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TOWARDS DEVELOPING A SUSTAINABILITY ASSESSMENT FRAMEWORK FOR BUILDINGS IN UGANDA: A LITERATURE REVIEW

JULIUS SEMANDA [1], SIBUSISO MOYO [2], SAMUEL HP CHIKAFALIMANI [3] and NATHAN KIBWAMI [4]

[1, 3] Department of Entrepreneurial Studies and Management, Durban University of Technology, Durban, South Africa.
[2] Research, Innovation, and Postgraduate Studies & School for Data Science and Computational Thinking, Stellenbosch, South Africa.
[4] Department of Construction Economics and Management, Makerere University, Kampala, Uganda.
Email: [1] 22064549@dut4life.ac.za, [2] smoyo@sun.ac.za, [3] samuelc@dut.ac.za, [4] nathan.kibwami@mak.ac.ug

Abstract

The construction sector is one of the main contributors to sustainable development, and its importance in encouraging environmental protection, economic growth, and social advancement is undeniable. The present study reviewed existing literature to help develop a framework for assessing the sustainability of buildings in Uganda. To develop the framework, indicators were needed, therefore, sustainability indicators from the main sustainability rating tools like BREEAM, LEED, CASBEE, Green Star and IGBC, and the various journals were established. A systematic literature review of accessible literature was the research approach used. Inadequate public education and awareness, construction process technicalities, higher costs of sustainable building processes and materials, bureaucracy processes, unfamiliarity with sustainable technology, and lack of sustainable product information, were singled out as the main challenges for implementing sustainability processes in developing countries coupled with regional differences in local conditions, policies, and regulations in different countries. Embracing and implementing sustainability practices offers protection of air, water, land, and ecosystems, promotes harmony among people and between humanity and nature, and improves economic growth. Since no sustainability assessment tool/framework of buildings exists in Uganda, the study aims to establish one, to be able to foster sustainability practices. However, establishing policies, regulations, incentives, awareness, and industry support are important to promote sustainability in Uganda.

Keywords: Sustainability, Sustainable Development, Indicators, Building, Rating Tool

1. INTRODUCTION

1.1 Background

The concept of sustainability has gained broad recognition in the construction industry due to the adverse impact of construction activities on the natural environment (Rode, Burdett and Soares-Gonçalves, 2011). Forbes (2008) defines sustainability assessment is a procedure used to evaluate whether environmental and societal changes arising from man's activities and use of resources are decreasing or increasing our ability to maintain long-run sustainability. According to Pope, Annandale and Morrison-Saunders (2004) sustainability assessment is used to evaluate the impacts of policies, plans, and projects to ascertain the extent to which they affect sustainable development. 'Sustainability' originates from the Latin word *sustinere*, which means 'maintain', 'support', or 'endure'(Onions, 1967). According to Yılmaz and Bakış

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(2015); Bragança, Mateus and Koukkari (2010), sustainability means using natural resources in such an equilibrium condition that they do not reach decay, depletion, and unrenewable point and handing down the next generations by developing them. This agrees with Brundtland's report United Nations (1987) which declared that sustainability means "meeting the needs and expectations of the present without compromising future generations to meet their own needs and expectations". Furthermore, Hoşkara (2007) states that sustainability seems to be a concept of every field ranging from global development policy to the usage of energy sources and from production planning to architectural design in our age.

Bragança, Mateus and Koukkari (2010) postulated that a building project can be regarded as sustainable only when all the various dimensions of sustainability (environmental, economic, social, and cultural) are dealt with. He continued to mention that the various sustainability issues are interwoven, and the interaction of a building with its surroundings is also important (Bragança, Mateus and Koukkari 2010). Several studies conducted support the adoption of sustainability assessment as it promotes the conservation of natural resources, protection of the biosphere, minimization of waste production; improvement of economic growth, reduction of energy consumption, and costs, minimization of environmental damage costs; improves quality of life for all, alleviate poverty, satisfy human needs, promotes harmony among people and between humanity and nature (Ramadan 2022; Assylbekov *et al.,* 2021; Zarghami and Fatourehchi 2020). In addition, Bragança, Mateus and Koukkari (2010) depicted the purpose of sustainability assessments as to gather and report information for decision-making during different phases of building construction, design, and use. Furthermore, project owners are usually advised by local public authorities to undertake sustainability assessments before and after project development so as to make subsequent assessments to consider the design and management of each phase of a building's life cycle, including its demolition and disposal as waste. For such reasons, the sustainability assessment tools used in building construction have received much attention. However, assessing the impact of buildings on sustainability is not straightforward (Bragança, Mateus and Koukkari 2010).

