International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 8, 2025
https://theaspd.com/index.php

Suggesting Elements And Relative Weights For The Comprehensive Assessment Model For Neighborhood Sustainability (CAMNS) Compared To Eight Global Assessment Systems

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Abstract: *The rapid and ongoing urban expansion of residential areas worldwide and in Saudi Arabia has led to various adverse impacts on the natural environment, including heightened consumption of natural resources, elevated energy usage, increased environmental pollution, climate change, and detrimental effects on human health. In response, numerous measurement systems are made to assess residential neighborhood's sustainability, which serve as the fundamental building blocks of urban areas. These systems exhibit disparities in their essential components, sub-components, relative weights, and methodologies for assigning evaluation points and accreditation levels. This paper analyzes eight global assessment tools for neighborhood sustainability to find these systems' strengths, weaknesses, and shortcomings.*

This research aims to find an assessment model that comprehensively covers the aspects of neighborhood sustainability, which this paper proposes as the Comprehensive Assessment Model for Neighborhood Sustainability (CAMNS). This research analyzes eight global assessment tools for neighborhood sustainability to find these systems' strengths, weaknesses, and shortcomings. A three-level structure is proposed for the new CAMNS model. This paper covers the first and second levels of the proposed structure. The first level represents the four pillars of sustainability. Under these four pillars, 16 sub-elements are ideal for assessing neighborhood sustainability. The research also suggested the appropriate relative weighting of the primary and sub-items in line with the instruments under study, taking into account the coverage of all components of the assessment model.
Keywords: *Saudi Arabia, economic, environmental, neighborhoods, sustainability, CAMNS, assessment, model.*

1. INTRODUCTION

The rapid urbanization witnessed in Saudi Arabia over recent decades has had detrimental effects on the natural environment and society. As a response, there's a pressing need to establish a robust system to guide sustainable development within residential areas. This system should not only measure the extent of adherence to sustainability criteria but also provide guidelines and assessment mechanisms that comprehensively consider social, economic, environmental, and institutional dimensions (McGee, 2008).
The ongoing expansion of urban areas of the Kingdom has set an alarming acceleration in the consumption of natural resources, escalating energy usage, heightened environmental pollution, and adverse impacts on human health (Habitat, 2022). One of the significant issues is in the area of energy consumption, especially in the use of air conditioning, given the prevailing hot weather in the country and the increased population as projected (McGee, 2008; UN_DESA/Energy, 2021).
Furthermore, transportation is a major contributor to energy demand, primarily in the form of personal cars, which is further aggravated by the weak uptake of public transport systems. The Energy Efficiency Center in the Kingdom did a study to find out the poor FE of vehicles in Saudi Arabia compared to other nations (Bioregional, 2018). Climate change aggravates these difficulties; high-temperature variations and polluted air threaten many sectors (KAUST-AEE, 2014). Population growth in urban areas increased the emission of greenhouse gases, hence increasing the greenhouse effect and soil pollution (UN_DESA/Population, 2022.).
Additionally, there has been growth in the extent of urbanization, resulting in increased emissions from the transportation sector, power generation activities, and water desalination processes, thus causing air and soil pollution (IQAir, 2023). This expansion has also brought about poor lifestyles among the people, hence increasing cases of obesity and diseases caused by poor lifestyles and pollution. In the residential sector, energy consumption is high, and among the major consumers is air conditioning. Some of them include the poor insulation of buildings and have more to do with cultural beliefs and practices (SEEC/Transportation, 2023). The study's objectives are to enhance residents' lifestyle quality and advance the quality of living standards of the residential areas in the Kingdom, following Vision 2030's objectives. It aims to increase the sustainability of Saudi neighborhoods by creating an unprecedented

assessment model in this field. There is a definitive strategy or system for evaluating the sustainability levels of residential neighborhoods in Saudi Arabia (IQAir, 2023). The findings of this research hold promise in furnishing fundamental insights into the sustainability aspects of residential neighborhoods, paving the way for the future development of more sustainable residential areas (Boff, 1997).
This paper aims to comprehensively review several global measuring systems for assessing neighborhood sustainability. The study aims to create a common evaluation model that addresses the drawbacks of these tools and then proposes a base model for sustainability assessment in Saudi residential neighborhoods (Tracker, 2021a). The proposed model will cover sustainability measurement elements of many studied systems and also set out the approach for distributing relative weights between primary and sub-elements(EIA, 2015). To achieve this goal, the paper addresses the positive and negative features of the analyzed global residential area sustainability evaluation systems and the parts of sustainability covered by these systems; additionally, it also discusses the gaps and insufficient coverage that occur(Tracker, 2021a). This study also outlines how international assessment systems are contrasted regarding their different elements and the approaches that previous studies suggest for developing a standard evaluation framework that can be used to compare such systems.
The primary and secondary evaluation criteria needed to evaluate the sustainability of a residential neighborhood in Saudi Arabia are also included in this study. It also analyses if the four components of sustainability have the same value (Environment, society, economy, institutional). It also discusses whether the weight is the same and whether the point number is the same in the residential neighborhood evaluation system in Saudi Arabia (Saquib et al., 2017). This study discusses whether the weight of all subsidiary evaluation elements should be the same and the right relative weight of each factor. It also highlights the distribution of evaluation scores among the aspects of the suggested Saudi neighborhood sustainability measurement model (Felimban et al., 2019)While focusing on these issues, the paper aims to provide a comprehensive development and customized sustainability appraisal framework specifically designed for the particular setting of residential neighborhoods in Saudi Arabia.

2. LITERATURE REVIEW

2.1 Saudi Vision 2030

Towards the end of 2016, the Crown Prince of Saudi Arabia declared Vision 2030 as the Kingdom's national policy, focusing on preserving the environment, using renewable energy, and environmental sustainability in national development (Boyko et al., 2006; Programs, 2023). This vision corresponds to the global sustainable development goals and is broken into seventeen significant goals, each with sub-goals with adopted measurement indicators (Vision_2030, 2018). Vision 2030 has three primary themes: A Prosperous Society, an Economic Miracle, and a Powerful Homeland, each with two main goals (Programs, 2023). These objectives are divided into 27 sub-objectives and 96 detailed objectives, offering a complete set of national development guidelines. Thirteen executive programs, the Vision Realization Programs (VRPs), have been created to implement the vision. Each has specific targets and key performance indicators (KPIs) for the next five years (Vision_2030, 2018). The programs that these scholarships cover include finance, health, living space, and quality of life improvement (Vargas, 1990; Xia et al., 2015). Though not all 96 aims are relevant to the research topic, the relevant ones, related to the sustainability of residential neighborhoods, are discussed in detail in the fourth chapter to assess their impact on the proposed model (Programs, 2023).

2.2 Theory of the Neighborhood Unit

The "Neighborhood Unit Theory," also called the "Residential Neighborhood Theory," emphasizes the creation of a livable and safe residential environment with public facilities and necessary services (Alabsi, 2020). Emerging from the Industrial Revolution, Clarence Perry's 1923 introduction was centred on physical design, to address social issues such as alienation and community security (Al Amri, 2016). It is suggested that neighborhoods of 5,000 to 9,000 people, with the central locations of primary schools and public services and commercial activities in the periphery (Sharifi & Murayama, 2013). Internally, side streets provide safety with up to 400-800 meters of walking distance to primary schools(Al Amri, 2016). This pattern helps in community unity and decreases reliance on vehicles, encouraging interaction, cleanliness, and congestion avoidance (Sharifi & Murayama, 2013). Nevertheless, the drawbacks consist of criticisms regarding social homogenization, racial segregation, and suburban sprawl intensification, which question its suitability with sustainability principles(Al Amri, 2016).

2.3 Assessment Models for Neighborhood's Sustainability

The residential neighborhood is the basic building unit of resident areas, determining greatly energy consumption and environmental deterioration. Hence, there is a need to assess the sustainability of residential neighborhoods, and their performance needs to be compared to set standards (Al-Alwani, 2014). Different systems have been developed worldwide to serve this purpose, with some being designed as flexible global measurement systems to operate in diverse geographical contexts. On the other hand, other models are designed as regional systems limited to particular geographic areas in which they were created (Sharifi et al., 2012). This part outlines these systems, analyzing their measurement frameworks.
The assessment model comprises two main components: the conceptual framework and the indicators. This part explains the theoretical basis of the model creation, dealing with different models' types, indicator definitions and species, criteria of their selection, features, and the steps of the sustainability assessment and evaluation model formation (Bell & Morse, 2013). Sustainable development calls for a strong audit process, which is essential for testing and directing projects at all levels of sustainability (Burns, 2012). It involves evaluating the goals and objectives in the planning stage, implementation phase, and after-implementation environmental assessment with life-cycle analysis. Hence, in the first instance, objectives should be defined, and indicators developed to measure their success (Maclaren, 1996). This study uses a framework system for sustainability assessment based on pre-defined indicators. A framework improves the reliability of the assessment tool, aids the interpretation of the results and analysis, and provides for segmented evaluation (Caccam & Furlan, 2018). It also encourages the integration of indicators and highlights data gaps, underlining the framework's comprehensive nature and resulting in reliability (Al-Alwani, 2014).

2.4 Assessment Models' Framework

Predefined indicator-based evaluation models are widely used for sustainability performance measurements (Carlton, 2009). These models necessitate selecting indicators encompassing the three pillars of sustainability: the social, environmental, and economic aspects (Purvis et al., 2019). Therefore, a complete set of indicators framework is constructed to cover these dimensions and institutionalization, whereby each dimension comprises a group of indicators, which quantitatively represent how much alignment is achieved with the indicator's objectives (Bell & Morse, 2013). The results can be visualized using various visual techniques, including GIS (geographic information system) maps to improve clarity.

