

# Architectural design quality and social sustainability in building certification systems

## AUTHORS:

Lucia Oberfrancová<sup>1\*</sup>

Martin Wollensak<sup>2</sup>

<sup>1,2</sup> University of Applied Sciences, Technology, Business and Design, Faculty of Architecture and Design, Wismar, Germany

<sup>1</sup> Slovak University of Technology in Bratislava, Faculty of Architecture and Design, Institute of Ecological and Experimental Architecture, Slovakia

## \*CORRESPONDING AUTHOR

E-mail: lucia.oberfrancova@hs-wismar.de

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## ABSTRACT:

The main objective of the study is to examine to what extent the architectural design quality and social sustainability are taken into account in building certification systems. The following most commonly used building assessments in Europe (focus on Germany, Slovakia and Czech Republic) have been investigated: BREEAM, LEED, CESBA, LEVEL(s), DGNB, BNB, BNK, NaWoh, SBToolCZ and WELL. After extensive research of chosen certification systems and various sources on topics such as conditions of well-being, sociocultural indicators, assessment of social performance of sustainable buildings and design quality assessment, the main social and architectural design quality aspects were determined and used for further analysis and final evaluation. Studied aspects are divided into the following categories: user satisfaction and quality of life (building-related), sustainable and healthy lifestyle (building-related), architecture – design quality (building-related), innovation and social responsibility (external). The article contains a summary of results with overall evaluation and comparison of certification systems including weighting of studied categories in selected building assessments. Furthermore, indicators used in building certifications associated with the quality of life and the quality of architectural expression and their weighting are described and presented.

## KEYWORDS:

sustainable architecture, building certification, architectural design quality, social sustainability, user satisfaction, quality of life

## INTRODUCTION

Sustainability and quality of life are currently among the main topics of global development and their main objectives are included in the *Sustainable Development Goals* of the United Nations [1]. Aesthetic is an important element of sustainable construction – only “beautiful” buildings are accepted by people and thus long-standing. Especially in the age of globalization, it is necessary to question the impact of universal standards on the design quality and respect regional and cultural aspects and the uniqueness of local architecture. The European Union, with its initiative *New European Bauhaus* under the slogan “beautiful I sustainable I together”, recognized the importance of combining sustainability and aesthetics in order to make the *European Green Deal* a reality in the minds of citizens [2].

Regarding the three-pillar sustainability model, sustainability is only achieved if all three fields – social, environmental and economic sustainability – are given equal consideration. However, according to the Danish study *Categorizing Building Certi-*

*fication Systems According to the Definition of Sustainable Building* [3], the majority of the examined building certifications mostly focus on the criteria within the environmental dimension (an average weighting of 51%). The social sustainability accounts on average for 43%, where great focus is on the physical conditions of the indoor environment [3]. Nevertheless, aspects such as user satisfaction, quality of life, sustainable and healthy lifestyle, inclusion, equity, healthy resources, safety and security also play an important role among the *Sustainable Development Goals* [1]. Furthermore, creation of liveable, beautiful and inclusive places as described in the *New European Bauhaus* [2] is an intended goal of designing sustainability, so aesthetics and architectural design quality should also be given consideration in certification systems.

The main objective of the study is to examine the extent to which architectural design quality and social sustainability are taken into account in building assessments – which aspects associated with the quality of life and the quality of architectural expression are considered and which could be added?

## SELECTED BUILDING CERTIFICATION SYSTEMS

“There are over 600 sustainability certifications for products and buildings being used in the world today [4].” The following most commonly used certification systems in Europe, with focus on Germany, Slovakia and the Czech Republic, have been investigated in the study: *BREEAM*, *LEED*, *CESBA*, *LEVEL(s)*, *DGNB*, *BNB*, *BNK*, *NaWoh*, *SBTool Czech Republic*, and *WELL*.

In Central Europe, the three most widely used building certifications are British *BREEAM* (*Building Research Establishment Environment Assessment Method*, first listed green building rating tool), German *DGNB* (German abbreviation for *German Sustainable Building Certification*, second generation sustainable building assessment) and *LEED* (*Leadership in Energy and Environmental Design*, most widely used green building rating system in the world) from the United States. In addition, a number of national certification systems are used, e.g. in the Czech Republic, it is *SBToolCZ* (*Sustainable Building Tool Czech Republic*, based on general international scheme *SBTool* developed by the International initiative for Sustainable Built Environment) [5, 6, 7, 8, 9].

*CESBA* (*Common European Sustainable Built Environment Assessment*) is intended not only as a certification tool, but especially as a guide for the whole building processes, based on criteria catalogue that serves as a basis for regionally adapted evaluation tools [5]. *Level(s)* is an EU framework for sustainable construction introduced by the European Commission in 2017 with the goal to improve the sustainability performance of buildings through the whole lifecycle [10].