Notably, Akhanova et al., (2019) explained that sustainability assessment tools serve as reference methods for building practitioners to promote building sustainability by setting design priorities and goals and quantifying environmental performance. In addition, Cole (2003); Ando *et al.,* (2005); Alshamrani, Galal and Alkass (2014) point out that assessment tools can be used to evaluate performance measures and collect information that guides sustainable design and help decision-making processes. Furthermore, Nguyen and Altan (2011) postulated that the basic importance of sustainability assessment tools includes to: (1) Improve buildings' functional performance; (2) decrease environmental burden; (3) estimate buildings' environmental influence; and (4) objectively assess and evaluate buildings' development. Sustainability indicators form the basis of the assessment and help the sustainability rating tools to do the assessment for the performance of a building and hence Fowler and Rauch (2006) defines the sustainability rating tool as "tools that examine the performance or expected performance of a 'whole building' and translate that examination into an overall assessment that allows for comparison against other buildings". Research according to Assefa et al., (2022) shows that the most prominent sustainability rating tools include BREEAM, LEED, and

CASBEE. Von Bertalanffy (1968); Lai and Huili Lin (2017) demonstrate that according to systems theory, all parts of a system must work together to achieve its goals. The purpose of this paper is to establish the sustainability assessment indicators and the possible challenges associated with embracing sustainability practices with the future aim of developing a sustainability assessment framework for buildings in Uganda.

1.2 Problem statement

The first generation rating tools including BREEAM, LEED and CASBEE are used in developed countries (Lee and Burnett (2006); Ding (2008); Cole, (2003); Assefa, Lee and Shiue (2022). Interestingly, research by Akhanova *et al*., (2019) and Gou and Xie (2017) shows that these tools were developed for evaluating sustainable buildings in particular regions based on local sustainability requirements. Therefore, due to the variations in cultural perceptions, climate, geography and natural resources availability, a system established for a specific region may not be suitable for adoption in another region (Banani *et al.,* 2016; Cole, 2003). It's against this background that a developing country like Uganda needs a building sustainability assessment system. The aim of the wider research is to develop a building sustainability assessment framework for buildings in Uganda with the approach to adapting pertinent indicators and assessment items of selected well-recognized international assessment systems and journals pertaining to sustainability assessment. The present paper focuses on the following objectives;

a. To identify building sustainability indicators

b. To establish the suitable applicable sustainability assessment tools

c. To identify challenges of sustainability assessment

d. To propose a way forward on developing the sustainability assessment framework.

The developed framework should match the Ugandan context and should be addressing all buildings. This framework will serve as a reference for developing a National/Regional sustainability assessment system, and guide policymakers and designers to construct and operate sustainable buildings in Uganda.

2. RESEARCH METHODOLOGY

2.1 Research approach

The methodology followed a literature review method. Research by Gough, *et al.,* (2017); Badi and Murtagh (2019); and Green (2005) suggests that a systematic literature review is a structured, transparent and reproducible method, characterized by being an objective, replicable approach that can provide a comprehensive knowledge of scientific research published in a given field of study. Additionally, Tranfield, Denyer and Smart (2003)) stresses that the aim of a literature review is to identify gaps in the literature as well as addressing existing limitations on a given topic. According to de Oliveira *et al.,* (2023), literature review is one of the crucial parts of the content of the paper because it facilitates the researcher to be able to point out research gaps from previous studies. This study reviewed the various global

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environmental, social, and economic sustainability indicators in the construction industry. The PRISMA Framework was used to analyze the past literature review to develop a systematic literature review. Khan and Qureshi (2020) explains that the PRISMA statement framework demonstrates the overview process of selection and exclusion of publications for the review. Research further stresses that the PRISMA model can assist the researcher to focus on improving the review paper reporting (Khan and Qureshi 2020). The steps in the PRISMA framework include Identification, Screening, Eligibility, and Included. Using this PRISMA framework helps the researcher to go smoothly among all the information gained from the databases.

