Building Certification Systems and Processes

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ABSTRACT **Multiple recognised benefits of sustainable buildings are effectively communicated through assessment models. In order to use existing certification models or to engage in the development of new schemes, it is necessary to build knowledge about their character, organisation, and procedures. Having regarded that the assessment methodology is undergoing a continuous process of development, this paper aims to discuss the core features and components of building certification, from the time of the emergence of initial models to the future horizons, thus drawing a holistic picture about this instrument that is relevant for the achievement of sustainability of buildings.**

The paper consists of five parts. The first part presents the background of building certification models. Furthermore, their key characteristics are discussed, from the assessment of environmental quality of buildings, to the typological variations, to territorial applicability, to the connection with the regulations, to the scope of economic and social issues encompassed by the assessment. The system of assessment models is analysed in the third section, and the comparison of hierarchical organisation of several well-known models is given. The fourth part of the paper presents different examples of the assessment process, from the registration for certification to the certificate awarding. Finally, the fifth section summarises the main observations regarding development trends, current status, and possible directions of future advancement of certification models in the function of their increased use.

KEYWORDS certification model, system and process, building typology, territorial boundaries

1 Introduction

Since the development of the first versions, the certification models have highlighted the importance of considering the sustainability of buildings of various types and sizes. The certification contributes to the improvement of the quality of buildings, integrates life cycle approach with the design, supports the implementation and the development of regulations, and encourages the orientation of the construction industry towards the goals of sustainable development.

All rating models have a common goal to assess and verify the level of achieved quality of a building by providing a certificate that:

- proves that the reduction of the negative impacts of a building on the environment has been achieved, while at the same time the technical, economic, social, and functional requirements have been respected or upgraded through holistic sustainability considerations;
- promotes sustainable building design and construction among different actors and stakeholders;
- increases the value of a certified building in real estate market (e.g., Eichholtz, Kok, & Quigley, 2010).

By reviewing the characteristics of different well-known models for building certification, their development paths and the established systems and processes, and by comparing specific models with the general objectives of building ratings, this paper analyses potentials and limitations regarding sustainability assessment of buildings from the present perspective, and reflects possible directions for further advancement in the field.

1.1 Development of Certification Models

The first energy labelling systems – energy passes – were introduced in Europe during the 1980s as a reaction to the previously occurred energy crises. With the rise in awareness of environmental impact, the need for a more comprehensive consideration of the quality of buildings started to increase, and expanding assessment boundaries were ultimately determined by the Life Cycle Assessment (LCA) method. This opened a path to the development of databases of building materials and furthermore brought environmental aspects closer to the building industry. Subsequently, efforts to integrate energy issues, performance of building materials, and other building-related environmental topics, to quantify quality, and to allow for comparability of obtained results led to the formation of models for comprehensive building assessment. The best-known building certification models today are BREEAM (Building Research Establishment's Environmental Assessment Methodology), LEED (Leadership in Energy and Environmental Design), and DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen (German Sustainable Building Council)).

In 1990, the UK based organisation Building Research Establishment (BRE) launched its first BREEAM building certificate. BREEAM is labelled as the first real attempt to establish a comprehensive methodology for the assessment of a broad range of environmental issues of buildings (Haapio, 2008, p. 7), the first assessment method that was integrated into regulations, and the first certificate that included the environmental performance of materials (Anderson & Shiers, 2009). Nowadays, BREEAM is a widespread, recognised, and comprehensive platform that offers rating schemes for new infrastructure projects, developments at the neighbourhood scale, new-build domestic and non-domestic buildings, existing non-domestic buildings in-use, and domestic and non-domestic building fit-outs and refurbishments.