Alongside *DGNB*, *BNB* (German abbreviation for *Assessment System for Sustainable Building*) is a German instrument usually used for planning and evaluating of public construction projects and it complements the *Guideline for Sustainable Building* [11] as sustainable assessment [12]. *BNK* (German abbreviation for *Assessment System for Sustainable Small Housing*) is a German certification system for sustainable small residential projects [13] and *NaWoh* (German abbreviation for *Sustainable Housing Quality Seal*) is an assessment method for new residential buildings with more than four residential units [14].

*WELL* building standard is the first international standard that focuses on healthy and pleasant building environment for people and therefore it has been included in the study [15].

## SELECTED BUILDING PROJECT PROFILES

The most relevant building profiles have been chosen for the study in order to get widely applicable results. Both public and residential buildings are analysed. As regards public buildings, general evaluation schemes, office buildings as a standard profile and educational institution buildings were evaluated. The certification schemes for new construction, renovation, refurbishment, buildings in use and interiors were analysed in order to cover the widest possible spectrum of situations and building stages. The focus of the study is on user's quality of life and quality of architectural expression linked to a single building.

## SOURCES AND CONSIDERED INDICATORS

Criteria of chosen certification systems and profiles relevant to social sustainability, aesthetic and architectural design quality have been analysed, evaluated and compared in the study. After extensive research of chosen certification systems and various sources on topics such as conditions of well-being, sociocultural indicators and assessment of social performance of sustainable buildings, the main social and architectural design aspects for further consideration were formulated. The following sources were used in the process of defining the criteria relevant for analysis and for final evaluation:

- *Guide to sustainable building certification* (collaboration study by Danish Building Research Institute – SBI and the innovative company of 3XN Architects – GXN, 2018) [4]
- *Guideline for sustainable building* (German Federal Ministry of the Interior, Building and Community, 2019) [11]
- *Social indicators of sustainable building* (research report by Institut Wohnen und Umwelt – IWU, Darmstadt, 2012) [16]
- *Social criteria of sustainable development in relation to green building assessment tools* (article by Atanda, J.O., Öztürk, A. in *Environ. Dev. Sustain.*, 2020) [17]
- *Urban physics – Fundamentals of climate and environmentally friendly cities* (Mehra, S.-R., 2021) [18]
- *DIN EN 15643-3:2012 Sustainability of construction works – Assessment of buildings – Part 3: Framework for the assessment of social performance* [19]
- *DIN EN 16309: 2014 Sustainability of construction works – Assessment of social performance of buildings – Calculation methodology* [20]
- *BREEAM*, Version 2016 international, new construction, general office, educational institution and residential buildings [21], Version 2020 international, buildings in use, commercial (office, education) and residential buildings [22], Version 2015 international, refurbishment and fit-out, non-domestic buildings (office, educational institution) [23], Version 2014, refurbishment and fit-out, domestic buildings [24]
- *LEED*, Version V 4.1, 2021, new construction and major renovation, general and school buildings [25], Version V 4.1, 2020, new construction and major renovation, residential buildings (single and multiple family housing) [26], Version V 4.1, 2021, commercial interiors [27], Version V 4.1, 2021, existing buildings and interiors, operation and maintenance [28]
- *CESBA*, Version V 1.1, 2012, new construction / refurbishment of existing buildings, generic tool [29]
- *Level(s)*, Version 2021, new construction / refurbishment of existing buildings, office and residential buildings [30]
- *DGNB*, Version 2020 international, new construction, office, educational institution and residential buildings [31], Version 2020 international, buildings in use, diverse types of use [32], Version 2018, interior, office buildings [33]
- *BNB*, Version 2015, new construction, office buildings [34], Version 2017, new construction, educational institution buildings [35]

- *BNK*, Version V 1.0, new construction, residential buildings (single family housing) [36]
- *NaWoh*, Version V 3.1, 2020, new construction, residential buildings (multiple family housing) [37]
- *SBCoolCZ*, Version 2011, new construction / reconstruction, office buildings [38], Version 2016, new construction / reconstruction, educational institution buildings [39], Version 2013, new construction / reconstruction, residential apartment buildings [40], Version 2013, new construction / reconstruction, residential single family housing [41]
- *WELL*, Version V 2, Q1 2021, new construction / existing buildings, diverse types of use [15]

The social dimension of sustainability and architectural quality in the study focuses on the aspects of building planning, construction and operation, using the following categories:

#### User satisfaction and quality of life (building-related)

- Health, comfort and well-being
  - Physical conditions
  - Healthy resources
- Inclusion and equity
- Safety and security
- User satisfaction

#### Sustainable and healthy lifestyle (building-related)

- Physical health and psychological well-being
- Motivation to sustainable behaviour
- Education / communication
- Mobility

#### Architecture – design quality (building-related)

- Design quality
- Design strategies
- Participation

#### Innovation (only sociocultural or design aspects)

#### Social responsibility (external)

- Responsible sourcing
- Influence on the district
- Construction site

Analysed features were chosen according to their relevance to building-related quality of life (user satisfaction and quality of life, sustainable and healthy lifestyle), to the aesthetic and design quality, if it was a goal of the criterion implemented in planning process and building operation (architecture – design quality), and to the social responsibility aspects that are indirectly related to buildings (social responsibility).

