REAL ESTATE SUSTAINABILITY ASSESSMENT SYSTEM BASED ON MODIFIED BREEAM BY USING AHP AND SAW METHODS

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Abstract

A large amount of natural resources and energy is wasted during and after the building construction process which might cause environmental problems such as climate changes. To achieve higher standards of environmental protection a range of building assessment systems has been established. However, they are mostly connected with the efficiency of an environmental protection and consumption of resources. Only few of them have limited possibilities to assess social and economic sustainability. A sustainable building includes aspects of environment, economy and society and therefore requirements to its assessment systems should be complex. We suggest that sustainability principles i.e., environmental, social and economic sustainability should be estimated in the same equal weightings. The authors of this article created a model for assessing the sustainability for recreational buildings. Our model was created, in collaboration with experts, using breakdown, compensation and AHP methods. The sustainability of Druskininkai Snow Arena (Lithuania) was assessed using sustainability assessment (SA) system based on proposed model.

Keywords: *Sustainable development; sustainability assessment (SA) system; model; buildings; Druskininkai Snow Arena*

JEL classification: P56, C44

INTRODUCTION

There are many reasons why sustainable real estate (RE) development is essential, such as chaotic urban development, non-renewable energy use, resource conservation, and climate change. Sustainable development principles are used in designing, assessing, constructing, using, and demolishing buildings to promote sustainability (Cortesi et al. 2022). Sustainable development policy essentially means that:

- mixed-use development is becoming the norm;
- public transport is preferred;
- a diversity of users of new development: owners and tenants, private and social housing;
- promoting high quality public, private and sustainable buildings;
- revitalising the economy of urban areas, while increasingly promoting urban living.

Therefore, a multi-criteria analysis of the components of sustainable urban development should be carried out (Kaklauskas et al. 2009). As Choguill (2008) argues, no city can be sustainable if its components are not sustainable, so it is important to start with buildings. Recently, many studies have been carried out and various assessment methodologies have been applied to buildings, in particular to address the efficiency of energy and other resource consumption. Assessing the sustainability of buildings is becoming one of the key issues in sustainable construction.

1. OVERVIEW OF BUILDING SUSTAINABILITY ASSESSMENT (SAS) SYSTEMS

Sustainability of buildings encompasses the various relationships between the built, natural and social systems, and therefore constitutes a set of priorities that need to be taken into account at each stage of the building life cycle. There are approximately 600 assessment systems that measure social, environmental and economic sustainability indicators. The main existing building SAS's that allow their use and adaptation in other countries are BREEAM, LEED and DGNB.

Currently, some building SAS's are internationally known and widely used, others are mainly country-specific and therefore only used in those countries. A lot of work has gone into the development of SAS's that help practitioners to measure, calculate and assess the impact of buildings on natural systems from an environmental, social and economic perspective, to communicate this to different stakeholders and to suggest the most effective ways to improve the built environment. The main international organisation bringing together countries where building SAS's are widely applied or under development is the World Green Building Council (WGBC), which was established in 1999 and currently has a membership of over 84 countries (World Green Building Council 2013). Table 1 shows the SAS's that have been developed to reduce the negative environmental impact of the design, construction, renovation and/or operation of buildings, but their use is limited by differences in climate, legislation, culture and other factors in different countries. The WGBC does not promote sustainability assessment models, but aims to support and encourage the emergence of new or adapted SAS's in specific countries. For this reason, it engages with local authorities, organises various global conferences and provides training.

Table 1. Buildings sustainability assessment systems

Buildings sustainability assessment systems	Year, country
BREEAM *(Building Research Establishment Environmental Assessment Method)*	1990, UK
BEPAC *(Building Environmental Performance Assessment Criteria)*	1993, Canada
Minergie	1994/1997, Switzerland
SBTool *(Sustainable Building Challenge)*, GBTool	1995, International
Green Globes	1996, Canada, UK
HQE *(High Quality Environmental Standard)*	1996, France
BEAM Plus *(HK-BEAM – Hong Kong Building Environmental Assesment Method)*	1996, Hong Kong
LEED *(The Leadership in Energy and Environment Design)*	1998, USA
SPeAR *(Arup's Sustainable Project Appraisal Routine)*	2000, UK
EcoEffect	2000, Sweden
BEAT 2002 *(Building Environmental Assessment Tool)*	2000, Denmark
CEPAS *(The Comprehensive Environmental Performance Assessment Scheme for Buildings)*	2001, Hong Kong
CASBEE *(Comprehensive Assessment System for Building Environmental Efficiency)*	2001, Japan
NABERS *(National Australian Building Environment Rating System)*	2001, Australia
Green Star	2002, Australia
TQB *(Total Quality Building Assessment)*	2002, Austria
BeCost	2002, Finland
GOBAS *(Green Olympic Building Assessment System)*	2003, China
BCA-GM *(Building and Construction Authority Green Mark)*	2005, Singapore
Protocollo ITACA *(Innovation and Transparency of the Contracts and Environmental Compability)*	2005, Italy
LiderA	2000/2005, Portugal
DGNB *(German Sustainable Building Council)*	2007, Germany
CSH *(Code for Sustainable Homes)*	2007, UK
SBAT *(Sustainable Building Assessment Tool)*	2007, South Africa
BEES 4.0 *(Building for Environment and Economic Sustainability)*	2007, USA
VERDE	2010, Spain