In 1998, the US Green Building Council launched its first LEED certificate that dealt with the assessment of energy savings, water efficiency, reduction of carbon dioxide emissions, improvement of indoor environmental quality, and stewardship of resources and sensitivity to their impact. Because of a checklist-based system that was easy to apply, the LEED label gained international publicity within a short period. Gradually, the scope of the LEED framework has enlarged to finally include: different schemes for the assessment of building design and construction; interior design and construction; building operation and maintenance; neighbourhood development; and homes. Just like other developed models, the LEED platform and its different schemes are continually being revised and upgraded. LEED Version 4, for example, offers improvements in terms of environmental outcomes, flexibility to different project types and regional context, etc. (US Green Building Council, 2013b).

In 2009, the German Sustainable Building Council and the German Federal Ministry of Traffic, Construction and Urban Development together released an initial scheme for the evaluation of office buildings, known as BMVBS (abbr. Bundesministerium für Verkehr, Bau und Stadtentwicklung (Federal Ministry of Traffic, Construction and Urban Development)), but later continued their work separately. While the application of BMVBS became mandatory for newly constructed federal office buildings, the developed DGNB certification model, although based on German standards, is voluntary. Nowadays, DGNB is an internationally adaptable certification system with the ability to assess various building types and districts (DGNB, 2017). Compared to the other two assessment models – BREEAM and LEED – the DGNB model is more thorough and complex.

Today, national green building councils worldwide are joined into a global network called the World Green Building Council (WGBC) that administers different national models (like Japanese CASBEE – Comprehensive Assessment System for Built Environment Efficiency, Spanish 'Verde', or Korean Green Building Certification – KGBC), adjusts large international platforms such as the LEED, BREEAM, DGNB, and Australian Green Star to different national conditions (e.g., BREEAM-NOR for Norway, Green Star SA for South Africa, etc.), and engages in the development of new models.

2 Key Characteristics of Certification Models

Every building certificate has several key characteristics that define its structure and content, in particular referring to:

- the environmental dimension of sustainability, i.e. the environmental quality of buildings;
- social and economic dimensions of sustainability;
- building typology;
- regulative grounds; and
- territory for which a certification model is intended.

2.1 Environmental Quality of Buildings

Following the review of different models developed internationally, it can be concluded that the assessment of the environmental quality of buildings continues to represent their key objective. Basically, most of the negative environmental effects of buildings originate from the use of natural resources: energy, water, land, and raw materials i.e. the products obtained from these raw materials (Table 2.1).

The Table 2.1 shows that:

- the use of different types of natural resources can lead to the same type of environmental effects on the environment;
- the use of any type of natural resources in activities connected with the buildings generates multiple types of environmental effects;
- the use of any type of natural resource generates effects that further make new effects, based on the principle of chain reaction;
- the largest number of effects caused by the use of natural resources finally result in negative impacts on the living world, and to human health and wellbeing;
- some environmental implications of the use of natural resources make a reversible impact on causative activities and states, e.g., depletion of energy resources influences the possibility to obtain useful forms of energy; and
- the effects listed according to the type of used natural resources do not correspond to the life cycle of buildings, i.e. they occur during different life cycle phases, which means that the sole consideration of the use of resources is not sufficient to comprehensively assess the environmental quality of buildings.

Besides environmental impact of resource use, there also exists the impacts that depend on the way a building is set as functional materialised structure, i.e. the way in which occupants use a building. Pollution through artificial light, noise, municipal waste generation, microclimate changes caused by the physical structure of a building, and the disturbance of natural mechanisms by the same cause, etc. are some examples of environmental impacts that cannot be assessed by using only the resource use-based approach without applying the Life Cycle Assessment (LCA) method.

TYPE OF USED RESOURCES	ENVIRONMENTAL EFFECTS			
ENERGY USE	Air pollution	Oxygen content		Effects on the living world
		Smog		
		Acid rain		
		Global warming	Sea level rise	
			Climate change	
	Water pollution			
	Soil pollution			
	Depletion of energy resources			
MATERIALS USE	Direct effects on human health			
	Air pollution	Smog		Effects on the living world
		Acid rains		
	Water pollution			
	Waste generation and soil pollution			
	Visual pollution			
	Pollution with noise and vibrations (during installation and decommissioning)			
	Effects connected with energy use			
	Effects connected with water use			
	Effects connected with land use			
	Microclimate changes			
	Disturbance of natural mechanisms			
	Depletion of raw materials resources			
WATER USE	Lack of fresh water			Effects on the living world
	Water pollution	Eutrophication		
		Soil pollution		
LAND USE	Soil pollution	Water and air pollution		Effects on the living world
		Degradation of natural values		
	Changes in land cover, soil composition and relief morphology	Erosion		
		Degradation of natural values		
		Desertification		
		Changes in the watercourses		
	Microclimate changes			
	Deforestation	Erosion		
		Reduced oxygen content		
		Global warming		
	Reduced areas of free land			