2.5 International Models for Neighborhood's Sustainability Assessment

The foundations of sustainable neighborhood measurement systems were laid in the year 2000 with the advent of SPeAR in the UK as the first integrated assessment and measurement system (Charrette, 2023). After this, several measurement systems were developed around the world. The HQE2R European, implemented by France in 2001, and the ECOCITY, approved by the European Union in 2002, were some of the international systems that spurred other upcoming systems all over the world (Choguill, 2008). Among these are the Japanese CASBEE system, inaugurated in 2007, and the American LEED-ND system, as well as the British BREEAM system, both founded in 2009. Middle East witnessed the birth of its first measurement systems in 2007 with the release of the QSAS system from Qatar, followed by the introduction of the Pearl system from the United Arab Emirates in 2010 (Mouratidis, 2020).
Many previous studies have analyzed and compared tools for assessing the sustainability of neighborhoods, which are briefly presented in the table below (Sun et al., 2021). At first, the research highlights and chooses assessment models that have drawn the attention of many researchers (Tracker, 2021b). Afterward, attention moves to the study and analysis of these chosen models as case studies.

Table 1: The selected international models for the neighborhood's sustainability assessment.

Assessment Model	Description
LEED-ND	Leadership in Energy and Environmental Design - Neighborhood Development
BREEAM	Building Research Establishment Environmental Assessment Method
CASBEE	Comprehensive Assessment System for Built Environment Efficiency
DGNB Districts	Deutsche Gesellschaft für Nachhaltiges Bauen - Districts
Earth Craft Communities (ECC)	Earth Craft Communities

Star Community Index	Sustainable Tools for Assessing and Rating Communities
QSAS	Qatar Sustainability Assessment System
Pearl	Pearl Rating System

These systems can be categorized based on their appearance in previous studies into three groups:
1. Primary International systems are the referent models for the comparison studies, which also involve LEED-ND, BREEAM, and CASBEE (Cornwall, 2007).
2. Secondary systems are reference systems but have limited geographical coverage compared to the primary systems. Some examples include DGNB Districts, Earth Craft Communities (ECC), Star Community Index, QSAS, and Pearl systems (Daniels, 2009).
3. Local systems are more regional and have not been analyzed as comprehensively and comparatively as in the remaining two groups (Dawodu, 2019).

2.5.1 LEED-ND

The sustainability of urban communities is discussed in the sense of assessing sustainability in different systems that implement different assessment technologies and measurement criteria in the United States (Dehghanmongabadi et al., 2014). The same holds for these initiatives as they equally agree with the fundamental principles of sustainable urbanization. One of the LEED-ND systems models is the most commonly used criteria for determining the sustainability of a neighborhood not only in the US but also around the globe (LEED-ND, 2018). LEED-ND, established by the Green Building Council (USGBC) of the US, evolved in 2007 from a partnership between USGBC, the National Resource Defense Council (NRDC), and the Congress for New Urbanism (CNU) (Douglas, 2008). This partnership sought to create a system for sustainability in the development of the neighborhood. LEED-ND system has been revised many times since 2009, with the latest being the fourth version. Originally employed for neighborhood development projects as a model in the United States, it has, however, been used as an instrument of evaluation in different countries including Canada, Malaysia, South Korea, and China (LEED-ND, 2018). LEED-ND has several accreditation levels ranging from Accredited, the highest, to platinum, Gold, and silver the lowest.

The Platinum level is for the projects that stand out in the neighborhood sustainability by their uniqueness and innovation. LEED-ND has a unique approach that differs from other LEED systems that concentrate on the site assessment, building design, and the neighborhood's relationship to its landscape, local context, and regional surroundings (EarthCraft-C, 2005). Several researchers have investigated the effectiveness of the LEED-ND as a tool for evaluating neighborhood sustainability, resulting in different opinions (LEED-ND, 2018). According to a study, LEED-ND is a complete evaluation system with indicators such as energy efficiency, pollution reduction, and green building promotion (Komeily & Srinivasan, 2015). Nevertheless, Komeily also criticizes LEED-ND for not emphasizing the economic and social aspects and requests including community participation and social justice in the provisions (Komeily & Srinivasan, 2015). Similarly, it has been stressed that LEED-ND overlooks economic issues such as job creation and economic accessibility, similar to environmental sustainability (Sharifi & Murayama, 2014). These findings are also included in other studies, which advise including social and economic factors in the LEED-ND assessment, especially in Spain (Braulio-Gonzalo et al., 2015; Komeily & Srinivasan, 2015; Sharifi & Murayama, 2014). It has been argued that LEED-ND does contribute to sustainable development in a significant way by promoting compact, walkable, and transit-oriented development (Talen et al., 2013). Other study also favors the LEED-ND for its balance between economic, environmental and social sustainability (Gargiulo et al., 2018).

Studies are aware of the fact that this tool has its limitations in the assessment of social inclusiveness (Gargiulo et al., 2018). It has been agreed that LEED-ND is a way of promoting sustainability development, but at the same time, they also mention its shortcomings in terms of social inclusion and resilience evaluation (Ameen et al., 2014; Diaz-Sarachaga & Jato-Espino, 2019). Opinions differ on the flexibility of LEED-ND in different cultural and social environments. Studies disprove the claim that LEED-ND can promote sustainable development in different contexts (Sharifi & Murayama, 2014). They suggest its restricted use in other countries except the United States due to cultural and contextual differences (Sharifi & Murayama, 2014; Talen et al., 2013; Yildiz et al., 2016). In an article, it has been pointed out that rigidity is the main problem of LEED-ND and it does not allow for the needed flexibility to meet local needs and conditions (Berardi, 2015). In addition, the expensive and intricate LEED-ND certification process is another factor that hinders small projects from applying this model (Sharifi & Murayama, 2014; Yildiz et al., 2016). To sum up, even though LEED-ND has been appreciated for the fact that it is a promoter of sustainable urban development through its restricted attention to social and economic factors, its lack of adaptability and high costs show how important the process of refining and adaptation to different contexts will be (Edwards, 2005).

2.5.2 BREEAM Communities

The BREEAM family initially focusing on Green Building assessment, debuted its first edition in the United Kingdom in 1990. Over time, versions and updates of the system were introduced, like BREEAM Communities in 2011 which was meant to assess the sustainability of the neighborhood. BREEAM Communities is used as an independent criterion for awarding third-party assessment certificates to urban communities in terms of their sustainability. In contrast to its forerunners, BREEAM Communities intends to implement sustainability standards from the project's beginning and assess the sustainability alternatives during the planning phase (BREEAM_C, 2012). The evaluation criteria in BREEAM Communities are divided into five primary groups: Governance, Social and Economic Well-being, Resource and Energy, Land Use and Ecology, and Transport and Movement (EIA, 2023). Every primary group is made up of a few sub-assessment items that deal with matters like climate, energy, resources, place formation, transportation, society, environment biodiversity, business, economics, buildings, and innovation (BREEAM_C, 2012).

Thirty assessment points are necessary for accreditation in BREEAM Communities. Higher levels of accreditation, from Good to Superior Performance, are granted based on total evaluation scores, which range from 30 to 85 (BREEAM_C, 2012). It is important to mention that BREEAM Communities currently does not have a site selection assessment because it is usually done by local authorities, developers, and landowners. The system mainly assesses design sustainability and plans for neighborhood-level and larger development projects. Besides, the post-construction certification is not included in the current version of the assessment, but it may be added to later versions (Sharifi & Murayama, 2013). BREEAM Communities is one of the most complete systems for measuring neighborhood sustainability. The system generally deals with the majority of sustainability areas, such as soil, energy, water transport, environment pollution, waste buildings, infrastructure, social aspects, housing walkability, green area compactness, economics, and institutional aspects (Gargiulo et al., 2018). Hence, BREEAM Communities seems to be the perfect instrument for evaluating neighborhood sustainability (Sharifi & Murayama, 2013, 2014).

Besides its comprehensiveness, the BREEAM-Communities system has a lot of strengths. The main advantages are the simplicity of use and the possibility of adjusting to particular cases in the region. It has been argued that BREEAM-Communities is one of the most compatible systems with other sustainability assessment tools, so it makes a more comprehensive sustainability assessment (El-khateeb, 2019). Studies are also of the opinion that BREEAM-Communities stands out for its capability to combine quantitative and qualitative assessment methods well which in turn makes it possible for the system to give a more accurate level of sustainability in the neighborhood (Gargiulo et al., 2018; Sharifi & Murayama, 2013, 2014). On the contrary, it has been that the BREEAM-Communities system does not cover all aspects of flexibility (Diaz-Sarachaga & Jato-Espino, 2019). Moreover, the system does not fully cover the site selection as there were no evaluation points or monitoring of its environmental impact (Diaz-Sarachaga & Jato-Espino, 2019). It has been stated that communities look at new urban community developments more than existing ones (Diaz-Sarachaga & Jato-Espino, 2019; Kyrkou & Karthaus, 2011). Hence, it minimizes the advantages of BREEAM communities when assessing the sustainability of old communities and previously existing neighborhoods (Kyrkou & Karthaus, 2011; Sharifi & Murayama, 2013).

On the social side, it is studied that BREEAM-Communities does not give enough attention to the social aspect of the environment (Berardi, 2015). BREEAM-Communities does not appreciate the importance of community participation, which might fail to achieve the goals and requirements set by the stakeholders. Besides, the system does not take care of the social justice elements (Fatani et al., 2019). Thus, it is wrong to say that BREEAM-Communities includes all the aspects of sustainability, as justice is one of the most essential goals of sustainability (Forsyth & Crewe, 2009). Hence, it is believed that the BREEAM communities may not be a good measure of sustainability in certain circumstances (Berardi, 2015). It is also said that BREEAM-Communities does not have a clear definition of what is meant by the term "community" which can result in ambiguity and inconsistency in the application of evaluation criteria when using this tool, so it should be specified more accurately how to apply evaluation criteria in different contexts (Sharifi & Murayama, 2014). Moreover, one of the main flaws of BREEAM-Communities is that it depends too much on voluntary participation, which might not be possible in some cases (Friedmann, 2010). The voluntariness of the certification is why there is no assurance that communities will carry out what has been recommended by the assessment. This could be the reason why the system will not be so efficient in promoting sustainable practices and lessening the environmental impact of neighborhoods in the future (Sharifi & Murayama, 2014).