Sustainability rating systems used worldwide are often based on the BREEAM or LEED model with local modifications to suit different environmental conditions, construction regulations, or standards (Abdelaal et al. 2022). The BREEAM rating system is flexible, transparent, and widely used in many countries. Many sustainable development rating systems have been created worldwide to evaluate aspects of sustainable building development, but they often do not cover all essential components equally. They may need to address social, economic, and environmental sustainability aspects adequately, and their criteria and credit allocation may need to be clarified. Sustainable RE development requires consideration of environmental, social, and economic factors (Ferrari et al. 2022). It is vital to transform environmental building assessment systems into sustainability assessments.

2. THE BUILDINGS SUSTAINABILITY ASSESSMENT MODEL

A new RE assessment model has been developed that equally evaluates environmental, economic, and social aspects. The method for creating a sustainability assessment model for real estate involves several steps (Fig. 1):

1. Selection of evaluation criteria.
2. Selection of experts.
3. Distribution of credit scores for criteria using the breakdown method.
4. Balancing the significance of criteria.
5. Determining the significance of an additional group of criteria.
6. Adding new criteria to the evaluation system.
7. Determining the significance of additional criteria using the AHP method (Sisman et al. 2023).
8. Determining the consistency of individual expert opinions and their general agreement.

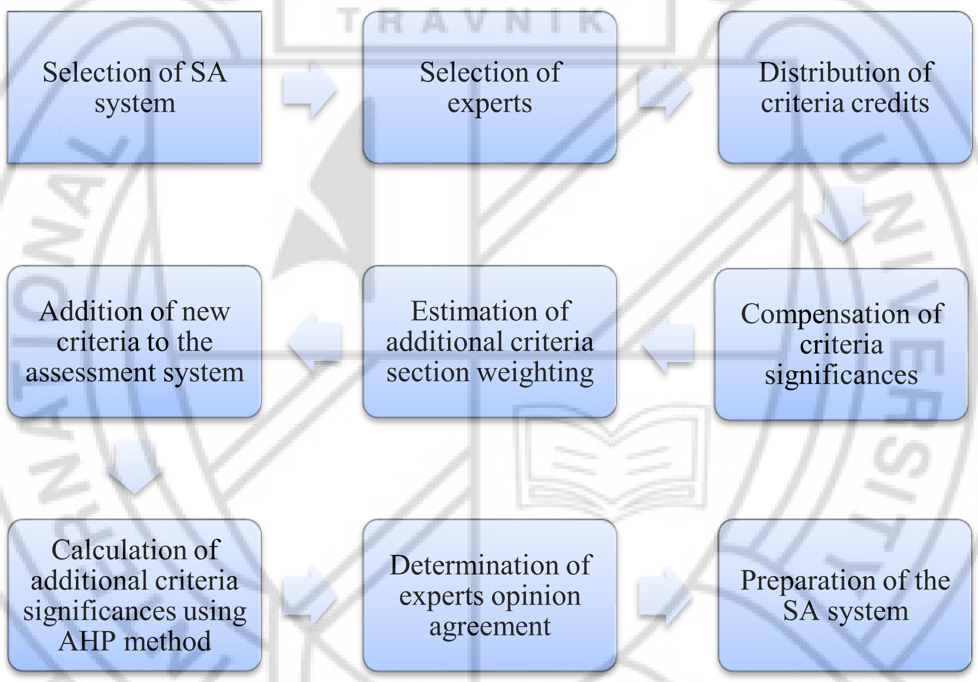

Fig. 1. Proposed methodology to create an assessment model for buildings sustainability

A methodology for the development of a sustainability assessment model for buildings allows the ecological, economic and social aspects of sustainable real estate development to be evaluated as being of equal importance. The model has been developed by applying the proposed methodology based on expert, decomposition, balancing and AHP methods.
The model for assessing the sustainability can be applied to buildings for other uses, but with specific criteria and the involvement of a wider range of experts from different fields (users, developers, etc.).