TABLE 2.1 Environmental effects of use of natural resources in activities connected with the buildings

To assess the performance of buildings more holistically, developed certification models today combine both mentioned approaches. Nevertheless, the issues found in the overlap zone of the life cycle of a building and the life cycle of used materials require particular attention during the assessment, in order to reduce the probability of overlooking some important environmental items. For example, the assessment of land use is given more significance in the life cycle of buildings (e.g., during the site preparation, construction, or use), than in the life cycle of building materials. On the other hand, energy issues are addressed through both the material and the building LCAs, as evidenced by the criteria and indicators established in building assessment models and their supporting tools and databases. Recently, different research challenges and opportunities for successful integration of various LCA-related issues into the building assessment models have been identified (e.g., Anand & Amor, 2017).

2.2 Typological Variations

Typology plays an important role when it comes to the environmental impact of buildings. For example, different types of buildings have particular thermal comfort requirements that have varying energy demands. While the first assessment models referred only to offices and residential buildings, a broad variety of typological variations have become available in the meantime. Today, unified and flexible platforms offer various assessment schemes for residential buildings, offices, laboratories, manufacturing facilities, schools, hospitals, etc. For example, in the frames of one of its five different schemes – Building Design and Construction (BD+C), LEED offers assessment possibilities for the following building typologies: new construction and major renovation; core & shell development; schools; retail; data centres; warehouses and distribution centres; hospitality; healthcare; and multifamily housing. BREEAM International New Construction 2016 includes an even greater variety of typologies, from single and multiple residential dwellings, to residential institutions for short- or long-term stay, to offices, industrial units, and retail buildings, to education buildings (from preschool to higher education institutions), and finally to a variety of non-standard building types (like prisons, museums, libraries, etc.). At present, the DGNB model offers national schemes for the following building typologies: new offices; existing offices; residential buildings; dwellings; healthcare; education facilities; hotels; retail; assembly buildings; industrial; and tenant fit-out.

Unlike large platforms that allow for the evaluation of different building types from a common base, there are also those models that refer to the assessment of only one type of buildings, e.g., single family dwellings (LEED for Homes, CASBEE for Detached Houses (New Construction), or BRE's Home Quality Mark). It is certain that the models developed for one specific type of buildings can give more precise results in some segments. In addition to the typological characteristics that reflect on the characteristics of the life cycle and, therefore, on the definition of a model, the responsiveness to the characteristics of a territory for which a model is intended is equally important.

2.3 Territorial Applicability

As sustainable buildings are place-responsive by definition, the certification models must be well-suited to the intended territory. In the ideal case, an assessment model would tackle local issues in the most comprehensive way, because of a range of local specificities regarding climate, state of the environment, construction practice, typological characteristics, energy issues, water supply, land use, regulations, etc. However, the development or use of locally applicable certification models are currently rare. The majority of existing models are either intended for national use or are applicable to different national/regional conditions by virtue of the differentiation between the universal and the territory-specific assessment items. In the DGBN model, for example, international projects are certified under the DGNB CORE 14 scheme that adapts to national standards and requirements. BREEAM International New Construction 2016 distinguishes between 'fixed' assessment items with universal significance and 'variable' assessment items that are variable locally, and foresees that a first project registered for a BREEAM rating in a country or a region will undergo a special review process that aims to determine the territorial significance (weight) of assessment criteria. All projects subsequently registered for the BREEAM certification in the same country/region will be assessed on the basis of the weightings adopted for that territory (BREEAM, 2017, p. 22). Nevertheless, there is an ongoing debate about the efficacy of international assessment tools in measuring the building performance outside their country of origin, or even within the country of origin, if variable climate and topographic conditions exist (Banani, Vahdati, Shahrestani, & Clements-Croome, 2016; Suzer, 2015).