They also think the BREEAM-Communities system is too concentrated on technical solutions without considering social and cultural factors. Thus, the assessment goals may conflict with what people need and want from it (Gibson, 2006a). Besides, ignorance of social sustainability would result in non-intended negative effects, such as displacing vulnerable population groups from society (Sharifi & Murayama, 2014). It has been pointed out, that the BREEAM-Communities system was designed in the UK and is not flexible enough for use in different countries (Yildiz et al., 2016). Hence, the system may not be able to solve the problems and challenges of residential neighborhood s in other countries and regions, and thus, BREEAM-Communities standards will not apply to all neighborhoods, such as informal settlements or historical areas (Yildiz et al., 2016). In the end, it is claimed in a study that the BREEAM-Communities system is just an environmental tool and not a comprehensive one as it does not cover economic and social aspects (Komeily & Srinivasan, 2015).

2.5.3 CASBEE-UD

CASBEE-UD is one of Asia's most widely used assessment tools for evaluating neighborhood sustainability. Introduced in 2004 by the Japan Sustainable Building Consortium (JSBC), CASBEE-UD is based on the building system of CASBEE (Gibson, 2006b). In contrast to its forerunner, CASBEE-UD does not evaluate the inner areas of buildings within the neighborhood because this is done by CASBEE building (CASBEE-UD, 2014). The CASBEE-UD system comprises six assessment groups, each focusing on different aspects of neighborhood sustainability: Natural environmental quality, Service function for the designated area, Contribution to the local community, Environmental impact on microclimates, Facade and landscape, Social infrastructure and Management of the local environment (CASBEE-UD, 2014). The CASBEE-UD system accreditation is awarded based on the Built Environment Efficiency (BEE) value, which shows how well-built environment quality (Q) and built environment load (L) are balanced. The levels of accreditation go from Poor to Excellent, which shows the degree of efficiency and sustainability that is achieved by the neighborhood regarding its built environment quality and load (CASBEE-UD, 2014).

The CASBEE-UD system puts a lot of emphasis on different aspects of environmental quality, community contribution, and infrastructure management, thus becoming the full framework for evaluating neighborhood sustainability in Asia (CASBEE-UD, 2014). CASBEE-UD, which UD is the acronym for a neighborhood designing system and was developed as an assessment tool for the sustainability of neighborhoods in Japan, has been subjected to various assessments to determine its effectiveness and limitations (CASBEE-UD, 2014). The study has been conducted in a case study to determine CASBEE-UD's functions in evaluating neighborhood sustainability (Sharifi et al., 2012). The study shows that CASBEE-UD deals with a large number of sustainability aspects comprehensively, such as site and soil, energy, water, transport, environment pollution, waste, buildings, infrastructure, social life, housing, walkability, green areas, compactness, economics, institutional life (Sharifi et al., 2012).

Nevertheless, CASBEE-UD is not perfect, although it has a wide scope of applications. It has been pointed out that the system does not have a clear direction for defining sustainability priorities and distributing importance scores among different evaluation aspects (Sharifi et al., 2012). Besides, CASBEE-UD does not give a way forward to improving the areas found as weaknesses in the assessment (Gibson, 2005). It has been discovered the drawbacks of CASBEE-UD, indicate that it is not possible to apply it in other countries because it concentrates on Japanese building codes and regulations (Karol & Brunner, 2009; Sharifi et al., 2012). However, some sustainability issues such as people's participation and the conservation of cultural resources are not considered by the system (Karol & Brunner, 2009). One of the comparison studies done was on the urban community assessment tools, where CASBEE-UD was noted to be highly oriented towards environmental elements (Sharifi & Murayama, 2013). But they also noted that the tool contained undesirable social aspects of social organization including cohesiveness, fairness, engagement, and safety. This makes the tool unsuitable in various situations, especially in countries that may have different problems from South Africa. In addition, it has been criticized that CASBEE-UD is not clear in defining the indicators and criteria that are used, hence it is hard for users to comprehend as well as effectively utilize the system. The main challenge in applying and implementing the system is the high degree of its complexity (Sharifi & Murayama, 2013).

2.5.4 DGNB for Urban Districts

The German Sustainable Building Council (DGNB) initiated the Development of the DGNB Districts Assessment System for Sustainable Communities in the year 2012. This system is used as an assessment and accreditation instrument to support the formation of sustainable and fully functional societies in Germany and Europe. The DGNB Districts Assessment System offers three certificates over the project lifecycle: Pre-certification: Issued for the urban development plans.

1. A document that confirms one has planned and developed at least a quarter of the finished projects.
2. Certificate for districts that are practically done or are more than 75% complete.

Independent assessors accredited with DGNB conduct assessments; however, the final assessment and audit are conducted by DGNB before accreditation. The DGNB system is structured around five primary evaluation groups, which are further divided into 31 sub-criteria:

1. Environment quality
2. Economic quality
3. Sociocultural and functional quality
4. Technical quality
5. Process quality

These primary groups cover a broad area of sustainability, namely environmental, economic, sociocultural/functional, technical, and process aspects (DNGB, 2020). Thus, through such evaluation groups and sub-criteria, the DGNB Districts Assessment System intends to make sustainable principles a part of the planning, development, and implementation of the urban districts to foster the development of healthier, more resilient, and sustainable urban living environments (GOV.SA, 2022). DGNB, a German Sustainable Building Council (DGNB) launched the Distinguished Assessment System for the Districts of Sustainable Communities in the year 2012 (Australia, 2016). It can be noted that this system evaluates and provides accreditation for the development of sustainable and habitable communities in Germany and Europe (DNGB, 2020). The DGNB Districts Assessment System offers three certificates over the project lifecycle:

6. Pre-certification: Issued for the projects to be implemented in the urban areas for development.
6. Certificate of planning and development of at least 25% of the implemented projects.
6. Certificate for districts that are at least 75% built.

The DNGB-UD system that has been established by the German Sustainable Building Council has been through various evaluations and analyses to establish the extent of its efficiency in measuring the sustainability of neighborhoods (DNGB, 2020). Studies have given positive feedback on the DNGB-UD system and noted that it is all-inclusive and covers a wide area in the assessment of sustainability (Gargiulo et al., 2018; Lee et al., 2015). Still, the study acknowledges that although the DNGB-UD system is quite exhaustive, it is still possible to have a lack of coverage of sustainability aspects, an opinion has been shared in a study, which pointed out the social and economic aspects that need enhancement (Ameen et al., 2014; Sharifi & Murayama, 2013). The index called DNGB-UD was created by the German Sustainable Building Council, and to determine its reliability as a tool for measuring neighborhood sustainability it has been submitted to various evaluations and studies (Haidar, 2017). Studies consider the DNGB-UD system positive, focusing on its comprehensive character and wide range of use in sustainability assessment (Gargiulo et al., 2018; Lee et al., 2015). Nevertheless, the study believes that even though the DNGB-UD system covers all sustainability aspects, it may still not be fully comprehensive (Ameen et al., 2014; Sharifi & Murayama, 2013). Such opinion is also voiced by those who pointed to the necessity of enhancing social and economic factors which are not quite sufficiently developed in this system(Ameen et al., 2014).

The study states that the more balanced approach in the DNGB-UD system covers different aspects of neighborhood sustainability; thus, they imply that while it is all-inclusive, there are some areas where it falls short (Komeily & Srinivasan, 2015). Research stresses the idea that these systems are not flexible enough to fit into different environments, making their usage outside of German cities almost impossible (Diaz-Sarachaga & Jato-Espino, 2019). Besides, the difficulty of getting accreditation and its high cost, which is mentioned, are problems that especially less developed areas face (Komeily & Srinivasan, 2015; Sharifi & Murayama, 2013). Besides, the regional restrictions and the lack of adaptation to diverse cultural, social, and economic conditions can also be a problem for the DNGB-UD system. To sum up, it has been stressed that DNGB-UD seems weak in dealing with social justice issues like housing affordability and social integration, which are areas for improvement of this assessment system (Diaz-Sarachaga & Jato-Espino, 2019; Komeily & Srinivasan, 2015).

2.5.5 Earth Craft Communities (ECC)

Earth Craft-Communities (ECC) was launched in 2005 as a system for the assessment and accreditation of sustainable communities. ECC was created by a group of organizations: The Atlanta Home Builders Association, Urban Land Institute, Atlanta Regional Committee, and County Council from Atlanta (Hirt, 2007). The objectives were to promote low-impact development, conservation of natural spaces, efficient water and energy management, and sustainable transportation, among other things related to general sustainability (EarthCraft-C, 2014). To get the certification under Earth Craft-Communities, all buildings in the community have to be assessed via EC-Houses Sustainability Assessment for single-family homes or by using the EC-Multifamily system for multi-unit buildings, or else they can use the EC Light Commercial Sustainability Assessment System for commercial building (Hurley & Horne, 2006). The ECC system offers the implementation of technical assistance during the design stage through site visits and advice from program administrators for trainers, designers, owners, or developers (EarthCraft-C, 2014). Like the LEED-ND system, the ECC system is constructed on seven assessment groups, each with mandatory and optional requirements. The main rating groups for the LEED system are Site Selection, Water Management, Planning and Design, Landscape Conservation, Community Engagement, Green Building, and Innovation Points (Hunt et al., 2008). To get the certification, a project should have at least 100 points from the optional and all mandatory requirements (EarthCraft-C, 2014).

