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EXPRESSION OF SUSTAINABLE ARCHITECTURE AND ITS DIRECTIONS

Doctoral dissertation
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LIST OF ABBREVIATIONS AND DEFINITIONS

Aesthetics – (in Greek *Aisthētikos* – sensorial) is a philosophical field that delves into the concepts of beauty, taste, and the underlying principles of art, with an emphasis on the subjective aspects related to our senses and emotions (Zangwill, 2019). The notion of *Aesthetics* was developed by the 18th century philosopher Baumgarten. According to him, this knowledge reflects our experience in the surrounding world, cultural traditions and moral values (Wang and Yu, 2018). In this dissertation, *Aesthetics* in architecture is considered "as a visual and sensory experience that reflects ethical attitudes and values of a particular group or population" (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2022).

Anthropocentrism – an approach that positions human beings as the focal point of moral and ethical considerations. Anthropocentrism is closely tied to humanism, prioritizing human values and well-being. It views ethics through a human-centered lens, valuing nature only for its usefulness to humans. In contrast, ecological ethics explores other perspectives like *biocentrism* (valuing all living beings intrinsically) and *ecocentrism* (valuing entire ecosystems). While anthropocentrism has been dominant, modern environmental ethics aims for a more inclusive and holistic approach, considering both human and environmental well-being (Kalenda, 2006).

Architecture – "functional, spatial and visually perceptible artistic formation of buildings, urban complexes and landscape" (LR Seimas, 2017).

Biophilic design – a transformative, science based approach to architecture and urban planning that acknowledges the vital role of natural elements and systems in enhancing human health, well-being, and our connection with the environment, ultimately aiming to establish harmonious relationships between humans and nature (Browning et al., 2014).

Ecological consciousness – highler level of consciousness regarding humanity's role and importance within the natural world which recognizes the inseparable bond between humanity and nature and understanding how the well-being of society relies on the condition of the natural environment (Kalenda, 2006).

Environment – a complex system of animate (living) and inanimate (non-living) natural objects that surround an individual or a living organism, providing a habitat or living space. It encompasses various elements such as the air, water, land, plants, animals, and ecosystems. Human beings are deeply interconnected with the environment through ecological ties. This means that our well-being and survival are dependent on the health and functioning of the natural world (Kalenda, 2006).

Ethics (environmental, ecological) – the term *Ethics* used in this dissertation refers to environmental and ecological ethics, which is an applied field of normative ethics that studies connection between humans and the natural world and raises the

question of man's responsibility for the state of nature. The task of this ethics is to justify the ecological-moral value of behavior and to subordinate the process of assimilation of nature carried out in society to the criteria of morality (Kalenda, 2006).

Holism (or holistic approach) – a theoretical principle that refers to the integrity of nature and emphasizes the interdependency of each of its parts, including people. Ecocentric ethics is based on this principle (Kalenda, 2006).

Genius loci (Spirit of place) – a concept that originates from ancient Roman religion and philosophy. It refers to the distinctive character or essence of a particular location or place. In this context, *Genius* refers to the divine guardian or spirit associated with a specific place, and *loci* means place. The concept recognizes the unique and inherent character, atmosphere, and identity of a specific location or place, resulting from its natural features, cultural history, and human activities. It encompasses both tangible and intangible aspects that contribute to its overall essence. (Esmaeili & Sinclair, 2022).

Nature – an integrated set of ecological components (land, its depths, surface and underground waters, atmospheric air, forests and other vegetation, animals and microorganisms, genetic fund, landscapes, outer space) that guarantee natural conditions for human life and activity and the existence of living organisms (Kalenda, 2006).

Nature protection – a set of "international, state, regional and local administrative, economic, technological, political, legal and social measures" designed to protect and rationally use the Earth's nature and the nearest outer space for the benefit of all people, as well as future generations. The ethical aspect of nature conservation emphasizes the importance of preserving and loving nature in guaranteeing the normal existence and development of humans and other species (Kalenda, 2006).

Regenerative approach (or Regenerative sustainability) – the *Regenerative approach*, as the most advanced concept of sustainability, seeks to trespass the boundaries of only sustaining the current state and instead focuses on restoring the damage caused by human activities, aiming to create a sustainable built environment that emulates the qualities of natural systems in terms of materials, interactions, and overall behavior (Brown et al, 2018).

Restorative approach (or Restorative sustainability) – an approach in sustainability paradigm that seeks to rejuvenate and restore social and ecological systems to a state of well-being (Andreucci et al, 2021).

Sustainability – Sustainability, from a scientific perspective, illustrates the ability of a system or process to be continued over an extended duration without exhausting crucial resources or causing substantial damage to the environment,

society, or economy. It involves the responsible and balanced utilization of natural resources, while considering the interconnections between ecological, social, economic, and cultural factors. Sustainability is a core concept of sustainable development.

Sustainability aesthetics – in general understanding, aesthetics revealing and emphasizing the "intrinsic beauty of our connectedness to ecosystems and sustainable systems and holding potential for the built environment"; as a specific approach *Sustainability aesthetics* is discussed in Introduction and chapter *Aesthetic expression of sustainability* (Gražulevičiūtė-Vileniškė et al, 2022).

Sustainable architecture (or sustainable building) – architecture characterized by physical, social, cultural, and visual longevity that is valuable in historical, aesthetic, or scientific perspective (Rutkauskas, 2012). In current understanding, sustainable architecture is defined as the wholenees of design, construction, and operation of buildings and structures that minimize negative environmental impacts, conserve natural resources, and promote the well-being of occupants and surrounding communities. It employs a comprehensive strategy that covers the complete lifespan of a structure, which includes planning, construction, utilization, and eventual dismantling or repurposing. See chapter *Defining sustainable architecture*.

Sustainable development – "the development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs". The definition was formulated within the document "Our Common Future," commonly referred to as the Brundtland report. This report was issued by the World Commission on Environment and Development (WCED), a commission under the United Nations, in 1987 (United Nations, 1987). The concept of sustainable development was further elaborated upon at the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992, also known as the Earth Summit (United Nations, n.d.). Besides the social and economic aspects, the idea of sustainable development has also been augmented with an ecological necessity (Kalenda, 2006). Currently, growing attention is given to the importance of its cultural dimension and its inclusion in sustainable development concept.

1. INTRODUCTION

1.1. Area of the Research

Sustainability has become a matter of significant public concern in the recent decades highlighting the need for sustainable solutions across all aspects of modern life. Sustainability in architecture has become a basic need which is usually analysed through the main four dimensions: environmental, economic, social, and cultural. However, while there has been an increasing volume of literature focused on the technological aspects of sustainable architecture, there still remains a notable gap in research that comprehensively examines the conceptual, philosophical, and artistic perspectives of this field (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2020).

The prevailing perception of sustainable architecture as a technical and functional discipline has led to a neglect of its aesthetic potential, resulting in a lack of sensibility to culture and place. Sustainable architecture should not only be viewed as a means to achieve environmental sustainability goals but also as an opportunity to create aesthetically pleasing and meaningful spaces that enhance the human experience. Therefore, incorporating aesthetics into the design process is necessary to achieve substantial and vital sustainability in urban contexts.