2.4 Regulations

Building certification models contain different legally prescribed norms. Through the system of criteria and indicators, the prescribed minimums are further upgraded and classified into several grades of archived sustainability quality. Given that the certification models set voluntary targets that are stricter than the valid legal requirements, or establish new norms in the segments that are not legally defined, they may be considered as a driving force for the development of regulations.

The development of models on the basis of national regulations that differ in their scope and strictness from one country to another causes a lack of consistency in baseline assumptions (Reed, Wilkinson, Bilos, & Schulte, 2011). To overcome this constraint, different proposals for the development of a global certification system and globally applicable building regulations have been given. Further standardisation, with the aim of allowing for the establishment of comparable thresholds of building quality and to enable the comparison of results obtained by using different models, represents a necessary development direction.

In general, the application of building rating systems is still voluntary. Currently, this represents one of the major constraints in the spreading of sustainable building practice.

2.5 Rating Scope: From Environmental to Sustainability Assessment

Early versions of rating models were commonly criticised for neglecting broader sustainability aspects (e.g., Cole, 1998; Cooper, 1999; Guy, 2005). Besides the environmental (Section 2.1), certification models today encompass different economic and social assessment items. The principal economic considerations in existing rating models are related to cost monitoring, economic efficiency calculations, and the life cycle cost analysis. Because of the complexity of the social dimension, some certification models distinguish between technical, social, and functional aspects and processes.

CASBEE and DGNB platforms comprehensively integrate different segments of sustainability into their certification systems (IBEC, 2014; DGNB, 2017). Additionally, DGNB version 2018 links assessment criteria with the following wider objectives: People First; Circular Economy; Design and Cultural Quality of Construction; Implementation of Sustainable Development Goals/Agenda 2030; EU-conformity; and Innovation. The positive evaluation of criteria that support the achievement of these objectives will be rewarded with bonuses (DGNB, n.d.).

Increased research interest in holistic sustainability assessment over the last decade has resulted in different proposals that extend beyond the building boundaries, like the integrated building-urban evaluation approach (Conte & Monno, 2012), or the approach that combines the active participation of stakeholders, and the common organisational hierarchy of the assessment system and spatial hierarchy of assessment subjects, thereby linking building sustainability with the concept of sustainable communities (Kosanović, Jovanović Popović, & Stanković, 2014).

3 System Organisation

Most of the certification models are organised as vertical branched systems consisting of a range of assessment items – criteria – that are grouped into categories (and optional subcategories). The scope of assessment items, their organisation within the categories, and the weight assigned to them are informed by the building typology to which a model is applied. For illustration, the platform BREEAM International New Construction 2016, which contains 57 individual assessment issues grouped into nine different categories (plus the category of Innovation), applies to a broad variety of building types, including residential buildings. Nonetheless, BREEAM distinguishes between building types by defining differing criteria and benchmarks for some assessment issues, and several criteria in this universal platform relate only to residential buildings. The model further elaborates on the requirements regarding the rating of residential types by offering four different classification routes, two of which relate to single dwellings (BREEAM, 2017, p. 402). Following the same principle, some criteria in the universal platform, LEED v4 for Building Design and Construction (US Green Building Council, 2017), like Design for Flexibility, or Furniture and Medical Furnishing (both of which are found in the category Materials and Resources) apply only to healthcare buildings (Table 3.1).