Earth Craft Communities is marked by its strong focus on energy savings. The program sets the standard for energy efficiency that buildings should meet or even exceed (Hurley, 2011). It promotes using energy-efficient appliances and passive design measures to minimize energy needs for heating and cooling, which cuts greenhouse gas emissions, ultimately helping combat global warming (Cloutier et al., 2018). Further to this, Earth Craft Communities emphasizes community and health by sponsoring various types of housing, such as affordable houses, which results in an inclusive and harmonious community (Liu et al., 2015). Another way of reducing the usage of cars, cleaning the air, and addressing traffic congestion, which eventually results in the welfare of a community, is through the promotion of sustainable transportation modes such as biking and public transit (Sharifi & Murayama, 2013). However, the program also has some disadvantages, such as its temporal scope, which is mainly limited to the United States, especially Atlanta, and this makes it unworkable elsewhere (Lozano, 2008). Additionally, Earth Craft Communities focuses on residential and mixed-use projects, meaning that there is no accreditation for commercial and industrial developments, thus limiting the impact on sustainability at the regional level (Sharifi & Murayama, 2013). However, Earth Craft Communities fails to cover all sustainability aspects in an integrated way; it is primarily void of consideration of water conservation, water efficiency, and low waste, which are of utmost importance to developers and urban communities who are working toward holistic sustainability objectives (Cloutier et al., 2018).

2.5.6 Star Community Index (Star-CI)

The STAR Community system, developed in 2012, is a rating system adopted by local communities to identify how they are meeting their sustainability goals (Mahmood, 2018). A product of the collaboration of the International Council for Local Environmental Initiatives (ICLEI), USGBC, National League of Cities, Center for American Progress, and many stakeholders, STAR is a common system for measuring sustainability progress with nationally known standards (Communities, 2016). In contrast to some other systems, STAR Community focuses on the social and economic aspects of sustainability. Star Communities assigns assessment teams to consider a project's economic, job creation, education, arts, social justice, health, and environmental impact (Communities, 2016). Later versions of STAR were refined to be all-inclusive, covering economic, social, and environmental dimensions comprehensively, and adding an institutional work component as the fourth dimension of sustainability (Communities, 2016).

STAR Community is composed of eight assessment categories that address all the aspects of sustainable development, including the Built Environment, Climate and Energy, Economy and Jobs, Education, Arts and Community, Equity and Empowerment, Health and Safety, Natural Systems, and Innovation and Process (Communities, 2016). The STAR system delivers 100 assessment points for each assessment group except the last group, Innovation & Process. As a result, the total points in the system are 750 assessment points (Martinet et al., 2022). The system provides accreditation levels starting with two stars for 250 points, three for 450 points, and five for 650 points, with each level reflecting different levels of sustainability accomplishment(Communities, 2016). The Star Community Index System provides integrative frameworks for assessing the sustainability of urban communities in terms of environment, society, and economy (Minnery, 2009). Thus, it provides many indicators and measurement instruments for evaluating the performance of sustainable residential neighborhoods, facilitating the process of increasing the sustainability level in the neighborhood (Sharifi & Murayama, 2013).

Studies have applauded the possibilities of the STAR Community Index system to be versatile and changeable, as well as the possibility of its tuning according to the specifics of the given communities and conditions (Gargiulo et al., 2018). This flexibility allows the situations in the system to match those in each community and thus make the system more appropriate and usable (Gargiulo et al., 2018). has some concerns about the comprehensiveness of the STAR Community Index indicating the complexity and a great deal of data gathered and processed. This complexity is sometimes hard to manage concerning time and cost aspects for developers(Siew, 2014). Another critique is given by those who state that some of the elements that comprise the tool, known as STAR Community Index, are not necessarily linked to sustainability (Sharifi & Murayama, 2013). Furthermore, it is possible to distinguish between meaningful and unmeaning indicators, for example, where such indicators as those concerning transportation and land use could hardly be considered meaningful for societies with a deficiency of resources or rural populations, or at least in questionably meaningful (Sharifi & Murayama, 2013). Studies state that the STAR Community Index is not flexible enough (Diaz-Sarachaga & Jato-Espino, 2019; Siew, 2014). They stress flexibility concerning sustainability evaluation, as regards change in the community's situation, including the ability to adapt to such changes (Diaz-Sarachaga & Jato-Espino, 2019; Siew, 2014).

2.5.6 QSAS- Neighborhood

The QSAS (now GSAS) system was created by the Gulf Organization for Research and Development (GORD) in cooperation with the Center for Energy Studies and Building Simulation at the University of Pennsylvania, USA, to address the fast urban growth in the Gulf countries (Moldan et al., 2012). Originally referred to as the Qatar Sustainability Assessment System (QSAS) it was later renamed the Global Sustainability Assessment System (GSAS) to reflect its wider relevance than Qatar itself. The system is designed to minimize the adverse effects of urbanization on the environment and focus on local and regional requirements (GSAS, 2019). GSAS integrates the approach of sustainable buildings and urban environments tailored to each project's specific environmental context and spatial characteristics (Ameen et al., 2015). It became part of the curriculum of Qatari universities as a GSAS-accredited sustainability program (GSAS, 2019). The assessment criteria in GSAS are organized into eight primary evaluation groups: urban connectivity, Compactness, Diversity, Transport, Density, Passive Solar Design, Mixed Land Uses, and Greening of the urban. Such groups address several issues of sustainable urban development, such as connectivity, land use, transportation, energy efficiency, and green infrastructure (GSAS, 2019).

The QSAS District is a system created by Research and Development (GORD) that combines various criteria from neighborhood urban planning as well as green building characteristics from the QSAS Green Building System, giving an all-around approach to assessing neighborhood sustainability (Ferwati et al., 2019). However, contends that although the QSAS District system pays much attention to environmental sustainability, for example, air quality and water conservation, it is not all-inclusive, particularly regarding social and economic aspects (Sharifi & Murayama, 2013). The study underlines the versatility and adaptability of the QSAS District system, which makes it applicable to various situations, needs, and settings (Gargiulo et al., 2018). The study highlights the fulfillment process of a large amount of data and information that may strain the entire system and present a hurdle in its wide use (Ameen et al., 2014; Cheshmehzangi et al., 2020). Research resonates with Ameen's worries and points out the imposing nature of the requirement for a considerable amount of data, especially in newly developed areas and less developed countries where the data is usually missed (Cheshmehzangi et al., 2020). Nevertheless, study claim that if the scale of QSAS is improved and additional elements and indicators are added, then these problems will be solved and its comprehensiveness and applicability will be increased (Ameen et al., 2014; Ferwati et al., 2019).

2.5.8 Pearl Community Rating System

The Pearl System was developed in 2010 to sustain the Estidama Initiative in the UAE by the Abu Dhabi Urban Planning Council (UPC) to promote sustainability in buildings and urban communities of Abu

Dhabi in accordance with the Emirate 2030 strategic plan. Adopting certain aspects of the BREEAM and LEED-ND systems but focusing on their drawbacks, the Pearl System is a system that considers the specificity and cultural aspects of the United Arab Emirates (Nathan & Reddy, 2008). It adds a cultural aspect to the traditional sustainability dimensions: environment, society, and economy (Pearls, 2010). The Pearl System contains three categories of assessment relating to the size of the project, including residential villas or single dwellings, buildings, and residential communities. It comprises seven main measurement groups: Integrated Development Process, Natural Systems, Livable Communities, Precious Water, Resourceful Energy, Stewarding Materials, and Innovating Practice (Council, 2010). Pearl System is accredited in five levels where one pearl certificate is for compliance with all mandatory credits, and five pearls are gained by obtaining 125 evaluation points (Council, 2010; Pearls, 2010). The Pearl Community system has been a prominent sustainability categorization model being used in the Arabian Gulf region and among Arab states like the UAE (Tumusiime, 2013).

Nonetheless, the study considers that the system is imperfect since it does not reflect all components of the sustainability concept (Komeily & Srinivasan, 2015). Studies argue that the Pearl Community system is centered mainly on the physical aspects of sustainability but without paying much attention to the social dimension (Ameen et al., 2014; Diaz-Sarachaga & Jato-Espino, 2019). Although the system mainly focuses on water and energy efficiency criteria, it misses important social and economic aspects that contribute to comprehensive sustainability (Komeily & Srinivasan, 2015). Secondly, the study suggests that the system's immobility is another serious disadvantage (Teriman, 2012). It has been argued that the system's rigidity limits the possibility of diverse urban designs and cultural contexts (Institute, 2006). For example, the priority of a natural ventilation system may not be practical in areas with high humidity or extreme temperatures (Ogburn, 2023).

However, this operational rigidity becomes a nuisance to communities that do not meet the prescribed standards, making them unable to score high sustainability ratings even if they perform well in other dimensions of sustainability(Ameen et al., 2014; Diaz-Sarachaga & Jato-Espino, 2019). Research has made the same note regarding the Direction System, stating that it is highly dependent on huge inputs and data that are difficult for the implementation phase (Cheshmehzangi et al., 2020). The collection, recording, and input of this information require a lot of time and work from the people using the Pearl Community system to evaluate residential neighborhoods (Olalla-Tárraga, 2006). This can be a major challenge for the users and developers, especially in developing regions, underprivileged neighborhoods, and poor countries where the data might be insufficient (Cheshmehzangi et al., 2020; Sala et al., 2015). Besides, the study pointed out that the Pearl Community system is ultra-prescriptive; it adheres rigidly to a set of standards that may not be globally applicable to all such projects and targeted development areas (Komeily & Srinivasan, 2015; Tech, 2023). The inflexibility could confine the system's ability to be utilized or applied across different contexts (Komeily & Srinivasan, 2015).

In addition, research also highlights the Pearl Community system's limitation in its emphasis on new neighborhood development projects, ignoring existing buildings and communities (Sharifi & Murayama, 2013). This omission reduces the system's ability to handle sustainability challenges in existing neighborhoods, thus making it less effective (Sharifi & Murayama, 2013). Finally, the study raised concerns about the Pearl Community system's incomplete perception of the project life cycle (Patricios, 2002). Ameen thinks that the system does not see long-term environmental aspects like the environment around the structure and the sustainability of building materials. The omission suggests that a project can score high within the system but still have long-term environmental impacts (Ameen et al., 2014; Institue, 2011; Patricios, 2002).