2.2 Selection criteria

The reviewed papers were selected from Scopus, google scholar, and PubMed databases using keywords contained in Table 1 and the results that came out were 1228 documents. The process of the review is explained in figure 1 below. The inclusive dates for the searches ranged from January 2000 to January 2023 covering a total of 23 years. Only English-language peer-reviewed journal papers and conference papers were included. Furthermore, some of the sources were rejected based on irrelevancy in terms of context and content and papers whose full text could not be accessed, duplicates, and as well as unpublished materials.

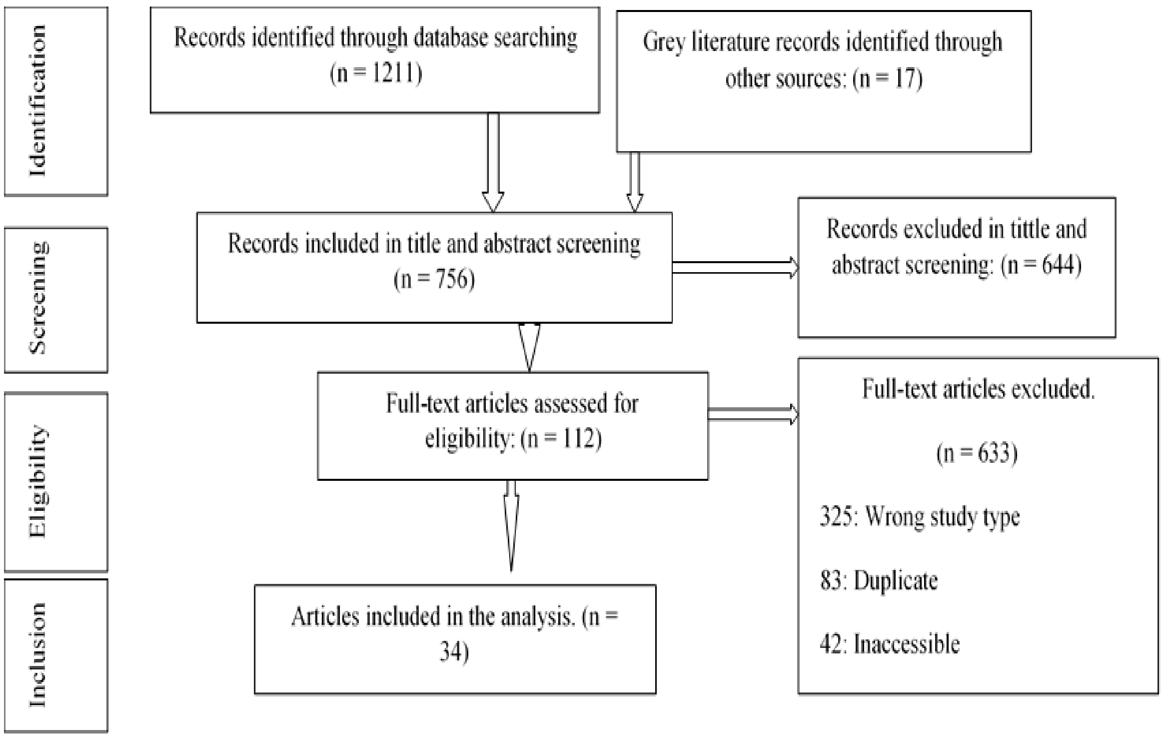

Figure 1: preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow diagram (Liberati *et al.* 2009)

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Table 1: Keyword combinations used for the database searches

Search no.	Search term
1	Sustainability indicators AND construction
2	Sustainability indicators AND environmental
3	Sustainability indicators AND economic
4	Sustainability indicators AND social AND construction
5	Sustainability indicators AND the built environment
6	Sustainability indicators AND building

3. FINDINGS AND DISCUSSION

3.1 Identification of sustainability indicators for Buildings

Sustainability indicators were identified from the various journals resulting from the search process shown in Figure 1 above. These indicators were placed under social, economic, and environmental categories as shown in Table 2. Based on the references used, construction cost was the most mentioned followed by operational and maintenance costs and building management while durability of the building was the least mentioned under the economic sustainability category. Whereas neighborhood accessibility and amenities, inclusion and cohesion, were the most mentioned under the social sustainability indicators followed by cultural and heritage conservation affordability, occupant health, comfort, and well-being, construction workforce health, and safety were the most referenced; influence on local development and migration effects were some of the least referenced social sustainability assessment indicators. Furthermore, it's evident that water and wastewater efficiency strategies indicator is highly referenced with indoor air quality, site selection, acoustic comfort, renewable materials, thermal comfort, daylighting and viewing comfort; following closely with a substantial number of references and environmental management, resource depletion and location; being the least referenced environmental sustainability assessment indicators as shown in Table 2 below. Based on the analysis, it's evident that there are no publications made on the subject in Uganda, this is traced back to the fact that sustainability assessment of buildings is indispensable and has not yet been fully embraced by most developing nations mostly on the African continent as shown in figure 2 below.