The definition of sustainable architecture emphasizes the importance of its aesthetic value. The term "Architecture" is currently described as "the art and practice of designing and making buildings" or "the style in which buildings are made" (Cambridge University Press, n.d.). Art and style (synonymously – expression, aesthetics) are closely associated with culture and aesthetics. Aesthetics, in this context, refers not only to visual experience but also to cultural history and identity. As a tangible matter, buildings can last for thousands of years, but the ecological crises of the 1960s and 1970s highlighted environmental problems associated with the use of new substances and pollution caused by modern way of life. The term "sustainability," officially introduced considerations of environmental ethics in relation to the field of architecture and construction as an ethical responsibility to the future generations (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2021).

Sustainable architecture therefore relates with "sustainability aesthetics" which is an approach to design that combines environmental sustainability with aesthetic considerations. It refers to the idea that products, buildings, and landscapes can be designed in a way that is visually pleasing and inspiring while having less negative impact on the environment. This approach to design involves an assessment of the life cycle of materials, including an evaluation of the ecological consequences related to their production, utilization, and disposal.

Frequently, sustainable architectural design is aesthetically expressed by involving natural materials and elements, creating the green spaces, and integrating sustainable technologies and systems that improve energy efficiency while minimizing waste. By combining environmental sustainability with aesthetics, sustainability aesthetics aims to create designs that are both socially and environmentally responsible and visually inspiring.

Even more, newest ethical considerations in the sustainability field insist on considering the new approach – regenerative sustainability – a holistic approach to sustainability that aims to restore, renew, and revitalise natural systems and resources to a state of health and abundance. Thus, the concept of sustainable architecture should be approached not only as a technical and economic challenge but as an ethical responsibility to the planet and future generations as well as a possibility of a new aesthetical language. However, the experiments of expressing "new aesthetics" sometimes lead to very unusual and unexpected results that cause discussion or sometimes even rejection by the public.

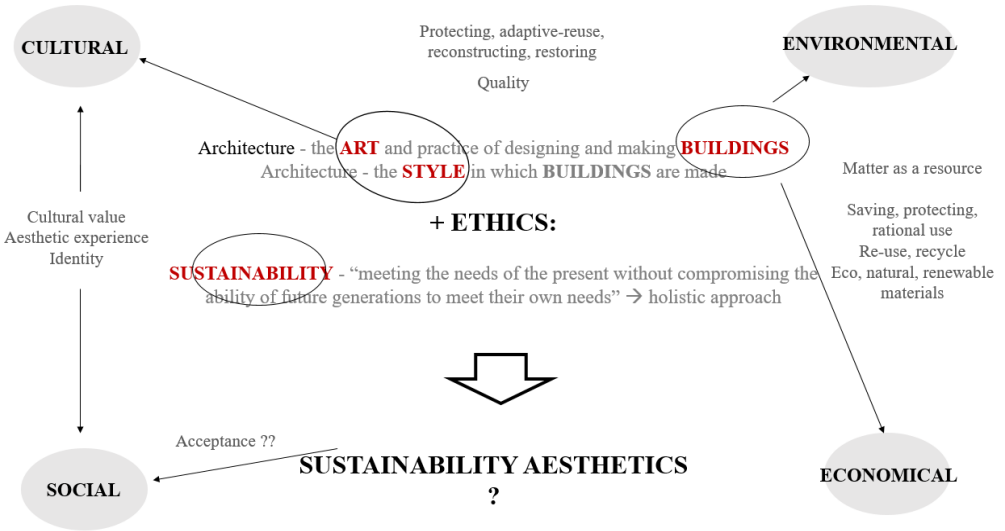

Fig. 1. Area of the research. The initial message decoded in terms "sustainability" and "architecture" illustrates the primary focus to aesthetics (art and style) and its relation to tangible matter (buildings) bringing the ethical responsibility which evolved to holistic approach and all together with the latest technological advances call out the emergence of new (sustainability) aesthetics. How is it expressed in architecture and is it accepted by the public? (Source: author)

Literature review conducted in the study illustrated the vagueness of definition "sustainable architecture" and the undefined characteristics of "sustainability aesthetics" as well as the currently prevailing focus on economical – technological aspects of sustainable buildings, a lack of publications analysing sustainability aesthetics and the limited number of research perspectives that cover the conceptual perspective of the field. Nevertheless, many scientists emphasise the importance of including the cultural dimension in sustainable development.

Therefore, this dissertation contributes to the understanding of the aesthetical development of sustainable architecture by attempting to revise and specify the definition of sustainability in the field of architecture, especially focused on its aesthetic features. The dissertation "Expression of sustainable architecture and its directions" explores the meaning and purpose of aesthetical experience of sustainable architecture, its expression (directions, trends, or style) and features as well as possible future development.

1.2. The Aim and Objectives of the Dissertation

The aim of this dissertation is to contribute to the understanding of the aesthetical development of sustainable architecture by identifying possibilities of creating aesthetically recognizable and pleasing sustainable architecture and developing methodological framework of describing and assessing the aesthetic expression of sustainable buildings.

The objectives of this dissertation illustrate the structure of the study and the main topics of scientific articles in which the results were published. Objectives of the dissertation are as follows:

1. To conduct a literature review that covers definition and development of sustainable architectural expression and its ethical background using timelines and mind mapping;
2. To analyse examples of sustainable architecture focusing on the sustainable buildings in the Baltic Sea region and to identify challenges and problems of their aesthetic expression;
3. To analyse the role of aesthetics in the assessment of sustainable architecture by studying architecture quality criteria and the most widely applied sustainable buildings' certification systems;
4. To form a methodology for describing and assessing the aesthetic expression of sustainable buildings based on theoretical concepts of biophilic design, sustainability aesthetics, regenerative design, and genius loci;
5. To conduct a field study of the selected architectural objects in Lithuania by applying the prepared conceptual methodology;
6. To complement the existing classifications of sustainable architecture directions by providing a new classification that reflects the current variety of sustainable architecture trends and to evaluate their psychological acceptability by conducting a sociological survey and preparing the quantitative and qualitative analysis of the data obtained.
7. To formulate the conclusions of the possibilities to create aesthetically recognizable and pleasing sustainable architecture.

1.3. Scientific Novelty of the Dissertation

Sustainability in architecture is a fast growing field of interest, especially as the public worldwide is getting concerned about environmental issues. However, the research has not yet caught up with the demand. The cultural dimension of the sustainable development, including the artistic expression of sustainable architecture still lack attention as described in the literature review (chapter II – *Overview of Scientific Literature*). This dissertation comprehensively examines the conceptual, philosophical, and artistic perspectives of this field.

This dissertation analyses the definition of aesthetics in sustainable architecture, examines the meaning of sustainability in architecture, analyses contemporary trends and their acceptance of architecture professionals and the general public. This dissertation provides a new perspective on aesthetics in sustainable architecture by analysing the relation between ethical attitudes towards the environment and

architectural expression, addressing current challenges, as well as exploring potential avenues for future development.