2.6 All system strengths and weaknesses summary

Based on the provided information, the table below shows the strengths and weaknesses of the assessment model under study:

System	Strength	Weaknesses
LEED-ND	• Comprehensive tool. • Strong focus on location and energy efficiency. • Widely adopted in the US and recognized globally. • Supports walkability	• Weak economic and social coverage of sustainability. • Limited adoption outside the US. • High accreditation cost. • More focused on individual buildings rather than the overall neighborhood.

BREEAM-C	• Comprehensive tool. • Strong focus on community-level sustainability. • Includes categories such as Health and Wellbeing.	• Limited adoption outside the UK and Europe. • Too focused on technical aspects rather than community engagement. • Relies heavily on voluntary participation.
CASBEE-UD	• Comprehensive tool. • Flexibility and applicability in different environments. • Strong focus on energy and resource efficiency. • Includes social functions category.	• Does not assess economic feasibility. • Limited application outside Japan. • Weak coverage of social aspects. • High complexity level.
DNGB-UD	• Comprehensive tool. • Strong focus on technical aspects of sustainability. • Used in a range of urban districts in Europe.	• Weak economic and social coverage of sustainability. • Limited application outside Germany. • High complexity level. • Less focus on social justice issues.
ECC	• Emphasis on energy efficiency and passive systems. • Focus on community and health. • Requires a mix of housing. • Includes operational and maintenance practices category.	• Limited scope to the USA. • Does not provide accreditation for commercial and industrial projects. • Does not focus on water conservation and waste reduction.
STAR-CI	• Comprehensive tool. • Strong focus on community engagement. • Used in a range of communities.	• Limited adoption outside the US. • Complexity and usability issues. • Needs improvement in resilience and adaptation levels.
QSAS-N	• Comprehensive tool designed for the Qatari context.	• Limited adoption outside Qatar. • Complexity and usability issues. • Needs improvement in resilience and adaptation levels.
Pearl-C	• Strong focus on community engagement and social sustainability. • Designed for the UAE context. • Used in a range of communities, including low-income neighborhoods.	• Limited adoption outside the UAE. • Weak economic and social coverage of sustainability. • Lack of consideration for the project life cycle. • Prescriptive nature of the system. • Needs improvement in resilience and adaptation levels.

These assessments provide insights into each system's strengths and weaknesses, helping stakeholders decide which tool best fits their sustainability goals and context (Saaty, 1987; Saaty, 2008).

3. METHODOLOGY

2.1 Research design and approach

A systematic method for assessing neighborhood sustainability is suggested to accomplish the study's objectives and effectively address the research questions. This evaluation structure comprises two levels:

1. First Level—Pillars of Sustainability: The environment, society, economy, and institutions are the first-level components of the structure. This level is targeted at research related to the importance and weighting of these pillars of sustainability, whether they are of equal value or not.

2. Second Level - Sub-Elements of Sustainability: The second tier of the formation comprises subordinate elements associated with each of the four sustainability pillars determined at the first level. Collectively, 16 sub-components have been chosen as sub-elements of the neighborhood sustainability assessment. These sub-elements have been revealed due to a thorough analysis of previous studies, which compared the neighborhood's sustainability evaluation systems. The selection process targeted the identification of the common sub-elements that have been used in most of the studies.

3.1 Data collection methods

Such an organized method allows for the development of a full picture of neighborhood sustainability and guarantees that environmental, social, economic, and institutional dimensions are sufficiently addressed and assessed. By defining both the other pillars and the particular sub-elements, this evaluation structure enables a detailed and comprehensive judgment of sustainability in residential neighborhoods. After a comprehensive comparison and analysis of structures used in past studies, several recurring elements were identified and incorporated into the suggested framework for this study. These components were highly present in several studies, either as main items or sub-items. Sixteen sub-categories were identified as the framework for assessing the study objectives. These sixteen sub-categories were then divided into the four core elements for the research's sustainability pillars.

4.1 Data analysis techniques

As discussed before, the study framework operates at two levels. The first level, called "primary categories," comprises the four pillars of sustainability. The second level, the sub-categories, defines the specific assessment components within each of the four primary categories. It should be noted that assigning some of the sub-categories to their primary categories was problematic. Certain sub-category elements demonstrate two-way influences among a few of the primary components. Another example is the promotion of walking and the decrease in the use of public transport, which affects environmental sustainability and also separately influences social and economic aspects. Below, Figure 1: The study's proposed assessment model levels

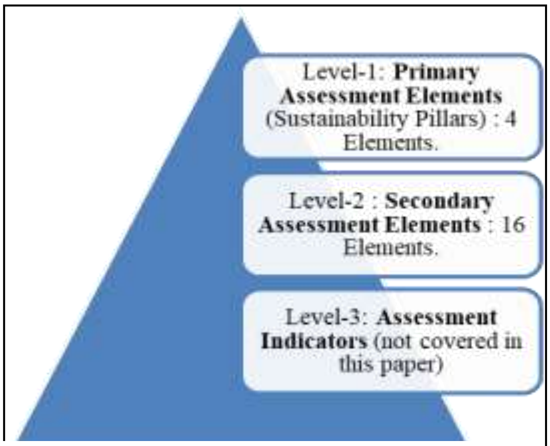


Figure 1: The study's proposed assessment model levels

ANALYSIS AND FINDINGS

One of the major factors that complicate the task of comparing different systems of measuring the sustainability of neighborhood s is the lack of a framework that can be followed when comparing such systems. The main and the sub-elements of each system are arranged differently, and therefore, the structure of each of them is quite different. Below, Table 2: the primary and sub-categories number in each assessment system.

Table 2: the primary and sub-categories number in each assessment system

Assessment System	Primary Categories	Sub-Categories
LEED-ND	5	59
BREEAM-C	5	40
CASBEE-UD	6	Varies
DNGB-UD	5	28
ECC	7	102

STAR-CI	8	49
QSAS-N	8	38
Pearl-C	7	64

These elements are multiple and rather different in the various systems it is therefore hard to make a comparison between the two. Thus, it is essential to have a rational basis for the assessment of each system and take into account the properties of the components and the focus on each of them. These questions and challenges are answered and questioned in this paper to establish a balanced and integrated approach to the assessment of neighborhoods' sustainability. This is because the number and categorization of the main and sub-elements that are mainly used in the sustainability measurement systems are different from one system to the other; thus, it is very hard to conduct adequate evaluations of the various systems. Every system may have its main and sub-elements defined differently; therefore, the degree of attention and incorporation may also differ. Also, some aspects can be emphasized within one system, and the other systems can neglect them or, on the contrary, omit them.

Furthermore, one should also know that some of the evaluation elements, particularly those related to different aspects of neighborhood sustainability, may be divided differently between the mentioned systems. For instance, offering pedestrian and bicycle lanes can be categorized under transportation, environmental conservation, and social interaction, thus demonstrating multipurpose use. To compare the results and investigate relationships between different components, it is crucial to develop a set of criteria that defines the elements of neighborhood sustainability, regardless of their relative importance in the systems under study. This framework aims to facilitate the reorganization and realignment of components from the different systems to evaluate each system against a set of guidelines effectively. It would reduce the problems associated with different classifications and variations within the system members and make the assessment fairer and more comprehensive.

5.1 Proposed Relative Weight (RW) of CAMNS framework's primary assessment categories

To determine the proportionate weight of each component in the framework for neighborhood sustainability assessment, we used weights from eight international models as benchmarks. Based on the above-mentioned framework, we used it as a reference point and repositioned indicators from different international systems following this framework. By employing this process, it became possible to determine the suggested weights of each assessment element in these systems. After that, we determined the median and mean of the primary and secondary categories for all the case studies. First, we calculated the median and mean of the three major systems, namely LEED, BREEAM, and CASBEE, and then the total figures for all eight case study models. Thus, we suggested the relative weights for the elements under consideration based on the analysis of these averages and medians from international cases.

The process of deciding on the average relative weight of each assessment item was divided into two phases. First, we calculated the Median and Mean of the three major systems, namely LEED, BREEAM, and CASBEE while highlighting the importance of these systems as the primary key reference frameworks. Next, a more general analysis was conducted on all the selected international case study systems to compare it with the results of the first stage. More specifically, we compared the Median and Mean relative weights of the primary three systems to the Median and Mean relative weights of all eight systems. Below, Table 3: the weight of the first level of the assessment categories, "the sustainability pillars," in each system under study. Then, the CAMNS proposed weight for the same categories. Also, below, Figure 2: The weight of the first level of the assessment categories, "the sustainability pillars," in each system under study.