## RESULTS – COMPARISON OF CERTIFICATION SYSTEMS

In **Fig. 1** and **2**, diagrams showing the weighting of studied categories in considered building assessments are presented. Next, the summary of study results is provided. It is necessary to mention that slightly subjective interpretation following from

the categorising and weighting of the criteria cannot be avoided in some cases as some certification systems and schemes differ very much. Furthermore, the methods of criteria rating within the certification vary as well – for instance, some systems are based on different weighting of criteria in total of 100%, some systems consist of preconditions and optimization / optional points or indicators without different criteria weighting in the system. This can cause small deviations in results.

### Overall evaluation

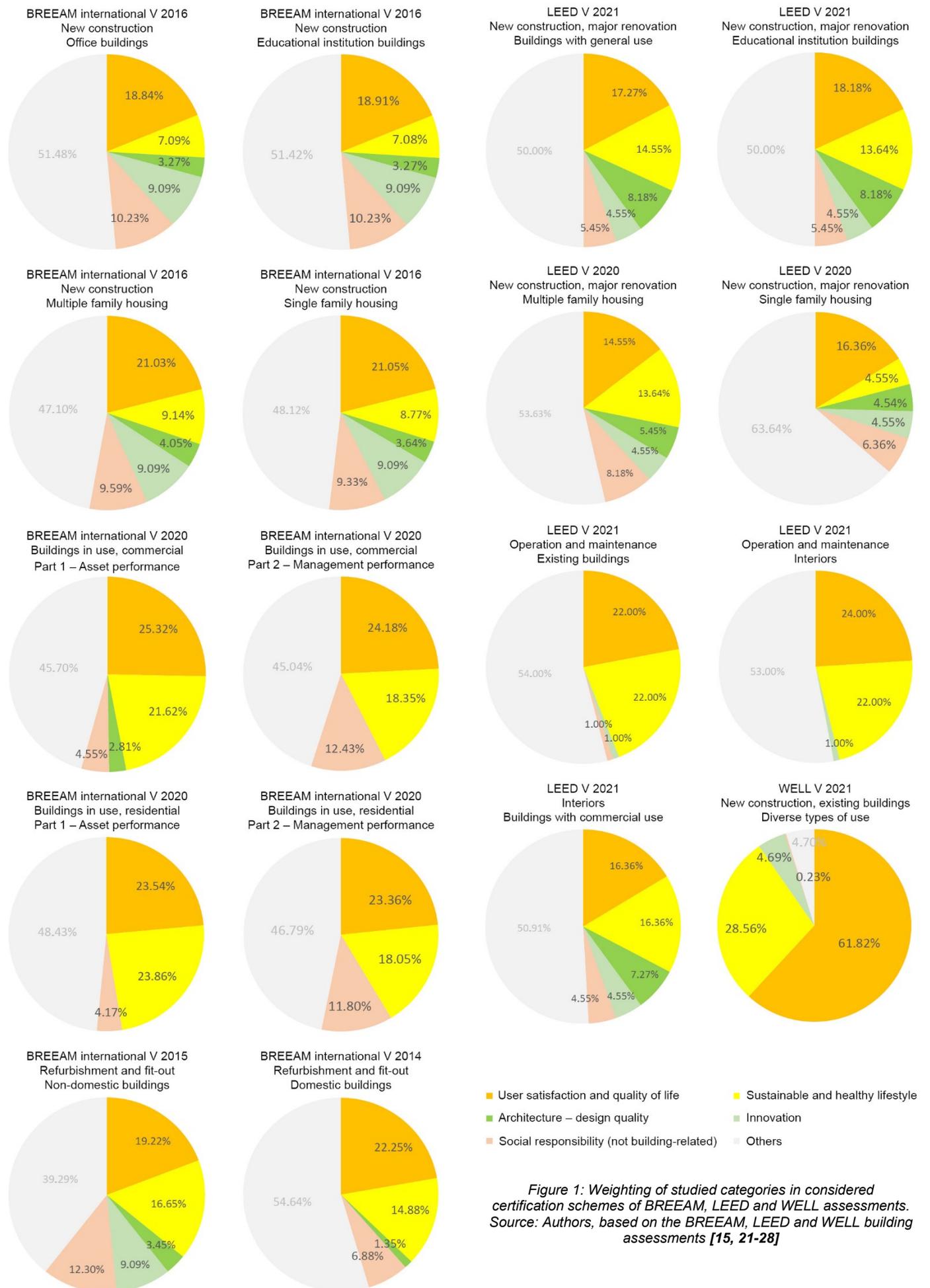
Average weighting of the category user satisfaction and quality of life and of the category sustainable and healthy lifestyle is 25.54% and 11.97%, respectively. Innovation aspects relevant to social sustainability score 0.23% on average. Altogether, average weighting of building-related social sustainability is 37.74%, slightly more than 1/3 of all criteria in certification. The representation of design quality in certifications is 5.64% on average. Social responsibility is weighted at 5.24% on average.