Table 2: Sustainability indicators

S/N	Sustainability indicators		
A	**Economic indicators**	**No. of Citations**	**Some supporting literature**
1	Affordability	5	Stender and Walter (2019)
2	Construction cost	8	Stender and Walter (2019); Arukala, Pancharathi and Pulukuri (2019)
3	Operational, and maintenance costs,	6	Shari, and Soebarto (2017); Aslani, Gholamreza and Ebrahimi (2015)
4	End of life costs,	3	Ahmad, and Thaheem (2018); VillarinhoRosa, and Haddad (2013)
5	Durability of the building,	1	Kamali and Hewage (2015)
6	Flexibility,	3	Ahmad, and Thaheem (2018)

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7	Integration of supply chains	2	Aslani, Gholamreza and Ebrahimi (2015)
8	Building management	6	Ahmad, and Thaheem (2018); Mahmoud, Zayed and Fahmy (2019)
9	Use of national and regional resources	2	Aslani, Gholamreza and Ebrahimi (2015); Gibberd (2017)
10	Use of regional resources	2	Aslani, Gholamreza and Ebrahimi (2015); Gibberd (2017)
B	**Social Indicators**		
1	Occupant Health, comfort, and well-being	6	Shari, and Soebarto (2017); Arukala, Pancharathi and Pulukuri (2019)
2	Influence on the economy,	2	Karji *et al.,* (2019)
3	Functionality and physical space usability,	3	AlWaer, Sibley and Lewis (2008)
4	Quality/decent Housing	2	Karji *et al.,* (2019); Mansor and Sheau-Ting (2021)
5	Aesthetic options & beauty of the building,	2	Kamali and Hewage (2015)
6	Construction workforce health and safety,	6	Karji *et al.,* (2019); Aslani, Gholamreza and Ebrahimi (2015)
7	Sustainable urban Design	3	VillarinhoRosa, and Haddad (2013); Karji *et al.,* (2019)
8	Influence on local social development,	1	Kamali and Hewage (2015)
9	Cultural & Heritage Conservation affordability	8	Stender and Walter (2019); Olukoya and Atanda (2020),
10	Safety and security,	3	Stender and Walter (2019)
11	User acceptance and satisfaction,	3	Karji *et al.,* (2019)
12	Neighborhood accessibility and amenities	9	Aslani, Gholamreza and Ebrahimi (2015); Olukoya and Atanda (2020)
13	Employment	5	Karji *et al.,* (2019); Stender and Walter (2019)
14	Migration Effects	2	Aslani, Gholamreza and Ebrahimi (2015); Heravi, Fathi & Faeghi (2015)
15	Education and Awareness	4	Gibberd (2017); Stender and Walter (2019)
16	Inclusion and Social Cohesion	9	Arukala, Pancharathi and Pulukuri (2019)
17	Innovative technology	2	AlWaer and Kirk (2012)
C	**Environmental indicators**		
1	Site selection,	12	Akhanova e*t al.,* (2019); Bragança, Mateus and Koukkari (2010)
2	Land Use and Impacts on Ecology	6	Shari and Soebarto (2017); Agyekum, Goodier and Oppon (2021)
3	Alternative transportation	4	Kamali and Hewage (2015); VillarinhoRosa and Haddad (2013)
4	Location	1	San-José *et al.,* (2007)
5	Renewable and non-renewable energy use,	4	Akhanova et al., (2019); Arukala, Pancharathi and Pulukuri (2019)
6	Energy efficiency strategies,	13	Abdel-Basset et al., (2021)
7	Embodied energy,	2	Kamali and Hewage (2015); Mahmoud, Zayed and Fahmy (2019)
8	Environmental management	1	Agyekum, Goodier and Oppon (2021)
9	Water and wastewater efficiency	16	Bragança, Mateus and Koukkari (2010);