BREEAM INTERNATIONAL NEW CONSTRUCTION 2016	LEED V4 FOR BUILDING DESIGN AND CONSTRUCTION	DGNB SCHEME FOR NEW CONSTRUCTION
Health and Wellbeing Visual comfort; indoor air quality; safe containment in laboratories; thermal comfort; acoustic performance; accessibility; hazards; private space; water quality. **Land Use and Ecology** Site selection; ecological value of site and protection of ecological features; minimising impact on existing site ecology; enhancing site ecology; long term impact on biodiversity. **Pollution** Impact of refrigerants; NOx emissions; surface water run-off; reduction of night time light pollution; reduction of noise pollution. **Transport** Public transport accessibility; proximity to amenities; alternative modes of transport; maximum car parking capacity; travel plan; home office. **Water** Water consumption; water monitoring; water leak detection and prevention; water efficient equipment. **Materials** Life cycle impacts; hard landscaping and boundary protection; responsible sourcing of construction products; designing for durability and resilience; material efficiency. **Waste** Construction waste management; recycled aggregates; operational waste; speculative floor and ceiling finishes; adaptation to climate change; functional adaptability. **Energy** Reduction of energy use and carbon emissions; energy monitoring; external lighting; low carbon design; energy efficient cold storage; energy efficient transport systems; energy efficient laboratory systems; energy efficient equipment; drying space. **Innovation** Up to 10 points for recognised additional sustainability related benefits. **Management** Project brief and design; life cycle costs and service life planning; responsible construction practices; commissioning and handover; aftercare.	**Indoor Environmental Quality** Minimum indoor air quality performance; environmental tobacco smoke control; minimum acoustic performance; enhanced indoor air quality strategies; low-emitting materials; construction indoor air quality assessment; thermal comfort; interior lighting; daylight; quality views; acoustic performance. **Sustainable Sites** Construction activity pollution prevention; environmental site assessment; site assessment, site development – protect or restore habitat; open space; rainwater management; heat island reduction; light pollution reduction; site masterplan; tenant design and construction guidelines; places of respite; direct exterior access; joint use facilities. **Location and Transportation** Neighbourhood development location; sensitive land protection; high-priority site; surrounding density and diverse uses; access to quality transit; bicycle facilities; reduced parking footprint; green vehicles. **Water Efficiency** Outdoor water use reduction; indoor water use reduction; building-level water metering; cooling tower water use; water metering. **Materials and Resources** Storage and collection of recyclables; construction and demolition waste management planning; building life-cycle impact reduction; environmental product declarations; sourcing of raw materials; material ingredients; PBT source reduction – mercury, lead, cadmium, and copper; furniture and medical furnishing; design for flexibility; construction and demolition waste management. **Energy and Atmosphere** Fundamental commissioning and verification; minimum energy performance; building level energy metering; fundamental refrigerant management; enhanced commissioning; optimise energy metering; demand response; renewable energy production; enhanced refrigerating management; green power; carbon offsets. **Innovation** Innovation; Accredited Professional. **Regional Priority** No defined criteria but credit points are awarded.	**Sociocultural and Functional Quality** Thermal comfort; air quality; acoustic comfort; view out; user control / possibility of influence; indoor and outdoor environmental quality; security; accessibility. **Site Quality** Micro-site; influence on neighbourhood; connection to transport systems; distance to relevant objects and facilities for the user. **Ecological Quality** Life cycle assessment of the building; risks to the local environment; responsible resource procurement; biodiversity at the location; drinking water demand; wastewater volumes; land use. **Technical Quality** Noise protection; quality of building envelope; use and integration of building technology; ease of cleaning; ease of deconstruction and recycling; protection against emission; mobility. **Economic Quality** Life cycle costs; flexibility and usability; commercial viability. **Process Quality** Quality of project preparation; securing sustainability aspects in tendering and assignment; documentation for a sustainable management; procedures for urban development and design; construction site/construction process; quality of the construction work; orderly commissioning; user communication; consideration of facility management.