3. SNOW ARENA'S SUSTAINABILITY ASSESSMENT

The Snow Arena ski slope complex is an 8-hectare structure with three snow-covered ski slopes for downhill skiing and snowboarding under one roof. It is a building for winter sports enthusiasts and professional athletes, who can ski here all year round (Fig. 2). The Snow Arena is one of the largest and most modern indoor ski resorts in Europe and, in terms of technical performance, is among the world's top five indoor ski resorts (Snow Arena 2011).

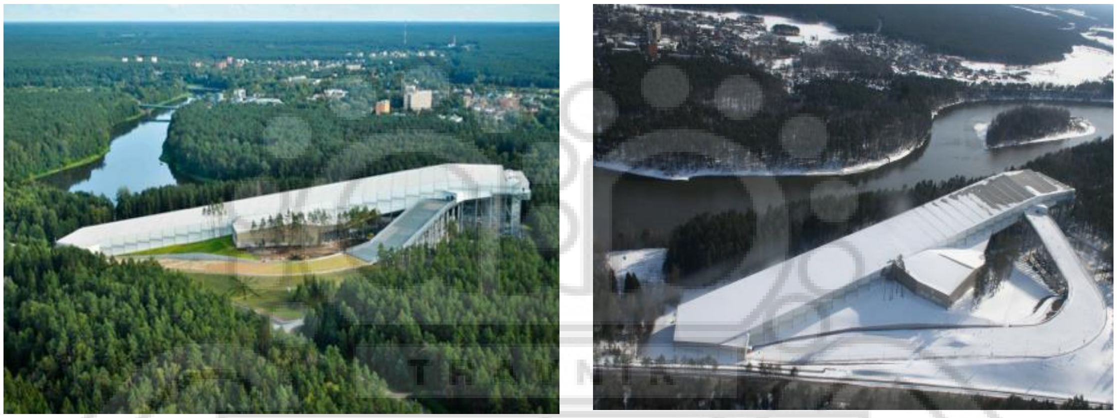

Fig. 2. Druskininkai Snow Arena

The Druskininkai Snow Arena is assessed for sustainability under the Recreational Complexes SAS by assessing each of the 11 groups of criteria, giving a number of credits, or none at all if a specific requirement is not met. Each criterion shall be scored by determining the percentage of fulfilment and multiplying it by its converted significance. Table 2 shows the sustainability calculations for Druskininkai Snow Arena.

Table 2. Assessment of Druskininkai Snow Arena sustainability

No.	Section	Credits achieved	Credits available	% of Credits achieved	Section weighting	Indicative (weighted) section score, %
1	Management	11	21	52.38	0.1243	6.51
2	Health & Wellbeing	12	15	80	0.13	10.40
3	Energy	16	29	55.17	0.1507	8.31
4	Transport	8	10	80	0.068	5.44
5	Water	6	9	66.67	0.06	4.00
6	Materials	5	9	55.56	0.0625	3.47
7	Waste	3	6	50	0.0438	2.19
8	Land Use & Ecology	3	10	30	0.06	1.80
9	Pollution	6	13	46.15	0.0712	3.29
10	Additional criteria (social + economic)	25	34	73.53	0.2295	16.88
11	Innovation	1	10	10	0.1	1.00
Final score					63.29%	
Rating					Very good	

The BREEAM New Construction 2018 score was 56.65% (out of 122 possible +10 additional, i.e. 75 credits). As the building also met the minimum mandatory requirements, it is rated as very good. This is the third sustainability rating out of a possible five and is a really high score for a recreational building in Lithuania. The difference between the SAS rating of the proposed recreational complex and the BREEAM New Construction 2018 rating was 65.82 - 56.65 = 9.17%. The higher score is due to the increased importance of socio-economic criteria in the SAS and the reduced importance of environmental criteria. In the main scoring system, using BREEAM New Construction 2018 as a basis, but recalculating the significance of the criteria using decomposition and rebalancing techniques, the criteria in the 10 groups, without the additional criteria (group 10), scored 46.41%. This is 9.13% lower (56.65-47.52) than for BREEAM New Construction 2018, due to the reduction of the environmental criteria. Thus, the SAS for recreational buildings proved to be suitable for assessing their sustainability and, as expected, the introduction of additional socio-economic criteria resulted in a higher score.

CONCLUSION

The proposed model has resulted in the creation of a RE sustainability assessment system that provides essential criteria with assigned values of significance, credit differences, and an overall rating percentage. This SAS can be used to rate the sustainability of various buildings and make comparisons. By using the proposed SAS, it can help promote sustainable development and not only reduce the use of natural resources, CO_2 emissions and mitigate climate change impacts but to consider more significant economic and social criteria of sustainability (Raslanas et al. 2016). Compared to other systems, the RE SAS is more suitable for rating the sustainability of buildings as it considers social and economic measures. Using sustainability assessment can help achieve project goals and effective strategic management.

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