Moreover, this research explores the common messages encoded in sustainable architecture and at the same time discusses the importance of aesthetics as a quality criterion in architecture, but highlights its unclear definition. The study represents a novel approach by exploring the common messages encoded in sustainable architecture and provides a unique perspective on considering "aesthetics as a visual and sensory experience that reflects the values of a specific population or group" (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2022).

The study offers an innovative perspective highlighting the importance of aesthetics as a quality criterion in architecture, but acknowledging its unclear definition. The study analyses the criteria for evaluating architectural objects, emphasising aesthetics as a crucial quality criterion for advancing sustainable architecture and sustainable development efforts, which helps to expand the existing concept of architectural quality.

This work systemises and expands existing classifications of sustainable architecture trends and provides a more contemporary and comprehensive understanding of sustainable architecture aesthetic directions. The study provides a methodological framework of describing and assessing the aesthetic expression of sustainable buildings that could bring practical value by acting as a source of inspiration.

Overall, this dissertation provides practical approaches, such as evaluation criteria of improving aesthetical-sensorial experience, as well as historic, opinion-based and philosophic considerations of applying sustainability concept in the field of architecture that allows to to develop the notion of aesthetic quality.

1.4. Structure of the Dissertation

The dissertation is based on a collection of scientific articles and is composed of six scientific articles published in Scopus Q1-Q2 ranked journals, including three of these journals also being ranked in Web of Science and one in Index Copernicus. Agreements have been obtained from the co-authors and publishers to include those scientific papers in the doctoral dissertation. The comprehensive list of articles is presented below according to their topics as contribution to this dissertation:

1. Daugelaite, A., Grazuleviciute-Vileniske, I. (2022). Retrospective Analysis of Sustainable Architecture: Mind-Mapping Development of Ideas and Expression. Journal of sustainable architecture and civil engineering = Darnioji architektūra ir statyba. Kaunas : Technologija. ISSN 2029-9990. eISSN 2335-2000. Vol. 30, no. 1, p. 78-92. DOI: 10.5755/j01.sace.30.1.29829 [Scopus; Index Copernicus; DOAJ] [CiteScore: 0,80; SNIP: 0,433; SJR: 0,212; Q2 (2021, Scopus Sources)] [M.kr.: H 003] [Contribution: 0,500]. The scientific contribution of the author of this dissertation lies in carrying out a historical analysis of development of sustainable architecture and its relation to ethical ideas, writing the main body of text, including results and discussion.

2. Daugelaite, A., Grazuleviciute-Vileniske, I. (2021). The Relationship between Ethics and Aesthetics in Sustainable Architecture of the Baltic Sea Region.

Sustainability. Basel: MDPI. ISSN 2071-1050. Vol. 13, iss. 4, art. no. 2259, p. 1-15. DOI: 10.3390/su13042259. [Social Sciences Citation Index (Web of Science); Scopus; DOAJ] [IF: 3,889; AIF: 4,719; IF/AIF: 0,824; Q2 (2021, InCites JCR SSCI)] [CiteScore: 5,00; SNIP: 1,310; SJR: 0,664; Q1 (2021, Scopus Sources)] [M.kr.: H 003] [Contribution: 0,500]. Scientific contribution the author of this dissertation consists of data collection and analysis, writing the article, and text editing for the final version.

3. Grazuleviciute-Vileniske, I. Viliūnas, G., Daugelaite, A. (2021). The role of aesthetics in building sustainability assessment. Spatium. Belgrade: Institute of architecture and urban & spatial planning of Serbia. ISSN 1450-569X. eISSN 2217-8066. Vol. 45, p. 79-89. DOI:10.2298/SPAT2145079G. [Scopus; DOAJ] [CiteScore: 0,50; SNIP: 0,210; SJR: 0,155; Q1 (2021, Scopus Sources)] [M.kr.: H 003] [Contribution: 0,334]. Scientific contribution the author of this dissertation consists of writing part of literature analysis, describing architectural theories relevant to balancing the aesthetic and environmental criteria in the assessment of sustainable architecture, text edition for the final version.

4. Daugelaite, A., Doğan, H. A., Grazuleviciute-Vileniske, I. (2022). Characterizing sustainability aesthetics of buildings and environments: methodological frame and pilot application to the hybrid environments. Landscape architecture and art. Jelgava: Latvia university of agriculture. ISSN 2255-8632. eISSN 2255-8640. Vol. 19, no. 19, p. 61-72. DOI: 10.22616/j.landarchart.2021.19.06. [Emerging Sources Citation Index (Web of Science); Scopus] [CiteScore: 0,50; SNIP: 0,362; SJR: 0,283; Q1 (2021, Scopus Sources)] [M.kr.: H 003] [Contribution: 0,333]. Scientific contribution the author of this dissertation consists of writing part of literature analysis, describing architectural theories and distinguishing the set of features of sustainable buildings.

5. Grazuleviciute-Vileniske, I., Daugelaite A, Viliunas G. (2022). Classification of Biophilic Buildings as Sustainable Environments. Buildings. Basel: MDPI. ISSN 2075-5309. 2022, vol. 12, iss. 10, art. no. 1542, p. 1-15. DOI: 10.3390/buildings12101542. [Science Citation Index Expanded (Web of Science); Scopus; DOAJ] [CiteScore: 3,80; SNIP: 1,372; SJR: 0,565; Q1 (2021, Scopus Sources)] [M.kr.: H 003] [Contribution: 0,334]. Scientific contribution the author of this dissertation consists of conceptualization, methodology, resources, writing—original draft preparation, writing— review and editing, visualization.

6. Daugelaite, A. (2023). Psychological Acceptance of Sustainable Architecture in Lithuania: A Qualitative Study. Journal of Sustainable Architecture and Civil Engineering = Darnioji architektūra ir statyba. Vol. 32 No. 1 (2023), pages 41-57.Kaunas: Technologija.

The published articles serve as a structural representation of the dissertation and demonstrate the fulfilment of the research objectives. The *Retrospective analysis of sustainable architecture: mind-mapping development of ideas and expression* (Daugėlaitė & Gražulevičiūtė-Vileniškė , 2022) provides a comprehensive literature review. *The relationship between ethics and aesthetics in sustainable architecture of the Baltic sea region* (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2021) complements the literature review presented in the previous article and provides a case study analysis

of certified as sustainable buildings in the Baltic Sea region. *The role of aesthetics in building sustainability assessment* (Gražulevičiūtė-Vileniške et al., 2021) analyses definition of a sustainable building through the criteria of four building certification systems (LEED, BREEAM, Living building challenge, and WELL). This study also distinguishes four approaches that "hold the potential for breakthrough in the aesthetic quality and uniqueness of sustainable architecture: sustainability aesthetics, spirit of place (genius loci), biophilic design, and a regenerative approach". The *Characterizing sustainability aesthetics of buildings and environments: methodological frame and pilot application to the hybrid environments* (Daugėlaitė et al., 2022) provides efforts to distinguish a set of aesthetic criteria of sustainable architecture and a methodology of evaluating it. This methodology is tested in the *Classification of biophilic buildings as sustainable environments* (Gražulevičiūtė-Vileniškė et al., 2022). Psychological acceptance of distinguished aesthetic trends of sustainable architecture and its qualities are analysed in the *Psychological Acceptance of Sustainable Architecture in Lithuania: A Qualitative Study* (Daugėlaitė, 2023). The detailed description of scientific articles is provided in chapter III. *Review of scientific articles included in the dissertation*.