TABLE 3.1 Comparative overview of categories and criteria in the following models: BREEAM International New Construction 2016; LEED v4 for Building Design and Construction; and DGNB Scheme for New Construction

On the other hand, the Code for Sustainable Homes (Department of Communities and Local Government, 2010) model offers a set of criteria (grouped into nine categories) that is tailored for residential units and hence better adjusted to typological specificities, similar to the LEED for Homes (which contains eight categories) (US Green Building Council, (2013), and CASBEE for Detached Houses (New Construction) (with six categories) (Murakami, Iwamura, & Cole, 2014) models. By analysing different models that are designed for the same building type (Table 3.2), it can be concluded that the vertical hierarchical organisation and the scope of assessment items vary; consequently, the models do not allow for the comparison of results between them, and the lack of a standardised basis is currently perceived as a constraint.

CODE FOR SUSTAINABLE HOMES	LEED FOR HOMES V4	CASBEE FOR DETACHED HOUSES (NEW CONSTRUCTION)
– Energy and CO2 emissions – Water – Materials – Surface Water Run-off – Waste – Pollution – Health and Wellbeing – Management – Ecology	– Energy and Atmosphere – Water Efficiency – Materials and Resources – Sustainable Sites – Regional Priority – Innovation – Indoor Environmental Quality – Location and Transportation	– Comfortable, healthy and safe indoor environment – Durability for long-term use – Consideration for the townscape and ecosystem – Energy and water conservation – Conservation of resources and reduction of waste – Consideration for the global, local and surrounding environment

TABLE 3.2 Comparative overview of categories in the Code for Sustainable Homes; LEED for Homes; and CASBEE for Detached Houses (New Construction) models.

Nevertheless, when comparing large assessment platforms, some common characteristics regarding categories, criteria, indicators, and weighting may be drawn. In every model, the categories are formed according to sustainability aspects, such as:

- ecological quality, e.g. energy performance of building, lifecycle impact of building materials, waste management, water consumption efficiency, pollution, land use, etc.;
- economical quality, e.g., life cycle costs; and
- sociocultural and functional quality, e.g., management of the planning and building process, location, transport, mobility, indoor environment quality, comfort, etc.

All models evaluate sustainability quality over mandatory criteria – prerequisites, and voluntary criteria. The most relevant criteria, defined as minimum necessary requirements, are mandatory. If mandatory criteria are not fulfilled, a certificate cannot be issued. Besides obligatory or voluntary fulfilment, the relevance of criteria is additionally defined by weight and assigned points. Each system has an individual rating and weighting method; accordingly, similar assessment topics can be given different priorities in different models. Generally, weighting enables distribution of the points and understanding of the relationship between prerequisites, credits, and specific outcomes (Pyke, McMahon, Larsen, Rajkovich, & Rohloff, 2012).

3.1 Indicators

The indicators are used to express the value of certain quality. For example, thermal comfort can be expressed by people's satisfaction with the indoor air quality (predicted mean vote). To provide comparability, assessment systems use both quantitative and qualitative, i.e. descriptive indicators. Most of the indicators relate to international standards issued by the International Standards Organisation (ISO) and the European Committee for Standardisation (CEN). In addition, LEED platforms refer to the standards of the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE), DGNB platform to the German Institute for Standardisation (DIN) and the Society of German Engineers (VDI), and the BREEAM model refers to the standards of the Chartered Institution of Building Services Engineers (CIBSE). While DGNB and BREEAM define the unit and the indicator, LEED allows for variety in providing proof of performance, e.g., for the criterion Thermal Comfort, the project team can choose between two options: to meet the requirements of the American ASHRAE standard or to meet the requirements of the ISO and CEN standards that are more commonly used in Europe.

The indicators of ecological quality within the models are approached differently. While some models express the ecological impact caused by building services or a material, others use LCA results (like DGNB), or rate the impact from environmentally friendly to harming (e.g., BREEAM). Furthermore, BREEAM includes total carbon dioxide emissions for production and building operation, total net water consumption (m^3) and transport-related carbon dioxide emissions. The benchmark can be defined by a limit of a certain indicator (e.g., for global warming potential); in other cases, a specific share of materials from a category must be met, or an energy standard must be fulfilled. Again, some models encourage the use of renewable or local materials and reward the fulfilment of this criteria with points.

