? A Ética na Riqueza das Nações, Companhia das Letras, Lisbon.

Häkkinen, T. & Belloni, K. (2011). Barriers and drivers for sustainable building. Building Research & Information, 39(3), 239-255.

Ikediashi, D. I., Ogunlana, S. O. & Ujene, A. O. (2014). An Investigation on Policy Direction and Drivers for Sustainable Facilities Management Practice in Nigeria. Journal of Facilities Management, 12(3), 303-322.

Kats G.H. (2003). Green Building Costs and Financial Benefits. Massachusetts Technology Collaborative, USA

Kim J. J. & Rigdon, B. (1998). Sustainable Architecture Module: Introduction to Sustainable Design. Michigan: National Pollution Prevention Center for Higher Education.

Malhotra N. K., & Birks, D. F., (2007). MARKETING research: an applied approach, financial times prentice, hall//trove.nla.gov.au/work/6855755

Muhwezi L., Kiberu F., Kyakula M., & Batambuze A. O. (2012). An Assessment of the Impact of Construction Activities on the Environment in Uganda: A Case Study of Iganga Municipality. KICEM Journal of Construction Engineering and Project Management, 2(4), 20-24, http://dx.doi.org/10.6106/JCEPM.2012.2.4.020

Newman P. & Kenworthy J. (2006). Urban Design to Reduce Automobile Dependence. An International Journal of Suburban and Metropolitan Studies, 2(1), 35-52, http://repositories.cdlib.org/cssd/opolis/vol2/iss1/art3.

Nduka, D. O. & Sotumbo, A. S. (2014). Perception on the Awareness of Green Building Rating Systems and Accrual Benefits in the Construction Industry in Nigeria. Journal of Sustainable Development in Africa, 16(7), 118-130.

Ofori G. (2006). Attaining sustainability through construction procurement in Singapore. CIB W092–Procurement Systems Conference 2006, Salford, UK.

Ortiz O., Castells F. and Sonnemann G. (2009). Sustainability in the construction industry: A review of recent developments based on LCA. Construction and Building Materials, 23(1), 28–39, https://doi.org/10.1016/j.conbuildmat.2007.11.012

Rehm, M. & Ade, R. (2013). Construction costs comparison between 'green' and conventional office buildings. Building Research & Information, 41(2), 198-208. http://dx.doi.org/10.1080/09613218.2013.769145

Sinou, M., & Kyvelou, S. (2006). Present and future of building performance assessment tools. Management of Environmental Quality: An International Journal, 17(5), 570–586.

Schwartz Y, and Raslan R. (2013). Variations in results of building energy simulation assessment tools, and their impact on BREEAM and LEED ratings: A case study. Energy and Buildings, 62, 350–359, http://dx.doi.org/10.1016/j.enbuild.2013.03.022.

Suopajarvi, H. J. (2011). Sustainability Assessment: Principles, Frameworks, Indicators and Tools. http://www.oulu.fi/sites/default/files/content/Suopajärvi-Hannu-Coursework_modified.pdf.

World Conservation Union (IUCN) (2006). Guidelines for Application of IUCN Red List Criteria at regional levels: IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK.

Wyatt, D. P. (1994). Recycling and Serviceability: The Twin Approach to Securing Sustainable Construction: Proceedings of First International Conference of CIB TG 16 on Sustainable Construction, Tampa, Florida, USA, 6-9 November, pp. 69-78.

Yaro J. A. (2010). The social dimensions of adaptation of climate change in Ghana. Development and climate change discussion paper no. 15. Washington, DC: World Bank.