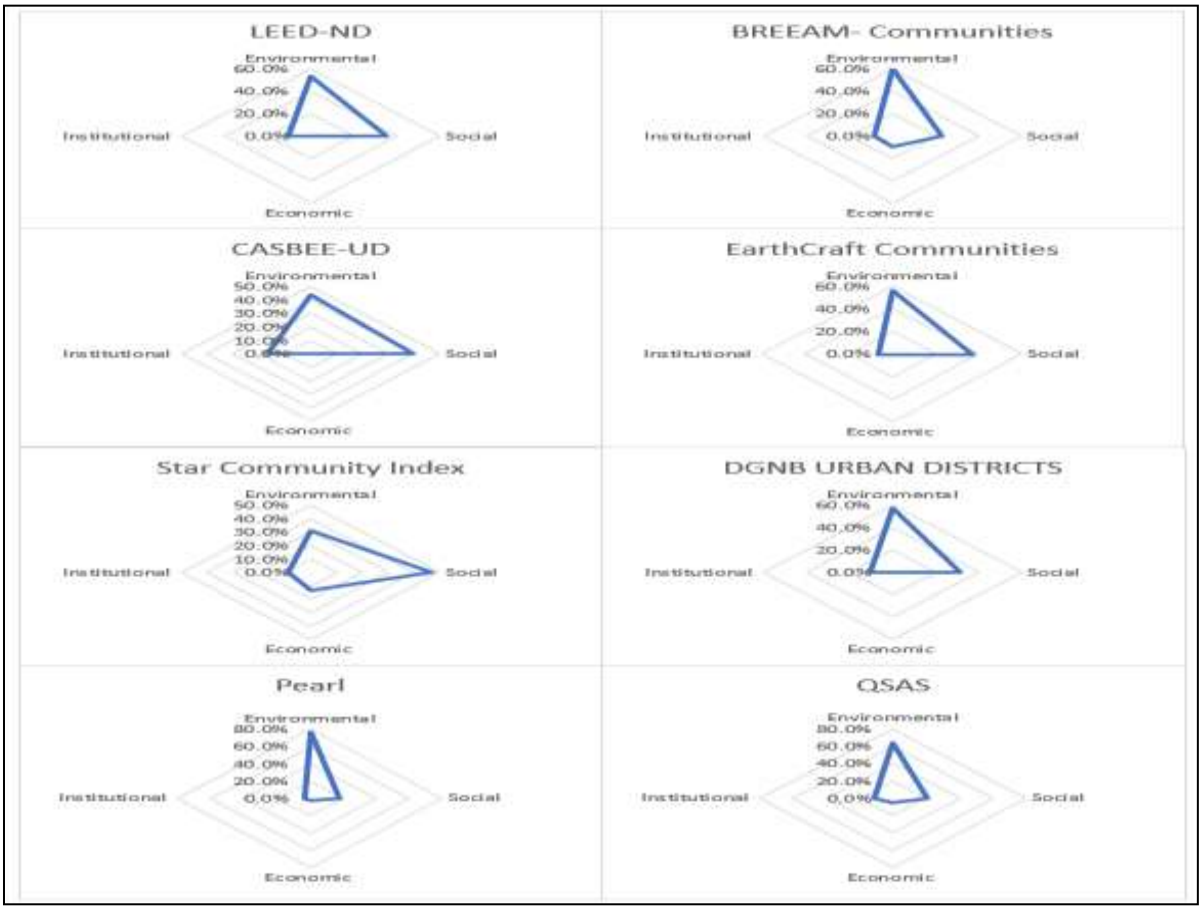
Table 3: the weight of the first level of the assessment categories, "the sustainability pillars," in each system under study. Then, the CAMNS proposed weight for the same categories.

Assessment Element (Level-1)		Primary Case Study Systems			Secondary case study Systems					Primary System Median	All System Median	CAMNS Proposed RW
		LEED-ND	BREEAM-C	CASBEE-UD	ECC	Star -C	DGNB-UD	Pearl	QSAS			
1	Environment	53 %	57 %	44 %	56 %	31 %	57 %	76 %	64 %	53 %	57 %	**53** %

2	Social	35 %	21 %	39 %	37 %	46 %	31 %	17 %	20 %	35 %	33 %	**33** %
3	Economic	0.0 %	8 %	0.0 %	0.0 %	13 %	0. %	2 %	4. %	0. %	1. %	**4** %
4	Institutional	10 %	11 %	16 %	6 %	8 %	10 %	3. %	10 %	11 %	10 %	**10** %

The process of calculating the average relative weight of each assessment item was carried out in two steps. First, we calculated the Median and Mean for the three key systems: LEED, BREEAM, and CASBEE, highlighting their importance as the primary reference scales. We then expanded our comparison to include all the chosen international case study systems and compared these results with the findings from the first part of this study. In particular, we compared the Median and Mean relative weights of the three key systems with the corresponding values for all eight systems under consideration.

Figure 2: The weight of the first level of the assessment categories, "the sustainability pillars," in each system under study.



Even if we look at a simple comparison table, the reader can see that the environmental aspect has the highest relative weight in evaluating the sustainability of residential neighborhoods within the three primary systems, and its average weight is 52%. 5%, while the social aspect was only 5%. In LEED-ND, the environmental aspect of the rating system accounted for 53%. 6% of the total sustainability elements, rising to 59. was 9% in the BREEAM-COM system and reduced to 44. The environmental impact scores in the Japanese CASBEE-UD system amounted to 0%. After this, the social aspect became the second most evaluated category with a mean relative weight of approximately 32. 6 %, followed by the institutional and organizational aspect, which had the arithmetic mean relative weight of 11 %. At the social level, the findings were slightly higher at 9%, and the economic aspect, on average, was at 3%. 0%.

4.2 Proposed Relative Weight (RW) of CAMNS framework's secondary assessment categories

As per the aforementioned methodology, we extended it to suggest relative weights of the subcategories falling under the environmental dimension of the study. We calculated the Median and Mean relative weights for the three major systems and compared them with the values obtained when all eight

International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 8, 2025
https://theaspd.com/index.php

investigated systems were considered. In this regard, the focus within the assessment systems should be noted on elements like ecology and materials, transport, energy, and water. However, the influence of the other items, such as site and soil, buildings, waste, pollution, and infrastructure seemed to have less influence on the evaluation of the sustainability of the neighborhood.

4.2.1 Environmental secondary assessment categories

Below, Table 4: The second level weight of the Environmental assessment categories in each system under study and CAMNS proposed RW.

Table 4: The second level weight of the Environmental assessment categories in each system under study and CAMNS proposed RW.

Assessment Element (Level-2): **Environment** Aspect: 1.		Primary Case Study Systems			Secondary case study Systems					Primary System Median	All System Median	**CAMNS R**
		LEED-ND	BREEAM-C	CASBEE-UD	ECC	Star -C	DGNB-UD	Pearl	QSAS			
1	Site & Soil	11. %	0.0 %	1.4 %	4.9 %	3.3 %	0.0 %	2.5 %	4.6 %	1.4 %	2.9%	3.0%
2	Energy	8.0 %	4.0 %	5.6 %	14.4 %	4.0 %	4.3 %	23.9 %	8.0 %	5.6 %	6.8%	7.0%
3	Water	6.3 %	2.6 %	5.6 %	9.9 %	6.0 %	4.3 %	23.3 %	18.7 %	5.6 %	6.1%	6.0%
4	Transport	11.6 %	14.9 %	9.3 %	15.5 %	2.7 %	10.9 %	0.6 %	6.9 %	11.6 %	10.1 %	12.0 %
5	Ecology & Materials	3.6 %	17.7 %	9.7 %	4.9 %	8.0 %	32.6 %	13.2 %	13.3 %	9.7 %	11.5 %	11.0 %
6	Pollution	0.9 %	3.7 %	0.0 %	0.7 %	2.7 %	3.3 %	0.0 %	10.0 %	0.9 %	1.8%	2.0%
7	Waste	0.9 %	0.0 %	1.4 %	0.7 %	2.0 %	0.0 %	4.4 %	2.5 %	0.9 %	1.1%	1.0%
8	Buildings	5.4 %	6.6 %	11.1 %	2.8 %	0.0 %	0.0 %	6.3 %	0.0 %	6.6 %	4.1%	6.0%
9	Infrastructure	5.4 %	8.1 %	0.0 %	2.5 %	2.7 %	2.2 %	2.5 %	0.0 %	5.4 %	2.5%	5.0%

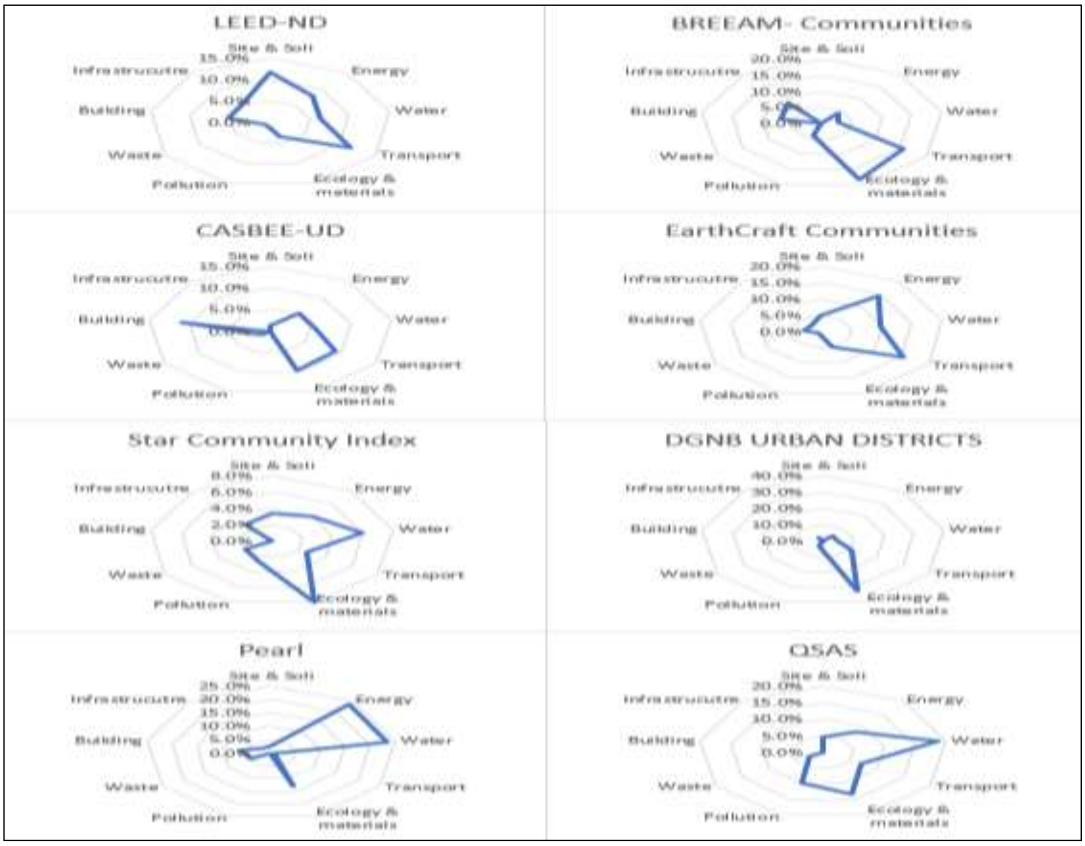


Figure 3: The second level is the weight of the environmental assessment categories in each system under study.

4.2.2 Social Secondary Assessment Categories

Below, Table 5: The second level weight of the social assessment categories in each system under study and CAMNS proposed RW.