The indicators to assess economic aspects can include space efficiency as it contributes to the economic efficiency. The most common indicator for this group is life cycle cost.

The indicators used to indicate social and functional quality relate to a broad range of items regarding mobility (e.g., accessibility to public transport, availability of recharging points for e-bikes and e-cars, availability of bike racks, proximity to local supplies), comfort (visual, acoustic, thermal), etc. To that purpose, both qualitative and quantitative indicators are applied, e.g., the average daylight factor or illuminance measured in Lux to indicate the visual comfort, or the concentration of volatile organic compounds (VOC) to indicate the indoor air quality. In the building design phase, comfort can be assessed by using simulations.

4 Certification Process

Building certification process involves different actors such as certification institute, owners, designers, and other professionals, and in some cases the building users. In addition, some certification models require the engagement of a professional who is licenced by the corresponding certification institute (e.g., LEED accredited professional, or BREEAM assessor). In an optimal process, the client and a professional assessor together discuss certification goals and set target values early in the design stage.

Every model has a particular rating process, for which reason the number of process steps, their organisation and synchronisation with the life cycle phases of a building, the types of issued certificates (e.g., preliminary certificate that is based on plans and intentions, or the final i.e. the full certificate issued according to the real state of realised projects), the expiration of issued certificate, etc. differ from one certification scheme to another.

For example, the CASBEE for Detached Houses model foresees a certification process that focuses on verification after building completion. The rating process in the BRE's model Home Quality Mark extends from the design phase (with interim assessment and certificate) to the post-construction stage, when the final certification occurs (BRE Global Ltd, 2016). In LEED for Homes, the certification process starts with registration, continues through the on-site verification throughout the design (when the preliminary rating is done) and construction (including mid-construction and final construction verification visits), the review of documentation that is submitted after the project has been completed, and ends with the award of the certificate (US Green Building Council, n.d.). In the LEED v4 commercial platform, the rating process consists of the following major steps:

- **registration**, prior to which the minimum programme requirements were checked, and the roles of project team members (owner, agent, and project administrator) were defined;
- **application**. Here, LEED credits that will be pursued are already identified, assigned to project team members, and followed by the submission of completed project material into the online portal;
- **review** carried out by the certification body. The exact review procedure and the deadline for submitting for review depend on the LEED scheme for which the project is applying (e.g., standard review, precertification review, or split review that includes both design and construction); and
- **certification** of completed project (US Green Building Council, 2017b).

In BREEAM International New Construction 2016, the assessment and certification process is aligned with the Royal Institute of British Architects (RIBA) Plan of Work, and consists of five stages: pre-assessment; design stage assessment; interim (design) certification;

construction stage assessment/review; and final (post-construction) certification (BREEAM, 2017). For other certification schemes, like BREEAM In-Use, the certification process is adapted to the corresponding planning process. Assessment and certification is guided by the independent, trained, and licenced assessor. Upon successful completion of the procedure, a certificate indicating the level of achieved quality of a building is issued.

The DGNB model provides a full certificate after the project realisation. Prior to that, a pre-check that sets the targeted level of quality and a preliminary certificate can be given. The assessment process is led by the DGNB accredited accessor who reports the project to the certification institute and advises individual stakeholders through all assessment stages – from concept development to project realisation. Together with the client and the participating planners, the assessor sets target values for agreed sustainability objectives and reviews them during the process. Once the project has been completed, the documents are submitted to the certification institute, which evaluates them and subsequently awards the certificate.