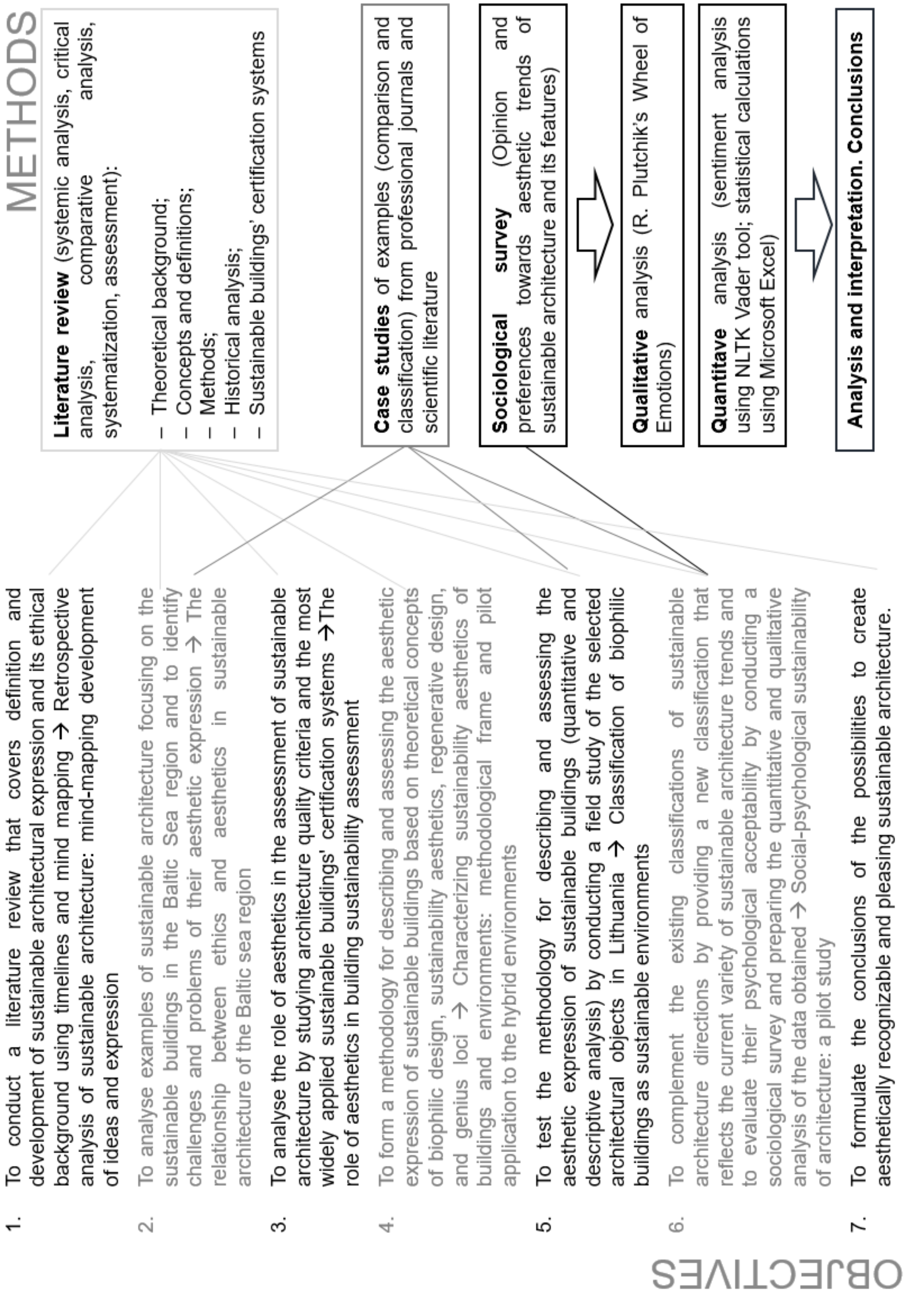

Fig. 2. Scheme of the research (Source: author)

2. OVERVIEW OF SCIENTIFIC LITERATURE

The chosen topics for the literature review are relevant and necessary to achieve the aim and objectives of this dissertation, which is to provide a comprehensive discussion on sustainable architecture and its aesthetics. The first topic, aesthetic expression of sustainability and development of the notion itself, was chosen to discuss the development of sustainability concept and aesthetic expression that is brought by this concept. Further, analysis of the meaning of aesthetics in sustainable architecture and the related challenges, deepens knowledge of the importance of aesthetics in sustainable architecture and reveals the challenges that are faced when attempting to integrate sustainability principles with aesthetic considerations. Moreover, the study showed the importance of aesthetics as a quality criterion in evaluating sustainable architecture, thus this topic was elaborated further. Lastly, analysis of existing trends of sustainable architecture provides an up-to-date classification of the existing aesthetic expression of sustainable architecture which is important for further psychological evaluation of its features.

2.1. Aesthetic expression of sustainability

Several studies have systematically analyzed literature sources related to sustainability and aesthetics, including one conducted in 2020 (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2020), a second in 2021 (Gražulevičiūtė-Vileniškė et al., 2021) and an updated analysis in May of 2023. Bibliographic resource in the Scopus database using keywords "sustainability OR sustainable AND aesthetics", resulting in 4,204 documents published between 1986 and May 2023 was analysed for this dissertation. The earliest document in the Scopus database was "A transcultural view of sustainable development. The landscape of design" (Khosla et al., 1986). No prior publications were found, signifying that the publishing date of the Brundtland report, which defined sustainability for the first time, opened ways for discussion starting 1987 (United Nations, 1987). Since 1987 the number of publications started increasing.

The growing importance of sustainability-related issues is particularly evident in the recent years – since 2015, the number of publications has increased more than double (179 papers in 2015, 490 papers in 2022). The search results highlight the complexity of the field due to the diverse range of content, which encompasses a wide variety of scientific disciplines, ranging from engineering to neuroscience. After excluding less relevant subject areas, the search yielded 1,320 documents, of which only 177 (13.41%) were classified as relevant to the field of arts and humanities. A comparatively small number of publications on sustainability aesthetics could possibly be of high interest to technological sciences in sustainability topic or these relevant publications might be infrequently included in this scientific database.