4.2.3 Economic Secondary Assessment Categories

Below,

Table 6: The second level is the weight of the economic assessment categories in each system under study, and CAMNS proposed RW.

Table 5: The second level weight of the social assessment categories in each system under study and CAMNS proposed RW.

Assessment Element (Level-2): **Social** Aspect: 1.		Primary Case Study Systems			Secondary case study Systems					Primary System Median	All System Median	**CAMNS Proposed RW**
		LEED-ND	BREEAM-C	CASBEE-UD	ECC	Star -C	DGNB-UD	Pearl	QSAS			
1	Community, employment & housing	11.6%	11.0%	21.3%	13.0%	44.0%	23.9%	7.5 %	17.7%	11.6%	15.3 %	15.0 %
2	Accessibility & Walkability	13. %	6.7 %	2.8 %	0.0 %	0.0 %	0.0 %	8.8 %	1.8 %	6.7 %	2.3%	7.0%
3	Green Area	1.8 %	2.1 %	5.6 %	10. %	0.0 %	0.0 %	0.0 %	0.0 %	2.1 %	0.9%	3.0%
4	Land use/ Compactness	8.9 %	2.1 %	9.7 %	14. %	2.7 %	7.6 %	1.3 %	1.1 %	8.9 %	5.1%	8.0%

Table 6: The second level is the weight of the economic assessment categories in each system under study, and CAMNS proposed RW.

Assessment Element (Level-2): **Economic** Aspect: 1.		Primary Case Study Systems			Secondary case study Systems					Primary System Median	All System Median	**CAMNS Proposed RW**
		LEED-ND	BREEAM-C	CASBEE-UD	ECC	Star -C	DGNB-UD	Pearl	QSAS			
1	Economic /Investment	0.0 %	8.7 %	0.0 %	0.0 %	13. %	0.0 %	2.5 %	4.7 %	0	1.3 %	4 %

4.2.4 Institutional secondary assessment categories

Below,
Table 7: The second level weight of the institutional assessment categories in each system under study and CAMNS proposed RW.

Table 7: The second level weight of the institutional assessment categories in each system under study and CAMNS proposed RW.

Assessment Element (Level-2): **Institutional** Aspect: 1.		Primary Case Study Systems			Secondary case study Systems					Primary System Median	All System Median	**CAMNS Proposed RW**
		LEED-ND	BREEAM-C	CASBEE-UD	ECC	Star -C	DGNB-UD	Pearl	QSAS			
1	Design & Plan / Institution	6.3 %	11. %	16. %	4.6 %	6.0 %	10. %	1.9 %	10. %	11. %	8.5%	8%
2	Innovation	4.5 %	0.0 %	0.0 %	1.8 %	2.7 %	0.0 %	1.3 %	0.0 %	0.0 %	0.6%	2%

4.3 CAMNS Proposed Relative Weight for the first and second levels of the assessment model categories.

Below, Table 8: CAMNS model proposed categories and relative weight.

Table 8: CAMNS model proposed categories and relative weight.

CAMNSS Assessment Model Subcategory		Main Category RW (Level-1)	Secondary Category RW (Level-2)
1	Environmental Aspect	53%	
1.1	Site & Soil		3.0%
1.2	Energy		7.0%
1.3	Water		6.0%
1.4	Transport		12.0%
1.5	Ecology and Materials		11.0%
1.6	Pollution		2.0%
1.7	Waste		1.0%
1.8	Buildings		6.0%
1.9	Infrastructure		5.0%
2	Social Aspect	33%	
2.1	Social /Community/ employment/ housing		15.0%
2.2	Accessibility & Walkability		7.0%
2.3	Green Area		3.0%
2.4	Land use/ Compactness		8.0%
3	Economic Aspect	4%	

3.1	Economy/ Investment		4%
4	Institutional Aspect	10%	
4.1	Design & Plan / Institution		8%
4.2	Innovation		2%

DISCUSSION

In the discourse surrounding sustainability, a recurring inquiry persists: Are all elements of sustainability of equal importance? Should each element be given the same weight in the assessment scheme, or is there any reason for variation in the evaluation scores assigned? It is also important to point out that there is no clear approach to allocating sustainability assessment scores to the four fundamental pillars (Karban, 2014). It is not even necessary that all of these elements are equally important and, therefore, require the same proportion of evaluation scores. The literature review highlights significant gaps in the priority given to the critical components of sustainability as captured by different global measurement systems. Overall, the environmental factor receives the highest interest among the four sustainability aspects in all the studied systems except for the STAR system (Bioregional, 2016). However, the importance of the environmental dimension that is assigned to it differs in the various evaluation systems.

For instance, the Pearl system stands out as the most efficient in addressing environmental protection, given a relative weight of 76. 7%. Moreover, in the area of emphasis on environmental elements, the STAR system performs the worst, with only 31%. 3% relative weight of the environmental factors. These findings align with previous studies' conclusions, which also identified a primary concern in most of the examined systems regarding environmental aspects while neglecting economic, social, and institutional aspects (Fatani et al., 2017). Earlier researchers in this context interpreted this emphasis as a sign of the measured quality and effectiveness of assessment systems. In contrast, other researchers regarded it as a possible drawback that requires correction.

This disparity begs a pivotal question: How should sustainability elements be considered as strengths or weaknesses in prioritization? It is also important to note that there is no definitive set of relative weights for these elements that everyone accepts or is fixed. The proposed distributions of evaluation scores provide the relative, subjective assessment by the respective measurement systems that do not have a common reference. For example, considering that focusing on the environmental aspect is a weakness when it comes to score distribution is debatable (Al Murshedi, 2017; Kırbıyık et al., 2019). However, it cannot be unambiguously described as a system advantage as well. What logical foundation is there for assuming that environmental sustainability precedes economic or societal sustainability? This question may continue the discussion further and might be helpful for future investigations. Below, Figure 4: The second level weight of assessment categories for each system under study, the median, and the study's proposed weight for the same categories.

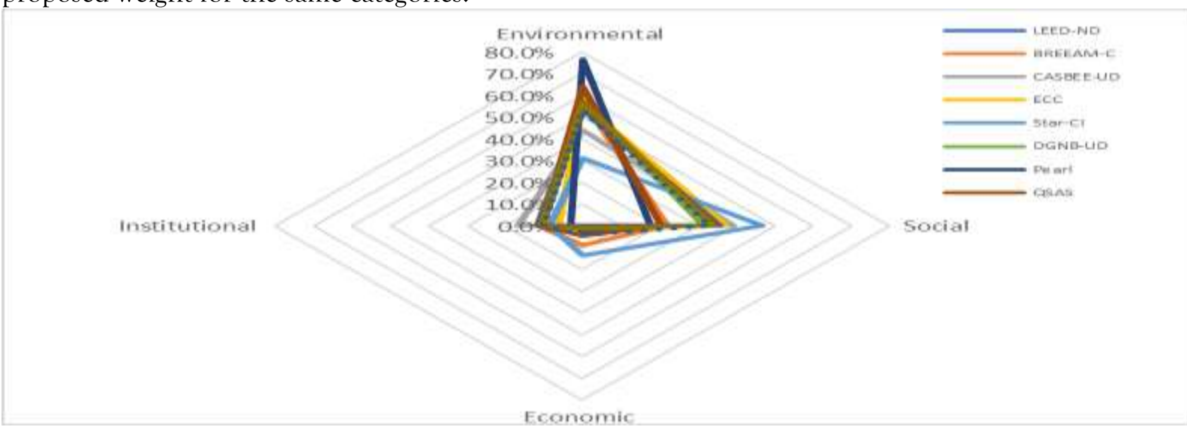


Figure 4: The second level weight of assessment categories for each system under study, the median, and the study's proposed weight for the same categories.

When comparing the results, some trends can be found that explain each system's effectiveness and possible disadvantages (Binsaedan et al., 2023). For example, LEED-ND seems to focus on water issues much more, giving a weight of 18% to this category, followed closely by community, employment, and housing aspects at 17.70%. Conversely, BREEAM-C gives considerable importance to the energy-related parameters with 23. However, it gives a negligible value to pollution concern (0. 00%) which may lead to ignoring this important aspect of sustainability (Al Shuwaikhat, 1999). Below, Table 9: A comparison between the weight of the second level of the assessment categories for each system under study.\

Table 9: A comparison between the weight of the second level of the assessment categories for each system under study.

	LEED-ND	BREEAM	CASBEE	ECC	Star -C	DGNB-UD	Pearl	QSAS
Site & Soil	4.6%	2.5%	0.0%	3.3%	4.9%	1.4%	0.0%	11.6 %
Energy	8.0%	23.9%	4.3%	4.0%	14.4%	5.6%	4.0%	8.0%
Water	18.7%	23.3%	4.3%	6.0%	9.9%	5.6%	2.6%	6.3%
Transport	6.9%	0.6%	10.9%	2.7%	15.5%	9.3%	14.9 %	11.6 %
Ecology & Materials	13.3%	13.2%	32.6%	8.0%	4.9%	9.7%	17.7 %	3.6%
Pollution	10.0%	0.0%	3.3%	2.7%	0.7%	0.0%	3.7%	0.9%
Waste	2.5%	4.4%	0.0%	2.0%	0.7%	1.4%	0.0%	0.9%
Buildings	0.0%	6.3%	0.0%	0.0%	2.8%	11.1%	6.6%	5.4%
Infrastructure	0.0%	2.5%	2.2%	2.7%	2.5%	0.0%	8.1%	5.4%
Community, employment & housing	17.7%	7.5%	23.9%	44.0 %	13.0%	21.3%	11.0 %	11.6 %
Accessibility & Walkability	1.8%	8.8%	0.0%	0.0%	0.0%	2.8%	6.7%	13.4 %
Green Area	0.0%	0.0%	0.0%	0.0%	10.2%	5.6%	2.1%	1.8%
Land use/ Compactness	1.1%	1.3%	7.6%	2.7%	14.1%	9.7%	2.1%	8.9%
Economic / Investment	4.7%	2.5%	0.0%	13.3 %	0.0%	0.0%	8.7%	0.0%
Design & Plan / Institution	10.7%	1.9%	10.9%	6.0%	4.6%	16.7%	11.7 %	6.3%
Innovation	0.0%	1.3%	0.0%	2.7%	1.8%	0.0%	0.0%	4.5%

In contrast, CASBEE-UD shows a high concern for ecology and materials (32.6%), depicting a strong environmental conservation approach. Nonetheless, it has little concern for economic and investment aspects (0.0%), making it questionable whether it comprehensively considers economic sustainability. ECC also demonstrates a remarkable concern with the community, employment, and housing aspects (44. 00%), which proves the institution's focus on the social responsibility of the community. However, it gives very little emphasis to waste management being only 0. 70% which affects proper waste management strategies. Analysing the public perception of Star-C one can identify that it has a strong focus on accessibility and walkability (13. 40 %). However, it seems less forceful in its design and planning/institutional emphasis (4. 60%) which could, in turn, restrict its ability to tackle sustainable systems' issues (Mark, 2017).