4.1 Certification Result

The result of certification process is expressed as a whole number or a percentage of earned credit points, accompanied by hierarchical description. In the BREEAM International New Construction 2016 model, for example, the total achieved credit points in each category are multiplied by weighting factors and translated into a scale ranging from Unclassified (< 30%), Pass (30-44%), Good (45-54%), Very Good (55-69%); Excellent (70-84%), to Outstanding (≥85%) (BREEAM, 2017). In each of the six DGNB assessment categories, the achieved credit points are multiplied by a weighting factor to calculate the degree of fulfilment. The total degree of fulfilment is first calculated by weighting the results from all categories, and then translated into a scale (by respecting minimum performance) ranging from Bronze (with a total performance index from 35% and minimum performance index of 0%), to Silver, to Gold, to Platinum (with total performance index from 80% and minimum performance index of 65%). To confirm successful completion of the rating procedure, the LEED version 4 platform uses a four-stage rating scale: Certified (40-49 points), Silver (50-59 credit points), Gold (60-79 points), and Platinum (80-110 points).

5 Discussion and Conclusions

Over the past three decades, certification models have informed the discussion about the environmental impacts of buildings and the possibilities for their reduction. Even with the recognised relevance and offered benefits, however, the application of certification models is still insufficient. Some reasons for the infrequent use of building rating models are their voluntary character, complex assessment process, and economic barriers.

The comparison between different building certification models is common nowadays (e.g., Doan et al., 2017; Ebert, Eßig, & Hauser, 2012; Nguyen & Altan, 2011; Rogmans & Ghunaim, 2016). The analysis of different versions of several well-known certification models shows that there exist certain development tendencies, such as the expansion from predominantly environmental to the more comprehensive sustainability evaluations. In addition, some new models or new versions of existing certification models have deepened assessments of resilience, e.g., the Home Quality Mark has introduced a subcategory entitiled Safety and Resilience (BRE Global Ltd, 2016), and BREEAM International New Construction 2016 has introduced the criterion Adaptation to Climate Change (BREEAM, 2017). Still, a more profound consideration of building resilience aspects is necessary (e.g., Champagne & Aktas, 2016). In principle, resilience-related items may be embodied into certification models either though the modification of sustainability criteria (e.g., by using climate change predictions to determine energy performance of buildings), or through the introduction of new criteria defined according to the territorial characteristics.

Furthermore, it has been noticed that certification models like LEED and BREEAM have been transformed over time into comprehensive unified platforms applicable to different types of buildings and different territories. The adjustment to conditions of a specific territory in universal models is solved by the modification of weightings (e.g., BREEAM International New Construction 2016) or by assigning additional points for applied regionally relevant measures (e.g., LEED v4 for Building Design and Construction). Although the widespread application of the same models enables the comparison of results, the extent to which universal platforms respond to varying local/regional peculiarities (e.g., regarding environmental conditions, building practice, regulations, etc.) has not been sufficiently analysed to-date. Therefore, the development and use of certification models whose structure, content, and assessment process are tailored according to the conditions existing within the defined spatial boundaries remain to be proven relevant. The acknowledged pertinence is additionally justified by the fact that existing models offer different assessment methodologies and different labels, which may create doubts in terms of the selection of an acceptable certification model.

To that end, one of the possible directions for the further development of certification models could concern the establishment of platforms intended for a particular building typology and territory, adjustable to building state (new construction, existing, or undergoing refurbishment). In that way, the specificities of the examined building type would be more profoundly addressed, having regarded that the life cycle impact of buildings is narrowly connected with their typology. Furthermore, territorial specificities at the local level could be managed by distinguishing a generic model from its local variants, i.e. by modifying criteria and indicators, or by introducing more comprehensive changes in generic structure where necessary.

The model intended for a particular building typology and territory, and adjustable to a building state, can be developed by the vertical (hierarchical) structuring of the assessment system (comprising categories, subcategories, criteria, and indicators) and the horizontal layering of the assessment process (comprising several different groups of activities) (Kosanović, 2012). The layers should be understood as independent and at the same time compatible and transparent segments of the rating process, defined in a way to allow for overlapping. The overlapping of layers would help to better distinguish between the newly built, the existing, and the buildings undergoing renovation, all belonging to the same type, and, further, to better address the user factor and to fully integrate the certification and design processes. The amalgamation of assessment layers with the life cycle of buildings, on the one hand, and the assessment system on the other, is vital for the successful transformation of the use of certification models into sustainable building practice.

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