Further, the search was specified using keywords "sustainability OR sustainable AND aesthetic AND architecture" finding a total of 584 publications, 99 of which in arts and humanities. Documents published in 2023 brought innovative topics in construction related fields such as "A road map to find in 3D printing a new design plasticity for construction – The state of art" (Teixeira et al., 2023), "Mycelium-Based

Composite Materials: Study of Acceptance" (Bonenberg et al., 2023), "Qualitative and quantitative study to assess the use of rammed earth construction technology <…>" (Strazzeri & Karrech, 2023), etc. Research works of the last several years illustrates the interest in experimenting with previously unknown possibilities in construction as well as increased attention to cultural dimension of sustainable development.

However, the number of publications directly related to aesthetics of sustainability or sustainable architecture is relatively small compared to the overall volume of literature on sustainability and the built environment. Related publications analyze various aspects of sustainability aesthetics. To illustrate, "Donovan (2017) has analyzed different sustainable architecture movements and their aesthetic expression, Finocchiaro and Wago (2017) analyzed the expression of zero emission buildings. Cenek (2013) analyzed building form from the perspective of sustainability. Gan & Zhang (2012) discussed ecological architectural aesthetics" (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2020). Dekay (2012) presented sustainability aesthetics as a concept that transcends the constraints of basic visual comprehension to encompass more complex levels of aesthetic perception including not only visual but also phenomenological, process-oriented, ecological, and evolutionary perspectives. The study conducted by Coburn and colleagues (2020) offers significant contributions to the understanding of aesthetic perception, as it identifies and differentiates the three main aspects that constitute this perception: behavioral-motivational responses, cognitive judgments, and emotional responses, which together form the most memorable experiences in the built environment. Faragalla & Asadi (2022) explore possibilities of biomimetic methodologies for designing adaptive façades. El Menshawy et al. (2022) presents an in-depth examination of green wall construction techniques, emphasizing the advantages of enhancing human well-being and urban sustainability.

The engineering-focused research in the Scopus database prompted a supplementary search for sustainability aesthetics and architecture sources in other platforms such as Google Scholar, Academia.edu, and Research Gate (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2020). Additional research illustrated scientific works describing sustainability aesthetics from various perspectives. Bothwell (2011) explored how sustainability aesthetic features can be integrated into the design process. Di Carlo (2016) focused on sustainable architecture and how it can improve the quality of life. Finocchicaro and Hestnes (2011) analyzed the integration of sustainability and aesthetics in architecture. Hemmati (2016) studied the relationship between sustainability and aesthetic values. Hill explored the potential of sustainable design to create a more sustainable future. Jauslin (2011) analyzed the concept of aesthetics in sustainable architecture. Kagan (2011) and Levit (2014) discussed the relationship between sustainability and beauty in design. Knowles (2011) analyzed the role of aesthetics in sustainable architecture and urban design. Marchand (2006) and others analyzed the role of aesthetics in sustainable urban design. Sauerbruch and L. Hutton (2011) explored the integration of sustainability and aesthetics in architecture. S. R. J. Sheppard (2001) discussed the relationship between sustainability and beauty in urban design. Spirn (1988) explored the role of aesthetics

in ecological design. Sunikka-Blank (2011) analyzed the relationship between sustainability and aesthetics in urban design (Gražulevičiūtė-Vileniškė & Daugėlaitė, 2020).

The United Nations established Sustainable Development Goals (SDGs) and objectives for countries around the world in 2015. These goals are accompanied by sustainable development strategies presented and implemented in international and national documents. Numerous objectives established for the year 2030 are connected to the built environment, and consequently, to the field of architecture. For example, "to develop resilient infrastructure, to make human-populated areas safe, resilient and sustainable, to take urgent action to combat climate change and its effects, to protect and restore, as well as promote the sustainable use of land ecosystems" (United Nations General Assembly, 2015).

Achieving many of the SDGs and targets is quantifiable, therefore, it initially looks like a technological task (Gražulevičiūtė-Vileniškė & Daugėlaitė, 2020). Nevertheless, the necessity of including cultural dimension is highlighted by several scientists and international documents, including "Culture: A Driver and an Enabler of Sustainable Development" (2010), Moldavanova (2014), and Meireis and Rippl (2019). These works argue that traditional dimensions of sustainable development – ecological, economic, and social – are insufficient to capture the complexities of modern societies, and that cultural aspects like values, beliefs, or traditions influence sustainable development outcomes. Inclusion of cultural sustainability into sustainable development efforts, ensures that policies and programs are more inclusive, relevant, and effective, and can better reflect the needs and aspirations of diverse communities.

However, over the past two decades, researchers and architecture critics, such as Heymann (2020), have pointed out that simply following formal principles of sustainability, such as those indicated by certification systems, does not necessarily guarantee the aesthetic quality of architectural objects. Furthermore, the aesthetics of this "formal" architecture may not always reflect the ideas of sustainability. Heymann notes that the LEED sustainability certification system – the main tool for regulating the sustainable construction of public buildings in the USA and many other countries – helps to maintain the existing architectural aesthetics rather than to achieve a sustainable architectural expression.

There is a clear lack of attention to the aesthetic aspects in the development of sustainable architecture (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2020). To illustrate, Donovan (2001) argues that sustainable architecture has progressed in ethical technology but is still lacking a comprehensive aesthetic language necessary for its further development. Jauslin (2011) pointed out the need for understanding the aesthetic possibilities within sustainable architecture. The author suggests that the prevailing perception of sustainable architecture as a technical and functional discipline has led to a neglect of its aesthetic potential. Jauslin argues that sustainable architecture can be aesthetically rich and meaningful, and that it should be approached as a creative and expressive field that engages with the cultural and social contexts of its surroundings. In other words, he suggests that sustainable architecture should not only be seen as a means to achieve environmental sustainability goals but also as an

opportunity to create aesthetically pleasing and meaningful spaces that enhance the human experience.

Guy and Farmer (2001) highlight the technologically driven focus of sustainable architecture, as well as little sensibility to culture and place. Hemmati (2016) argues that ecological considerations in sustainability are still prioritized over aesthetic concerns. Di Carlo (2016) argues that sustainable architecture ought to consider not only the ethical aspects but also take into account "aesthetics, style, and emotions". She emphasizes the need to incorporate aesthetics into the design process to achieve full sustainability in urban contexts. Wines (2000), an architectural researcher, artist, and architect, argued that sustainable architecture should prioritize aesthetic expression in addition to functional considerations. He suggested that without art, a building's sustainability is compromised, as people are less likely to maintain aesthetically unappealing buildings, regardless of their advanced technology and environmentally friendly features.

As a response to these problems, a direction called sustainability aesthetics (or aesthetics of sustainability) has emerged, emphasizing the importance of creating design that is not only functional and environmentally friendly but also aesthetically pleasing and meaningful, reflecting the values of sustainability. This concept emerged out of the ecological art movement of the 1960s and 1970s (also known as Environmental Art, Land Art, Earth Art, or Earthworks) as noted by Kagan (2011). This movement rejected "creating art solely for commercial or aesthetic purposes, and emphasise social engagement, awareness raising, and working with nature practices, paying attention and respect to the complex dynamics of natural phenomena in their relationships to human interventions" (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2020).