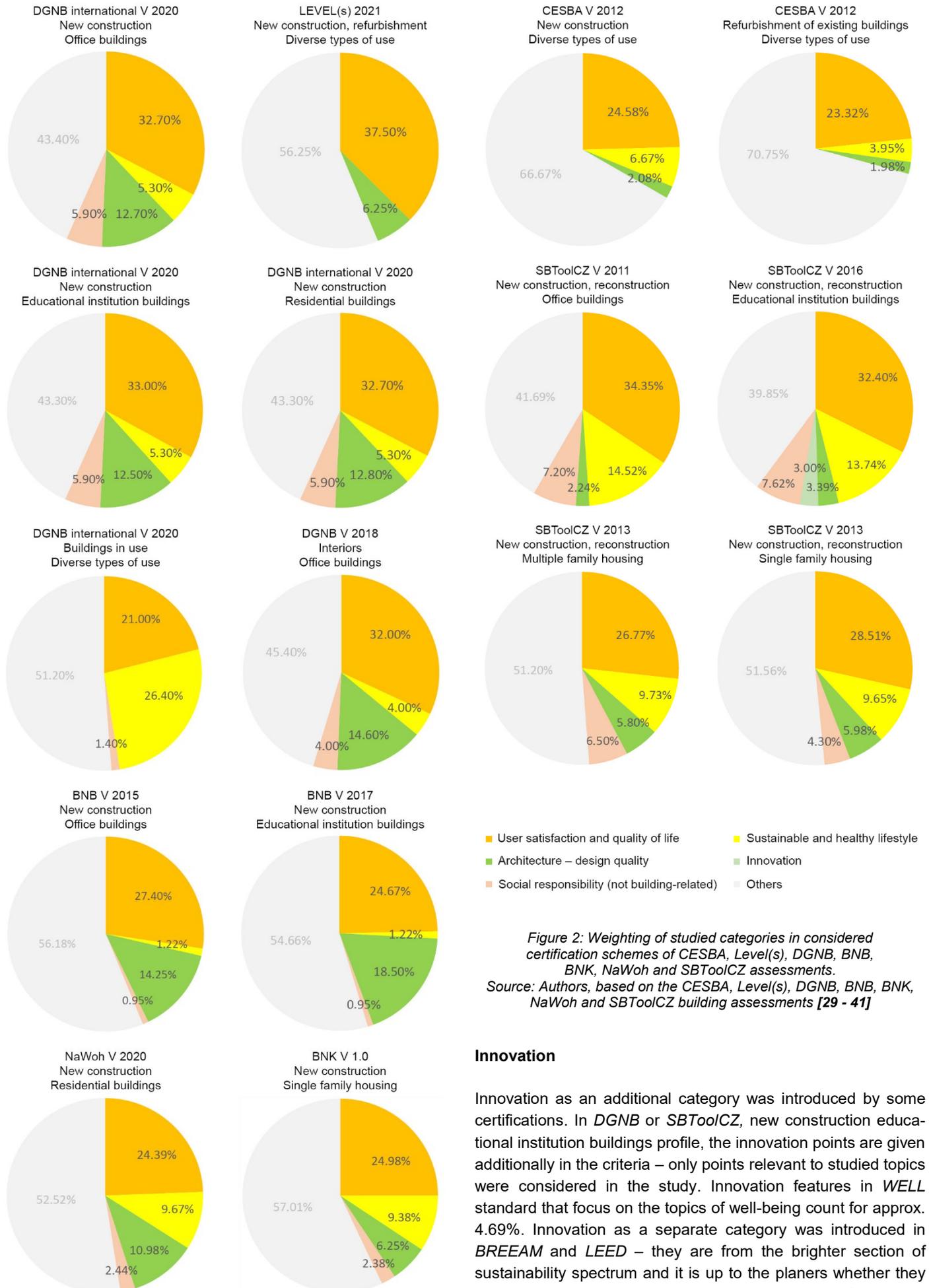
### Building-related social sustainability: User satisfaction and quality of life, sustainable and healthy lifestyle

Weighting of criteria relevant to the building-related social sustainability in building assessments varies from 20.91% (*LEED* new construction and major renovation, single family housing) to 95.07% (*WELL*). In total, the highest average weighting of building-related social sustainability aspects of 45.10% is given in certification profiles of buildings in use and operation and maintenance. The lowest average weighting of 34.36% for the category was given to interiors. The category user satisfaction and quality of life is given similar average weighting in the different certification schemes, however, with the highest consideration given to new construction, major renovation and refurbishment. The average weighting of the category sustainable and healthy lifestyle by profiles of buildings in use and operation and maintenance is 21.75%, more than double of the other profiles. This indicates that the influence of a building on the user's lifestyle in building operation stage is deemed to be of high importance.