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	strategies,		Agyekum, Goodier and Oppon (2021)
10	Regional (local) materials,	3	Kamali and Hewage (2015)
11	Durable materials	3	Aslani, Gholamreza and Ebrahimi (2015); Heravi, Fathi and Faeghi (2015)
12	Renewable materials,	9	Aslani, Gholamreza and Ebrahimi (2015); Akhanova *et al.,* (2019)
13	Construction and demolition waste management,	11	Kamali and Hewage (2015); Arukala, Pancharathi and Pulukuri (2019); Heravi, Fathi and Faeghi (2015); Agyekum, Goodier and Oppon (2021)
14	Greenhouse gas emissions,	2	Arukala, Pancharathi and Pulukuri (2019)
15	Indoor air quality,	13	Bragança, Mateus and Koukkari 2010); Kuriakose *et al.,* (2014)
16	Daylighting and viewing comfort,	9	Saraiva et al., (2018); Karji, A. et al., 2019
17	Thermal comfort,	9	Karji *et al.,* (2019); Kuriakose *et al.,* (2014)
18	Acoustic (noise) comfort	10	Bragança, Mateus and Koukkari (2010); Kuriakose *et al.,* (2014)
19	Resource depletion	1	Bragança, Mateus and Koukkari (2010)
20	Climate change	4	Arukala, Pancharathi and Pulukuri (2019)
21	Emissions to the air, water, and soil	5	Heravi, Fathi and Faeghi (2015)
22	Public Health and safety	2	Aslani, Gholamreza and Ebrahimi (2015)

3.2 Sustainability assessment tools

This study identified various sustainability indicators by studying the most common green building rating tools in four regions. Table 3 represents the criteria of each rating tool discussed in this study. The analysis in Table 3 shows that certain aspects are considered by most of the rating tools. Kamaruzzaman *et al.*, (2016) opined that energy is expected to hike in the future, a reason why most tools focus on energy, besides, Doan *et al.,* (2017) confirms that most of the green rating tools are promoted by international organisations, hence representing global concerns. Analysis shows that energy and water consumption, sustainable sites, material, waste and pollution, management, and IEQ (Internal Environmental Quality) are mentioned by all the listed rating tools. However, on analysing table 3 one can discover that there are differences in different rating tools. For example, the criterion of "environmental performance" covers a wide range of aspects of the Green Mark than the other three rating tools. Basically, it includes several sub-categories, covering sustainable construction, sustainable products, refrigerant management, and greenery provision. Langdon (2007); Hwang and Tan (2012); Illankoon *et al.,* (2016b); Kim, Greene and Kim (2014); Zhang, Platten and Shen (2011) noted that the initial cost is one of the main concerns in green building development. Therefore, the construction professionals' need not to be ignorant of cost considerations, as it would hinder the development of green buildings. Illankoon et al., (2017) found that the various global assessment tools and rating tools as in Table 3 lack integration among themselves, that's why different state governments have different policies and various requirements for the use of these tools. Therefore, it is necessary to implement a policy to integrate various policies and requirements of different countries. Based on the main policies, each country could implement plans to suit the requirements. According to the study, not any research has been made about the sustainability assessment of buildings in Uganda. This has led to a knowledge gap between

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sustainability assessment practice, its adoption/implementation, and the numerous benefits accruing from sustainability assessment implementation in Uganda.

3.3 Challenges of sustainability assessment

Ayarkwa *et al.,* (2022) found out that the lack of sustainability assessment practices in developing countries was due to a number of factors. Findings from Ayarkwa *et al.,* (2022); Hawang and Tan, (2012) outlined higher costs of sustainable building processes and materials; construction process technicalities; long bureaucratic processes; unfamiliarity with sustainable technology; inadequate public education and awareness; and lack of sustainable product information as the major challenges to implementing and embracing sustainability practices in developing countries.

3.3.1 Inadequate public education and Awareness

Kibert (2016) discussed that the conventional notion of how a building must be constructed exists, though he goes ahead to stress that due to perceived risks, many builders do not want to engage in sustainable construction. Interestingly, Agyekum *et al.,* (2019) highlighted that because of lack of understanding, environmental auditing adoption which is a beneficial sustainable building practice is usually not done. Research by Darko *et al.,* (2018) found out that due to insufficient knowledge in sustainability studies, there is inadequate public education concerning the advantages of sustainability assessment of buildings. Opoku, Ayarkwa and Agyekum (2019) postulated that this lack of awareness is a major challenge associated with sustainability assessment adoption.