To summarize, sustainability aesthetics is a design approach that prioritizes the creation of environmentally sustainable buildings that are also aesthetically pleasing and socially responsible. This approach aims to balance ecological, social, and economic aspects during the design process, while also integrating elements of beauty, harmony, and the human experience.

2.2. Defining sustainable architecture

Definition of sustainable development currently is a complex widely applicable notion (Pesqueux, 2009). The current understanding of sustainability and sustainable development is typically associated with the UN Brundtland Commission Report of 1987 (United Nations, 1987), emphasizing a human-centered approach that prioritizes equity across generations (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2020). However, the historical study of the development of sustainable architecture illustrates that it was closely related with ethical considerations towards the environment since the late 19th century (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2022).

The definition of *sustainability* is subject to ongoing debate, while new concepts like *restorative sustainability* and *regenerative sustainability* are emerging (Brown, et al, 2018; Istiadji, 2018). These evolving notions of sustainability have direct implications for the built environment and architectural design.

The influence of the concept spans from mandatory legal regulations to inspiring extraordinary projects or even utopias, yet the concept itself remains hardly defined

(Guy and Farmer, 2001; Berardi, 2013; Cole, 2012; Wilkinson, 2016). Wilkinson et al. (2016) identified various terms associated with *sustainable* in architecture, encompassing ecological, green, Gaian, eco-friendly, environmentally sensitive, and other environmentally conscious expressions, which can be defined differently and exhibit diverse architectural aesthetics (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2020).

According to Berardi (2013), a sustainable building contributes to overall sustainability by actively engaging in processes that enhance the regenerative and resilient qualities of the built environment across various sustainability aspects. The definition provided by Berardi highlights the importance of factors such as safety, flexibility, economic value, environmental impact mitigation, human well-being, occupant satisfaction, social equity, aesthetics, and cultural preservation in achieving sustainability. While aesthetics is acknowledged as a crucial element of human-centered cultural sustainability, the specifics of this aesthetic dimension remain undefined (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2020).

Currently, attempts to apply the sustainable development concept to mitigate negative environmental impacts have reached every sphere of life. Nevertheless, certain scholars and intellectuals argue that the current sustainable development paradigm is intrinsically limited because it is insufficient only to uphold the present situation (Ehrenfeld, 2008).

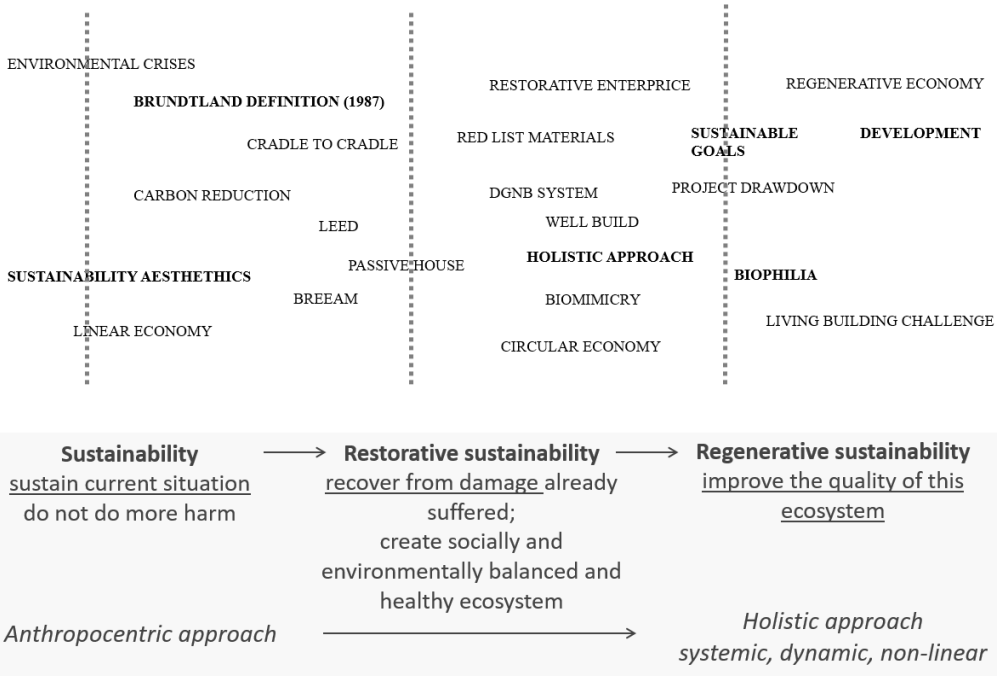

Fig. 3. The development of sustainability concept (adapted from Brown et al., 2018)

As a response, alternative approaches that transcend the traditional sustainable development paradigm are emerging. Recent scientific studies such as those done by Berardi (2013), Istiadji et al. (2018), Delancey (2004), etc. illustrated the shift of

sustainability paradigm towards a holistic and systemic approach. This shift is reflected by the emergence of new approaches, such as restorative and regenerative design, described as following stages of sustainability by Brown et al (2018). This study describes sustainability concept as “limiting impact. The balance point where we give back as much as we take”. Advanced concepts like restorative sustainability seek to return both social and ecological systems to a state of well-being, while regenerative sustainability aims to enable these systems to not only hold a healthy state but also evolve (Brown et al., 2018).

Brown et al. (2018) define restorative and regenerative buildings as those that combine sustainable construction practices with occupant health benefits, strengthen the human-nature connection, and employ biophilic design alongside sustainable building strategies. Regenerative sustainability is described as the most advanced sustainability form, aiming not only to restore but also enhance the neighboring natural environment by considering living and non-living components of the environment.

The emerging concept of resilient sustainability involves developing and implementing strategies to improve a system or community's ability to withstand and recover from shocks or stresses, while maintaining its long-term sustainability goals, by enhancing its adaptive capacity to respond to disturbances such as natural disasters, economic crises, or environmental degradation (Walker, 2004).

The New European Bauhaus Concept Paper (Von der Leyen et al., 2021) highlights the importance of adopting a systemic approach that highlights the interconnectedness of the natural and built environments. It emphasizes that buildings are not stand-alone entities but rather integral parts of larger systems and require care, adaptation, and regeneration over their lifecycles.

Mentioned scientific works illustrate the complexity of contemporary sustainable (further – restorative, regenerative) architecture and its interconnectedness with a variety of contexts as connected, interdependent systems. Contemporary sustainable architecture should be considered holistically, not only through a human-centered approach as it was followed since Brundtland report in 1987, and should also include broader considerations of built and natural environment.