### Architecture – design quality

Design quality receives average score of 5.64% with the highest weighting by *DGNB*, *NaWoh* and *BNB* assessments. Considering different certification profiles, the highest average weighting of design quality at 10.94% is given to interiors, the lowest at 0.4% to buildings in use and operation and maintenance. Furthermore, *DGNB* introduced an additional *DGNB* 'Diamond' certificate for 'Gold' and 'Platinum' certified new or renovation projects to honour well-designed architecture [42]. Despite the study's focus on building sustainability, a building needs to be seen in wider context and its urban integration is one of the crucial topics with regard to considering the architectural design quality. *"The urban environment, like architecture, forms its inhabitants. The inhabitants, reciprocally, form their environment – the city. Therefore, the cultural values of urban environment are very important for sustainable development, because they affect the perception of aesthetic and historical values of everyone, but mostly of young people [43]."*





■ User satisfaction and quality of life
 ■ Sustainable and healthy lifestyle  
■ Architecture – design quality
 ■ Innovation  
■ Social responsibility (not building-related)
 ■ Others

**Figure 2: Weighting of studied categories in considered certification schemes of CESBA, Level(s), DGNB, BNB, BNK, NaWoh and SBToolCZ assessments.**  
 Source: Authors, based on the CESBA, Level(s), DGNB, BNB, BNK, NaWoh and SBToolCZ building assessments [29 - 41]

**Innovation**

Innovation as an additional category was introduced by some certifications. In *DGNB* or *SBToolCZ*, new construction educational institution buildings profile, the innovation points are given additionally in the criteria – only points relevant to studied topics were considered in the study. Innovation features in *WELL* standard that focus on the topics of well-being count for approx. 4.69%. Innovation as a separate category was introduced in *BREEAM* and *LEED* – they are from the brighter section of sustainability spectrum and it is up to the planners whether they choose environmental, economic or social aspects for innova-

tion points. For this reason, the innovation category is shown in the evaluation matrix, but cannot be considered as an indicator linked to the social or design issues in the overall evaluation of this study.

### Social responsibility (external)

Consideration of social responsibility indicators varies from 0.23% (*WELL*) to 12.30% (*BREEAM* refurbishment and fit-out of non-domestic buildings). *BREEAM* achieves the highest weighting of the category (except for buildings in use asset performance profile).

## RESULTS – SOCIAL AND DESIGN QUALITY INDICATORS

### User satisfaction and quality of life (building-related)

Indicators relevant to user satisfaction and quality of life are divided into four groups: health, comfort and well-being, inclusion and equity, safety and security and user satisfaction. Their consideration varies in certifications.

- Health, comfort and well-being

This category consists of physical conditions and healthy resources. Physical conditions are measurable objective criteria represented by the majority of certifications, such as:

- Thermal comfort (operative and indoor air temperature, relative humidity, radiant temperature asymmetry and surface / floor temperature, drafts)
- Acoustic comfort (reverberation time, sound protection)
- Visual comfort (daylight, artificial light, glare control, light colour rendering, view from the building)
- Indoor air quality (ventilation rate, Volatile Organic Compounds (VOCs) / formaldehyde restrictions)

Some certifications, such as *WELL* or *DGNB*, include points for protection of non-smokers and protection from particulate matter in interiors produced by copiers and laser printers.

The (design) strategies for providing healthy resources for occupants of the majority of certification systems evaluate the avoidance of hazardous materials and using of low-emissions products (VOCs / formaldehyde restrictions). Moreover, *WELL*, *CESBA* and *LEED* new construction / major renovation schools include site remediation (environmental contamination site assessment and remediation). Besides refurbishment and fit-out, *WELL*, *BNK* and *BREEAM* also consider potable water quality indicators. Quality food and nutrition are covered by *WELL* standard. *WELL* and *LEED* new construction and major renovation include pest management and green cleaning products. All assessments evaluate clean energy only from energy-saving perspective.

- Inclusion and equity

This category includes (design) strategies for better quality of life, feeling of belonging and connectedness. The majority of building assessments evaluate common use facilities, open access for public, accessibility and universal design. Inclusion and equity are given the most consideration in *WELL* standard; e.g. family, new parent / mother support, civic engagement, diversity and inclusion, support for victims of domestic violence, housing equity, responsible labour practices. *LEED* new construction and major renovation profile includes equity and community benefits / affordable housing in residential or mixed-use projects.