DGNB-UD allocates significant weight to the land use/compactness factor (14. 10%) and economic/investment factor (13. 30%) which evidences the fact that DGNB-UD has a sustainable approach towards urban development. However, its weight assignment to innovation (0. 00%) could be viewed as a weakness that may limit the company's ability to respond to new sustainable innovative trends (Arab News, 2018). Pearl displays a fairly even split, although there is focus on a range of issues with equal emphasis on community (25%) and employment (22%) with a significant percentage towards housing (11. 00%) and design/planning and institutional (11. 70%). Nevertheless, its exclusion of any reference to economic and investment factors (0. 00%) could potentially become an issue for long-term sustainable goals.

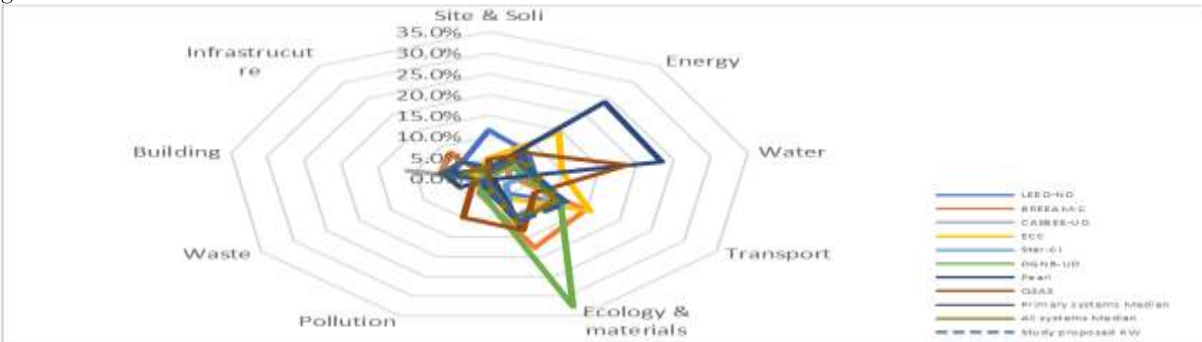


Figure 5: A wind rose diagram shows the weight of the environmental sub-categories in each system under study, the median, and the study's proposed weight for the CAMNS model for the same categories.

QSAS shows a remarkable concern for access and mobility (13. 40%) as well as energy (8. 00%) which indicates an intention to improve the life quality of cities and their energy usage. However, the company's strategic plan awarded minimal weight to innovation with only 4. 50% suggesting that the company may struggle to implement adaptive sustainability practices. Below, **Error! Reference source not found.** Also, below, **Error! Reference source not found.** In other words, although every measurement system has advantages in some aspects, it also has disadvantages that deserve consideration (ARUP, 2017). It is also important to understand how different sustainability categories are interconnected and how and to what extent the priorities of each system under consideration can be placed within the scope of sustainability discussions (Barton, 2000).

Above, Figure 5: A wind rose diagram shows the weight of the environmental sub-categories in each system under study, the median, and the study's proposed weight for the CAMNS model for the same categories. Below, Figure 6: A wind rose diagram shows the weight of the social sub-categories in each system under study, the median, and the study's proposed weight for the CAMNS model for the same categories.

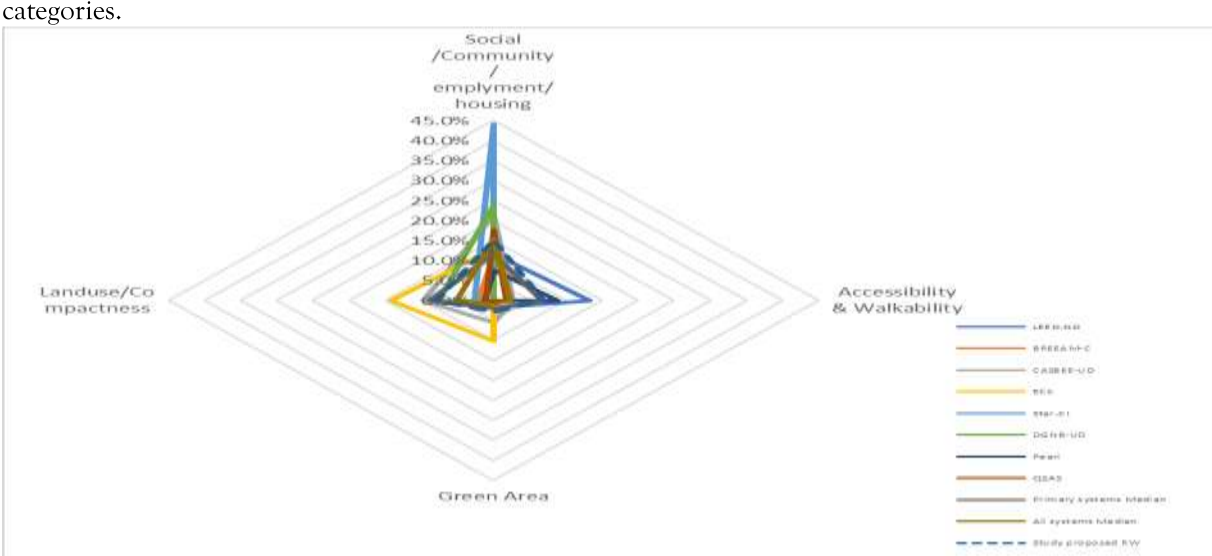


Figure 6: A wind rose diagram shows the weight of the social sub-categories in each system under study, the median, and the study's proposed weight for the CAMNS model for the same categories.

Therefore, suggestions that can be made include the following: More emphasis should be placed on the use of knowledge sharing and collaboration between the various systems to strengthen the overall sustainability assessment frameworks. Furthermore, an attempt should be made to develop measures and solutions to the above-mentioned shortcomings by incorporating the use of the related approaches and encouraging innovations in sustainability management. In addition, it is recommended that all stakeholders in urban planning and development assess the relevance and appropriateness of each of the systems' criteria to local contexts to ensure that sustainability initiatives are appropriate for the community. It is therefore critical to perform constant assessment and improvement of sustainability assessment methodologies to meet new challenges and opportunities as they emerge.

In the end, there is the need to embrace a shared and dynamic approach to sustainability assessment that would effectively capture the different perspectives and goals represented by the existing measurement frameworks to support the development of sustainable neighborhoods for the present and future generations. It is suggested that a detailed assessment system for neighborhood sustainability in Saudi Arabia should be established and implemented (Bal, 2019). As this system plays an important role in the community welfare and protection of natural resources, this model should incorporate environmental and societal aspects. Furthermore, economic and institutional factors must be incorporated to ensure sustainable economic development and proper governance in neighborhoods.

In this case, stakeholders must be involved in developing and implementing the evaluation system since they will be able to identify what is best for the nation and what is required in the local area. The proposed system should be pilot-tested to determine its applicability and efficiency in the Saudi environment and should be monitored and evaluated continuously to determine areas of strength, weakness, opportunities, and threats. It is recommended that capacity-building programs should be implemented to strengthen the skills and the level of understanding of local professionals in the field of sustainability assessment and management (Bahurmoz, 2006). In addition, the knowledge sharing and collaboration with the international partners may help identify and analyze other countries' experiences and integrate them into the development and implementation of the evaluation system in Ukraine. Through these recommendations, Saudi Arabia can set up the right and efficient framework for evaluating neighborhood sustainability and thus work towards developing sustainable and resilient communities for the present and future generations.

CONCLUSION

Overall, the comparative assessment of the eight global systems for evaluating the sustainability of residential neighborhoods reveals a nuanced landscape of strengths and weaknesses. All systems have different focuses and concerns regarding what constitutes sustainability and how cities should be managed. Although some systems have strengths in some areas, other areas of weakness may limit the ability of the systems to provide holistic solutions to sustainable development challenges. Turning to LEED-ND, it is worth mentioning that while it pays much attention to factors related to water usage and community health, it somewhat neglects pollution issues. BREEAM-C emphasizes environmental concerns with energy efficiency and thus has a good environmental concern but lacks a way of handling pollution and hence may not be effective in handling environmental degradation. CASBEE-UD boasts of its commitment to the conservation of the environment but it has a weakness of not paying adequate attention to economic aspects of sustainability.

ECC focuses more on the welfare of society, which is good but its lack of emphasis on waste management is problematic when it comes to sustainable use of resources. While Star-C's approach to prioritizing walkability improves the overall quality of urban living, its lack of attention to the institutional level may hamper the implementation of broader, more structural change. While DGNB-UD claims to consider the interdependencies between land use and economic factors, it seems to lack focus on innovation and thus might hinder the development of adaptive sustainable practices. It is, however, important to pay attention to the fact that while Pearl has managed to incorporate multiple facets of sustainability into its business model, the economic aspect is completely missing. QSAS's approach to accessibility and energy efficiency improves the quality of life in cities, but its weak commitment to innovation can negatively impact the prospects for sustainable development.

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