Features of sustainable architecture	
Environmental	Designed from life-cycle perspective (CIB, 2010) Minimized environmental impact (resource efficiency, waste and emissions reduction, material selection) (CIB, 2010) Adaptable throughout service life and end of life strategy (CIB, 2010) Environmentally friendly operation (Kamičaitytė-Virbašienė and Gražulevičiūtė-Vileniškė, 2009)
Social	Provide social value over time (CIB, 2010) Provide sense of place for its occupants (CIB, 2010) Reflect the identity of the place (Kamičaitytė-Virbašienė and Gražulevičiūtė-Vileniškė, 2009) Healthy (e.g., indoor air quality) (CIB, 2010) Comfortable (e.g., acoustic, thermal, visual, olfactory comfort) (CIB, 2010) Safe (e.g., working conditions) (CIB, 2010) Accessible for all (CIB, 2010) User-friendly, simple (CIB, 2010) Psychologically acceptable (Kamičaitytė-Virbašienė and Gražulevičiūtė-Vileniškė, 2009)
Cultural	Provide cultural value over time (CIB, 2010) Related and integrated into the local culture (CIB, 2010) Connected with environment (Kamičaitytė-Virbašienė and Gražulevičiūtė-Vileniškė, 2009) Aesthetic (Berardi, 2013; Kamičaitytė-Virbašienė and Gražulevičiūtė-Vileniškė, 2009)
Economic	Deliver economic value over time (CIB, 2010) Cost-effective in operation (CIB, 2010)
Political	Integrated into the relevant local plans and infrastructure, and connected into the existing services, networks, urban and suburban grids (CIB, 2010)
Philosophical	Holistic approach (CIB, 2010); Collaborative approach (CIB, 2010)

Fig. 4. Features of sustainable architecture according to conducted literature review (Berardi, 2013; Kamičaitytė-Virbašienė and Gražulevičiūtė-Vileniškė, 2009; CIB, 2010) by (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2020)

2.3. Meanings and challenges of aesthetics in sustainable architecture

In general understanding, "aesthetics is a branch of philosophy that is concerned with the nature of beauty and taste, as well as the creation and appreciation of art" (Cohen, 1998). The term "aesthetics" was defined by German philosopher Baumgarten in the 18th century, deriving the term from a Greek word "aisthēsis," which refers to perception or sensory experience. Baumgarten used the term to refer to a philosophy of art that focused on the sensory experience of beauty and the ways in which it could be understood and appreciated (Lee, 2011).

The traditional aesthetic theory, with its roots in ancient Greek philosophers like Plato and Aristotle, delves into the principles and theories behind art creation and interpretation, criteria for defining beauty, and the subjective experience of aesthetic

pleasure. Plato believed aesthetics is about studying perfect ideas that exist beyond what we can see, emphasizing that beauty is something objective and goes beyond the physical world. While Aristotle thought that beauty comes from how things are organized and can be experienced through our senses. He also stressed the importance of imitating or showing nature in art. Classical aesthetics seeks to comprehend the essence of art and beauty, as well as the emotional and intellectual reactions they elicit, by investigating the relation of art and reality, the impact of perception on aesthetic encounters, and the fundamental principles guiding artistic creation and appreciation (Shelley, 2022; Pappas, 2020; Destrée, 2021).

Aesthetics as a branch of philosophy has many directions. In the field of architecture, many of them could be discussed, however, the sustainability concept brings attention to environmental (sub-branch ecological) aesthetics which can be derived from the ideas of Aldo Leopold, who believed that the beauty of nature is intertwined with its ecological well-being and stability. Nevertheless, the concept of *ecological aesthetics* is seen as being in its initial phase of development, the ideas of philosophers such as Husserl, Heidegger, and Merleau-Ponty are seen as relevant to its progress. (Carlson, 2019).

The theories of landscape aesthetics include theories that could be relevant in designing architectural objects. For example, biological landscape aesthetic theories, such as *Prospect-refuge* theory by Appleton and *Human habitat* theory by Orians relate aesthetic pleasure with the satisfaction of human biological needs. Appleton suggests that people are drawn to places that have good visibility but are partially hidden. Orians grounds preference to landscape that recalls the grasslands with scattered trees having water site nearby (Zaleskienė & Gražulevičiūtė-Vileniškė, 2014). *Biophilia hypothesis* by Kellert and Wilson, as one of landscape aesthetic theories, includes those aspects and is becoming increasingly applicable in designing architectural objects. To illustrate, the Living Building Challenge describes biophilia as one of the core concepts to achieve beauty in architecture.

Cultural landscape aesthetic theories such as *Landscape heritage* (or historic landscapes) by Lowenthal and Fairclough, *Spirit of place* (or genius loci), *vividness or imageability* by Lynch, *Aesthetic of care* following Nassauer and Sheppard indicated by Zaleskienė & Gražulevičiūtė-Vileniškė (2014), have high potential in designing architectural objects as many of the discussed aspects could be adapted in building design.

Mixed landscape aesthetic theories such as *Restorative landscapes* that highlight the relation between naturalness of a scene and human restoration or stress reduction, or *Ecological aesthetics* by Carlson and Gobster that illustrates the interconnectedness of preferences for landscape with ethical considerations (Zaleskienė & Gražulevičiūtė-Vileniškė, 2014) illustrates the relevance in building design.

Even though a variety of aesthetic theories exist, aesthetics is subjective and varies across cultures and individuals (Fry, 2019). According to Fry, it is shaped by factors such as individual perception, personal experiences, cultural background and beliefs, social context, etc. For example, one of the landscape aesthetic theories, known as Topophilia, illustrates the emotional attachment to one's environment, closely tied to one's mental, emotional, and cognitive connections to a particular place

(Zaleskienė & Gražulevičiūtė-Vileniškė, 2014). Moreover, aesthetics may not only be related with personal experience. For example, Štelbienė (2015) highlights the importance of aesthetics in capturing the essence of a specific historical era and society's identity.

Therefore, a contemporary understating of the notion of "aesthetics" does not only refer to "beauty". The contemporary art philosophy includes a range of aesthetic categories, such as harmony, tragedy, irony, etc (Adrijauskas, 2005). In visual arts, such as architecture, "visual experience is the first and probably the most powerful way of perceiving, appreciating and evaluating the built environment" (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2022). Currently, aesthetics is understood in a more complex way.

Aesthetics in sustainable architecture usually introduce two common messages (Gražulevičiūtė-Vileniškė & Daugėlaitė, 2020): firstly, the revelation of the current unsustainable condition of our planet and the demonstration of the ecological danger as emphasized by Hill (2011); and second – "Creating the seduction" (Sauerbruch & Hutton, 2009), in other words to design attractive buildings which can showcase and encourage eco-friendly living. This helps challenge the belief that reducing consumption means sacrificing quality.

Recently published New European Bauhaus Concept Paper (Von der Leyen, et al., 2021) indicated reasons that change the current architectural language in sustainability framework:

1. There is a growing need to adopt circular ecological systems in construction, which involve managing waste, recycling, and using natural materials;
2. Buildings considered as autonomous systems including local energy generation and storage, water saving and harvesting, food production;
3. Integration of biodiversity;
4. The fusion of natural materials or processes that have evolved and proven to be effective over a long period with advanced technology like artificial intelligence, leads "to what might be called the cyborganic age, where Hi-Tech meets No-Tech".