- Safety and security

This category includes design or logistic strategies for safety and security of people in buildings. Emergency preparedness, resilience and recovery (extreme weather, flood events, radon risk, etc.), climate change adaptation and fire safety are among those given particular consideration. *Crime Prevention Through Environmental Design (CPTED)* concept that uses the design of the built environment to reduce the fear and incidence of crime and to improve the quality of life [44] is considered as part of the evaluation of subjective perception of safety and protection against assault (e.g. clear route guidance, parking spaces (visibility), lighting of main routes and parking areas, technical safety equipment).

In addition, *Level(s)* and *BREEAM* assess surface water run-off impact mitigation, including e.g. rainwater harvesting system, green roof, filter strips and drains, swales, trees, bio-retention systems, pervious pavements, detention basin, ponds and wetlands. Although these measures influence architectural and site design quality as well, the goal of the criteria is flood risk management; therefore, it is evaluated in this category.

- User satisfaction

This category includes (design) strategies that support the subjective feeling of well-being through the ability of users to control the environment in the building / room or the use of occupant surveys to evaluate and optimize user satisfaction. *WELL*, *DGNB*, *BNB* and *BREEAM* buildings in use profiles evaluate the possibility of user control (e.g. ease of use, operable windows, individual shading, glare protection, lighting and thermal control); *BNK* also considers user-friendliness of building services. Furthermore, *WELL*, *DGNB* buildings in use profile and *BREEAM* (besides refurbishment and fit-out) assessment include occupant surveys and complaint management to increase the satisfaction and well-being of the users.

*“Although occupant satisfaction is not a core part of the Level(s) common framework, it is recommended as a complement to the monitoring of quantitative parameters and general guidance is provided. (...) For the purposes of Level(s), the process is referred to as a Post Occupancy Evaluation (POE). Indicators 4.1 (Indoor air quality) and 4.2 (Time outside of thermal comfort range) are the main indicators within Level(s) for which a standardised survey method are specified [30].”*

## Sustainable and healthy lifestyle (building-related)

This category consists of four parts: physical health and psychological well-being, motivation to sustainable behaviour, education / communication with users and mobility. Their consideration varies in certifications.

- Physical health and psychological well-being

This category includes (design) strategies to motivate occupants for healthier lifestyle. *WELL* certification is a pioneer in this field and evaluates for instance health-promoting offers, ergonomic workstation design, circulation network, physical activity opportunities, spaces and equipment, active furnishings, stress management, relaxation opportunities and food production. The majority of assessments consider better access to nature, biophilic design and biodiversity at the site. In addition, quality of indoor and outdoor spaces is added here because of its main goal to create attractive spaces for people (e.g. communication, private and restorative areas).

*DGNB* interior office criterion includes ergonomic workstation design as well. *DGNB*, *BNB* and *BREEAM* assessments include access to amenities in order to motivate people to walk or use a bike instead of a car. Moreover, *BREEAM*, *DGNB*, *WELL* and *LEED* also assess the smoking policy. Furthermore, *SBToolCZ*'s profile of new construction, reconstruction of educational institution buildings introduced additional values for school buildings (facilities for teachers, e.g. spaces for relaxation; facilities for pupils and students, e.g. sport facilities, creative rooms, quiet zones; "healthy school" concept, e.g. provision of potable water in corridors, sport, gardening, inspiration spaces for personal development).

- Motivation to sustainable behaviour

This category includes (design) strategies to encourage users to behave in a more sustainable manner. *WELL*, *NaWoh*, *SBToolCZ*, *BREEAM* and *LEED* certification evaluate user-friendly facilities for waste collection and separation that facilitate the reuse, repurposing and recycling of waste from the asset. Moreover, *BREEAM* considers energy and water monitoring and the display of the aforesaid for occupants, green lease for commercial buildings in use and drying space in residential buildings to provide means for drying clothes with reduced energy consumption. As part of the additional values for school buildings in *SBToolCZ* new construction, reconstruction of educational institution buildings, innovation points "School as a Teaching Tool" (e.g. waste separation, energy consumption reduction) can be achieved.

- Education / communication with users

This category takes (design) strategies for communication and education of the building's occupants into account. *WELL* offers a wide-range programme on indicators, e.g. air quality monitoring and awareness, thermal comfort monitoring and display, drinking water and nutritional transparency and education, fruit and vegetable visibility, workstation orientation, health services and benefits, mental health and physical activity promotion and

self-monitoring, relaxation planning, cessation of tobacco use, parental and family support policies, employee education, opioid overdose response and emergency training.