3.3.2 Construction process technicalities

The processes involved in the construction of sustainable buildings could be overly complex as they may be associated with complicated technologies and construction procedures (Wu *et al.,* 2019). Moreover, Robichaud and Anantatmula (2011) postulated that the objectives of a project are hard to achieve especially when the construction complexities are not communicated early.

3.3.3 Higher Costs of sustainable building processes and Materials

Dwaikat and Ali (2016); Tagaza and Wilson (2004) contend that the estimated cost for sustainable building ranges from 1% to 25% more than conventional building and Wu *et al.,* (2019) suggested that the higher cost is a result of the complexity of the design layout coupled with modeling and green practices. More so, the use of sustainable building materials costs 3–4% more than using traditional building materials (Zhang, Platten and Shen 2011).

3.3.4 Long bureaucratic processes

Graeber (2015) reported that the bureaucratic process for accepting the use of new and modern technologies in construction projects could increase the project completion time. Zhang, Platten and Shen (2011) also outlined the lengthy approval processes that management must go through to seek acceptance of the construction processes for their projects. This lengthy approval poses many challenges, especially to the management of the project (Ling 2003).

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3.3.5 Unfamiliarity with sustainable technology

Silvius, SChIPPER and Planko (2012) explained that construction industry practitioners appear to have very little knowledge about sustainable construction materials and processes and are unfamiliar with the products, materials, system or design, this is in agreement with the reasons advanced by Eisenberg Done and Ishida (2002). Darko *et al.,* (2018) emphasized that unfamiliarity with sustainable technologies adversely affects the overall project outcome and performance.

3.3.6 Lack of sustainable product information

Studies by Schöggl, Baumgartner and Hofer (2017); Häkkinen and Belloni (2011) suggest that project team players lack information concerning sustainable materials and sustainable construction processes. Builders are continually compelled to interact with specialists who have such knowledge. Other identified challenges are risks due to the different contract forms of project delivery (Koolwijk, *et al.,* 2018) and lack of policies and more time needed to enforce sustainable building processes on construction sites (Tagaza and Wilson 2004).

From the above challenges, it is difficult for the authorities to assess existing and proposed building projects to ascertain whether they meet social, economic, and environmental, sustainability requirements. This has led to environmental degradation as buildings have cropped up in many wet areas.

3.4 Proposed way forward on developing the sustainability assessment tool/framework for Uganda.

Illankoon *et al.,* (2019) opined From that most of the sustainability assessment tools/frameworks are found/and used in developed and far nations like the United Kingdom, America, and Australia. However, these rating tools lack integration among themselves, and they cannot be used freely in different countries due to different regional climates, cultures, policies, and laws, implying that each country must develop a tool that suits the local requirements of sustainability assessment, this is in in agreement with the findings of Illankoon *et al.,* (2019). The lack of sustainability assessment practices implies missing out on the benefits of its adoption and implementation like protecting air, water, land, and ecosystems, minimizing waste production, minimizing CO_2 emission and pollutants, maintaining essential ecological processes and life support systems, improving economic growth, reducing energy consumption and costs, decreasing environmental damage costs, alleviating optimizing social benefits, improving health, comfort, and well-being, and promoting harmony among people and between humanity and nature, among others (Assylbekov *et al.,* 2021).

A sustainability assessment framework is needed to be able to enjoy the benefits associated with its practice. This framework should consist of a set of indicators that satisfy the local conditions of Uganda, used to assess the buildings to confirm whether they satisfy or fulfil the environmental, social, and economic aspects of sustainability to ensure safe and habitable housing in Uganda. The framework should be easy to use, linkable to the construction

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processes, precise, and flexible to accommodate different contract forms of project delivery, favour the interests of the built environment professionals and bring about reduced costs of the building processes and materials. However, the full implementation of sustainability practices in Uganda's construction industry requires government support through the making of regulations and laws, changing and strengthening the Ugandan building curriculum to incorporate sustainability content right from lower to higher levels of education, continuous creation of awareness about sustainability practices to the people generally and the built environment professionals, putting in place incentives and/or subsidies by the government. Additionally, the sustainability practices should encourage sustainability assessment at reduced or no tax being levied, liaising with sustainability assessment professionals from developed countries can help in implementing sustainability practices in developing countries like Uganda