*CESBA*, *DGNB*, *BNB*, *NaWoh*, *BNK*, *SBToolCZ* and *BREEAM* evaluate information for users (e.g. technical user manual, sustainability guide and information system). The aim is to inform the occupants on the topic of sustainability of the building, to motivate them to contribute through their behaviour to sustainability, but also in particular to their own well-being. Furthermore, *BREEAM* buildings in use profile considers carbon dioxide and carbon monoxide sensors and detection, management engagement and feedback and condition survey to encourage building owners to understand the physical condition of their property and to plan scheduled maintenance, repair or refurbishment activities.

- Mobility

This category represents (design) strategies to encourage users to use environmentally friendly / alternative forms of transportation. *WELL*, *CESBA*, *DGNB*, *BNB*, *NaWoh*, *SBToolCZ*, *BREEAM* and *LEED* include facilities for active occupants (e.g. bicycle parking, shower facilities), access to public transport network and safety of pedestrian traffic. In addition, *DGNB* considers bicycle infrastructure, rental system, e-mobility, barrier-free design of stops, innovative mobility elements and mobility sharing. *BNB* certification evaluates also the number of charging options for e-mobility and car sharing parking, *NaWoh* includes mobility concept and parking for bicycles, strollers, rollator walkers and cars.

Moreover, *SBToolCZ* considers car parking and motivation for bicycles and public transportation use for office buildings and support for pedestrian, bicycle or other alternative non-motorized transport, drop off / pick up area, collision-free supply to the school, support and motivation for shared transport for school staff and students. In addition, *BREEAM* includes maximum car parking capacity and travel plan for non-residential buildings, *LEED* also adds reduced parking footprint, car-sharing, electric vehicles and infrastructure and electric buses or school-owned vehicles for schools.

## Architecture – design quality (building-related)

The category of architecture – design quality consists of three groups of indicators: design quality, design strategies and participation. The degree of their consideration in certifications varies.

- Design quality

Evaluation of design quality is mostly based on design process strategies to achieve good architectural quality. The majority of certification systems consider architecture or urban design competition, design alternatives, architectural award or independent panel of experts, *BNB* implements also the criterion of architectural art. *DGNB* introduced additional *DGNB* 'Diamond' certificate for 'Gold' and 'Platinum' certified new or renovation projects to recognize and appreciate well-designed architec-

ture. "A panel of least three professional architects evaluate the building based on considerations that are part of good architecture. They look at factors like functionality, choice of materials, proportions, and context with the surroundings [45]." DGNB criteria included in the assessment of design and architectural quality [45]:

- Context: urban integration, access, open space
- Appropriateness: implementation, construction, durability, timelessness, scale / integration
- Design: proportion / composition, overall appeal, materiality / colouring, detailing
- Layout: form, plan and interior design, orientation, ease of use, functionality

Besides certification systems, there are tools specially developed to measure and evaluate design quality. For instance, UK *Design Quality Indicator (DQI)* is a method of assessing the design quality of buildings and it can also contribute to *BREEAM* rating [46]. The assessment is in the form of a questionnaire that contains a set of statements used to assess the perceptions of all stakeholders. Design quality is evaluated as a combination of construction quality (engineering performance of a building), functionality (arrangement, quality and interrelationship of space) and impact (building's ability to create a sense of place) [47]. However, some indicators used in *DQI* to evaluate design quality were classified as social indicators in this study, as the main goal of the criteria in certification was social quality (e.g. internal environment as impact indicator or access as functionality indicator). Interconnectedness between design and social indicators is visibly obvious here and shows that design quality is extremely important for user's well-being and satisfaction.

- Design strategies

Design strategies with the objective to create well-designed architecture are listed in the paper. *LEED* and *DGNB* with its additional *DGNB* 'Diamond' certificate are the only ones to consider crucial design aspects such as cultural identity, regional priority and site assessment before designing. Design quality and fitting-in at the location are essential with respect to people enjoying a building and the building's long-term use. However, architectural elements, for instance context with location, urban integration, form, scale, proportion, composition, materiality and colouring, are mainly considered in building assessments only indirectly, e.g. through additional tools such as *DGNB* 'Diamond' certificate or UK *Design Quality Indicator*.

The majority of certification systems evaluate design with respect to flexibility, adaptability and renovation (indicators: ceiling height, building depth, vertical access, floor layout, structure, technical building services etc.) and quality of indoor and outdoor spaces. Although the main objective of evaluating flexible / adaptable design is resource-saving and waste avoidance, the criterion positively contributes to building layout, long-term qualities and user satisfaction, therefore it is included within the architectural design strategies. Furthermore, *SBToolCZ* factors in site fencing of family houses (the less fencing, the better

evaluation) and facilities for teachers, e.g. private and common spaces; facilities for pupils and students, e.g. percentage of free space in main classrooms, variability of classroom layout; facilities for other school staff and for the pupils' parents as part of added values for school buildings. In addition, *BREEAM* introduced a new criterion for residential buildings - designing spaces that make home office possible.

Some certifications, such as *BREEAM* or *DGNB*, include the indicator of passive design or *Level(s)* design for comfortable thermal conditions. Assessed indicators are e.g. shading, glassing, insulation, thermal mass, response to weather conditions at site, passive design for better ventilation and protection from overheating. Some assessments require installation of photovoltaics or other renewable-energy systems. Such types of building services influence the architectural expression, however, the main objective are passive or active energy-saving measures without consideration for their integration in architecture and therefore, these criteria are not deemed to be architectural design strategies.

The weak point of the analysed certification systems is that the energy-saving measures (passive or active) are not required to be a part of an architectural concept. However, respecting the architecture and integration of passive strategies and building services into the architecture can create new possibilities with respect to quality. Biophilic design brings nature into buildings. Photovoltaics as shading elements are incorporated into the architectural concept of the façade and by responding to the movement of the sun give the architecture a dynamic character. Visible elements such as solar chimneys and ventilation ducts make energy concept transparent. Energy-optimized building form gives a building its fundamental expression. Authors of the article *Solar surface area to volume ratio* published in ALFA 4/2019 discuss the topic of building's form optimization aimed at using the ability of active building envelope surface to produce solar energy optimally and thus achieve higher carbon-dioxide imprint minimization than only by respecting the surface area to volume ratio of a building [48].

- Participation

The category of participation includes design process strategies that bring all relevant stakeholders into the planning process. Communication with future users and elucidation of the building concept are a part of designing that is very important for the acceptance and user satisfaction. "Today, citizens often want to apply their ideas to the environment and the public is proving to be the most influential factor in creating the environment [49]." Participation is taken into account by the majority of certification systems through integral planning, user participation, scope of requirements planning and informing the public. *BREEAM* also evaluates speculative finishes where future users select finishes to avoid unnecessary waste of materials.

### Innovation

The category of innovation is a small part of some certification systems and was considered in the evaluation only if the indicators are relevant to social sustainability or design quality.

## Social responsibility (external)

This category consists of three groups: responsible sourcing, influence on the district and construction site. The degree to which they are taken into account in certifications varies.

- Responsible sourcing

The majority of certification systems evaluate sustainable resource extraction with the help of indicators such as sustainably produced raw materials, use of renewable, recycled and regional products and use of certified materials. In addition, *WELL* standard considers responsible food sourcing.

- Influence on the district

The majority of assessments take immissions control (e.g. air, noise and light pollution reduction measures) and influence on the district (e.g. site image and attractiveness, potential synergy due to clustering) into account. *BREEAM* buildings in use profile also evaluates the reduction of watercourse pollution, chemical storage, local contamination mitigation, contamination from invasive plant species and response to pollution incidents.

- Construction site

This category contains (design) process strategies to reduce negative impact of construction processes on people, the site and the environment. The majority of certification systems take into account low-noise, low-dust and low-waste construction site, soil and groundwater protection on the construction site.

## CONCLUSION AND DISCUSSION

The first certification systems, which were established in the early 1990s, focused mainly on the assessment of energy-efficiency and environmental impact and were accordingly referred to as first-generation “green building” rating tools. *BREEAM* (1990) and *LEED* (1998) are such systems [5]. *DGNB* is one of the second-generation assessment methods, which “deal with the building in its entire lifecycle and also include economic, sociocultural and technical aspects. With the inclusion of more aspects in the process of assessment the building is defined as a so-called sustainable building [50].”

The importance of sociocultural, technical and economic aspects was recognised in building sustainability assessments. Still, topics such as user satisfaction, quality of life and health or design quality are rather subjective in comparison to measurable environmental and energy-saving indicators and require individual assessment. The contradiction between general objective and individual subjective criteria makes the evaluation difficult, as standardisation of the criteria based on personal perception and judgement is not possible.

How to assess unmeasurable subjective aspects with general applicability? There have been various efforts aimed at finding the appropriate method as an answer to the question. For instance, *DGNB* firstly considered architectural quality only with the help of the criteria of architecture or urban design competi-

tion and architectural art. Later, it introduced additional certificate *DGNB* 'Diamond' as a way to recognize and appreciate well-designed architecture. Other tools to provide an assessment method for design quality of buildings have also been developed, e.g. *Design Quality Indicator (DQI)*. Furthermore, certification systems worldwide gradually add new profiles such as interiors, buildings in use or maintenance and operation, where user satisfaction, comfort and productivity are weighted higher than in the schemes such as new construction or existing buildings. In addition to sustainable assessment, human-focused *WELL* certification has been established with the goal to create healthy and comfortable spaces for people.

Sustainably planned buildings can significantly contribute to making people feel comfortable and healthy in buildings. The study shows that the existing building assessments vary in the way they weight and evaluate the sociocultural, environmental and economic aspects of sustainability. After all, it is up to the planners to choose the appropriate certification system for the specific building and situation as a planning guide and rating tool to achieve the highest level of satisfaction.

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