4. CONCLUSION AND FURTHER RESEARCH

Sustainability assessment indicators were identified from literature where they were categorized under social, economic, and environmental where construction costs, operational and maintenance costs, building management, and affordability were the most mentioned economic sustainability indicators; neighborhood accessibility and amenities, inclusion and cohesion, cultural and heritage conservation affordability, occupant health, comfort, and well-being, construction workforce health, and safety were the most referenced social sustainability assessment indicators while water and wastewater efficiency strategies, indoor air quality, site selection, acoustic comfort, renewable materials, thermal comfort, daylighting and viewing comfort were the most mentioned environmental sustainability assessment indicators. Sustainability assessment rating tools were also established from the literature review and a number of indicators under each tool were identified. These indicators were similar to the ones from different journal literature. These tools were found to lack integration among themselves and could not be freely applied in other countries due to issues of law, local conditions, policies, and due to a host of challenges like inadequate public education and awareness, long bureaucratic processes, technicalities in construction, high costs of materials and building processes, unfamiliarity with sustainability practices as well as lack of policies.

Further research will focus on assessing the relevance and/or the importance or suitability of the identified sustainability indicators in the Ugandan construction industry, determining indices for the framework, and testing the applicability of the framework/tool for the sustainability assessment of buildings in Uganda. This will then give a basis and possibility for extending this work to a South African case study.

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Table 3: Assessment criteria of various green building rating tools

LEED (America)	BREEAM (United Kingdom)	Green Star (Australia)	IGBC Rating (India)
sites			
Sensitive land protection High priority sites Site assessment Protect or restore habitat Open space Heat island reduction	Proximity to amenities Site selection Ecological value of site and protection Enhancing site ecologyLong term impact on bio-diversity Building footprint	Ecological Value Sustainable Sites Heat Island Effect Light Pollution	Site preservation Basic amenities Proximity to building transport Natural topography and vegetation Preservation of trees
Energy			
Green power and carbon offsets Enhanced refrigerant management Renewable energy Advanced energy metering Optimized energy performance	Energy efficiency Energy monitoring External lighting Low and zero carbon technologies Energy efficient coldstorage Energy efficienttransport Energy efficientequipment Impact of refrigerants	Greenhouse Gas Emissions Peak ElectricityDemand Reduction Refrigerant Impacts Metering and Monitoring	Eco-friendly refrigerants Enhanced energy efficiencyOn-site renewable energy Off-site Renewable energy Commissioning Post-installationof equipment & systems Energy Metering and Management
Water			
Rainwater management Outdoor water use reduction Indoor water use reduction Cooling tower water use Water metering	Water quality Water consumption Water monitoring Water leak detection and prevention Water efficient equipment Surface water runoff	Potable Water Storm water	Landscape design Management of irrigation system Rainwater harvesting roof non roof Water efficient plumbing fixtures Wastewater treatment reuse Water Metering Waste-water during construction
IEQ			
Enhanced indoor air quality strategies Low emitting material Construction IAQ Management plan Indoor air quality assessment Thermal comfort Interior lighting Daylight Quality views Acoustic	Visual comfort Indoor air quality Thermal comfort Acoustic performanceNoise attenuation	Indoor AirQuality Acoustic Comfort Lighting Comfort Visual Comfort Indoor PollutantsThermal Comfort	CO_2 Monitoring Daylighting Minimum indoor and outdoorpollutants Outdoor views Low emitting material IAQ testing Occupant wellbeing facilitiesIAQ Management during construction

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performance			
Materials			
Building life cycle impact reduction Environmental product declaration Sourcing of raw material Material ingredients	Life Cycle ImpactsInsulation Responsible sourcing of material Designing for robustness Recycled aggregates Speculative floor andceiling finishes	Life Cycle Impacts Responsible Building Materials Sustainable Products Construction and Demolition Waste	Sustainable building materials Use of certified green building material
Management			
LEED accredited professional	Sustainable procurement Stakeholder participation LCC and service lifeplanning Responsible construction practices Construction site impacts	Green Star Accredited Professional Commissioningand Tuning Adaptation and Resilience Building Information Construction Environmental Management	Accredited professional Green building guidelines
Waste & pollution			
Construction and Demolition Waste Access to quality transit Bicycle facilities Reduced parking footprint Green vehicles Light pollution	Construction waste management Operational Waste Public transport accessibility Alternative modes oftransport Maximum car parkingcapacity Travel plan NO_x emission Reduce light pollution	Sustainable Transport Operational Waste	Low emitting vehicles Outdoor light pollution reduction Organize waste Management, post occupancy Handling of waste materials During construction

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