According to New European Bauhaus Concept Paper (Von der Leyen, et al., 2021) being exposed to a diverse range of aesthetic choices and expressions, one can develop a broader understanding and tolerance of different styles and perspectives. This can result in an increased openness to new and different aesthetic experiences, which can lead to a greater appreciation and acceptance of the diversity of architectural expression. Moreover, indicated changes can lead to increased necessity of finding a new architectural expression, the "new aesthetics".

Nevertheless, scholars acknowledge that sustainable architecture encounters obstacles associated with the development of its aesthetic expression. Hill (2011) highlights the emergence of a "normalizing effect" through sustainable architecture awards, where the initial groundbreaking and unconventional nature of environmentally friendly architecture from the 1970s has gradually transitioned into a more conventional and inspiring aesthetics (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2020).

Sustainability certification systems can be seen as having the same effect, because the initial focus is to improve technical performance in sustainable architecture and does not prioritize aesthetics (Heymann, 2012). Briggs (2011) illustrates the problem mentioned by Heymann. He argues that green building certification is increasingly used as a marketing tool to sell buildings at higher prices, often coming in line with hiring star architects who are then overshadowed by consultants tasked with redesigning the building to meet rating system requirements. This diminishes the lead architect's control over integrating design aesthetics and sustainability, limiting exploration of sustainable design's aesthetic expression to technical performative aspects. Briggs argues that reliance on only third-party rating systems can further disconnect environmental performance and aesthetics in the design process.

Sustainability aesthetics in contemporary architecture reflects the changing world in many aspects. The emergence of a holistic approach in response to growing environmental awareness has resulted in its increasingly widespread application. Digital tools such as parametric modelling has changed the expression of architecture since 1980's and offer unlimited possibilities for architects to express their creativity. Recent innovation in materials science has led to the emergence of unexpected materials, such as adapting algae for the production of solar panels (European Commission, 2022) and mycelium as a building material (Bonenberg et al., 2023). The development of artificial intelligence, high-tech evolution, etc., offers previously unknown possibilities for buildings and their design, such as kinetic facades. At the same time, protests against consumerisms in a form of radical exploration of building out of trash and living off-grid and zero waste is noted direction in architecture as expressing a way of life, suggests a potential in combining the reviving low-tech indigenous building technologies with high-tech applications to create high-low tech building hybrids (Von der Leyen, et al., 2021).

Designing with natural materials, using innovative design approaches, energy-efficient strategies and circular economy principles holds the potential to catalyze the development of new spatial typologies, including alternative building forms, public spaces, neighborhoods, products, and material production methods. To create a sustainable built environment with regenerative, non-extractive, and circular materials, a significant transformation in construction practices is needed throughout the construction process. This transformative approach allows for the emergence of a new and yet undiscovered aesthetics (Von der Leyen et al., 2021). Nevertheless, those examples are exceptions that illustrate possible trends for the future of sustainable architecture. Currently, the situation is struggling with a first step – to sustain the current situation.

2.4. Aesthetics as architecture quality criterion

Aesthetic values are not fixed or static but are shaped and influenced by cultural and social factors, and vice versa, they form our cultural identities (UNESCO, 2016). Štelbienė (2015) noted that the primary evaluation of a built object is based on its artistic expression. She analyses the work of Sauders (2001), the founding editor of Harvard Design Magazine, who grounds aesthetics as one of the most important

architectural quality criteria providing powerful emotional experience: “originality, power of form and subtlety must provide a vivid, indescribably emotional experience”. Moreover, architecture should be “allegorically expressing and/or reflecting the spirit of our times and ours the state of society and culture”.

For these reasons, aesthetics is an important architectural quality criterion, however, it is hardly defined. Is sustainable architecture a style or design framework, a path that is followed? Unlimited possibilities enable unexpected results. In this dissertation, aesthetics in architecture is considered “as a visual and sensory experience that reflects ethical attitudes and values of a particular group or population” (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2022). The definition of aesthetics in architecture used in this dissertation aligns with the aesthetic theories discussed in the previous chapter and encompasses various considerations that define aesthetics in architecture.

Although various methodologies exist, such as the life-cycle approach, green index, biophilic design, and the Living Building Challenge, WELL, which emphasize the importance of aesthetic-sensorial experience in building design, they are rarely applied in practice. Instead, the focus tends to be on energy efficiency requirements. To illustrate, the Law of Architecture of the Republic of Lithuania provides 10 quality criteria of architectural object LR Seimas (2017):

1. Urban integrity;
2. Relevance to the principles of sustainable development;
3. Quality of construction and created environment (ergonomics), durability;
4. Innovativeness (use of new technologies, materials, architectural and urban solutions);
5. Preservation of cultural heritage;
6. Adapting the environment to all members of society (universal design), ensuring the mobility of human flows and the accessibility (availability) of the designed objects;
7. Harmonious/integral architectural idea;
8. Creating a functional building structure;
9. Aesthetics;
10. The rationality of the decisions, after assessing the optimality of the price ratio of structural design and project realization.

Most of the mentioned architectural quality criteria are defined by Lithuanian law. For example, relevance to the principles of sustainable development (criterion no. 2) is defined only as regulation of energy efficiency by “STR 2.01.02:2016 Design and certification of energy efficiency of buildings”. Quality of construction and created environment (ergonomics), durability (criterion no. 3) is defined by many construction technical regulations and other Lithuanian laws. Rules of preservation of cultural heritage (criterion no. 5) are defined by (Law of protected areas and heritage management regulations). Adapting the environment to all members of society (criterion no. 6) is well defined by the Law of Construction and construction technical regulation “STR 2.03.01:2019 Accessibility of the Buildings”. Assessing the optimality of the price ratio (criterion no. 6) is defined by “STR 1.04.04:2017 Building design, project expertise”. However, quality criterion of aesthetics (criterion no. 9)

remains hardly defined. It illustrates Guy and Farmer's (2001) work that questions whether sustainable architecture can possess a distinct identity of its own.

2.5. Aesthetic trends of sustainable architecture

The sustainability concept offers a theoretical and, to some extent, legal framework, resulting in the existence of a diverse range of architectural designs that aim to achieve sustainability objectives. Aesthetic expression of nowadays sustainable architecture varies from eco-techonogical innovative buildings to vernacular place-based designs (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2020).

The most relevant classifications were provided by Wines (2000), Guy and Farmer (2001), and Sauerbruch and Hutton (2011). Although Di Carlo (2016) suggested a classification for sustainable urbanism, it is possible to use some aspects of his classification to describe architectural objects as well.

The classifications formulated by Guy and Farmer (2001) and Wines (2000) reflect the architectural expression of the late 20th century. However, architectural and urban practices have undergone significant changes and the principles of designing contemporary architectural forms have advanced considerably since then (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2020). Classification by Sauerbruch and Hutton (2011) is also rather old, narrow, incomplete, and does not reflect the variety of existing directions. Classification by Di Carlo (2016) is the most recent, however orientated to urbanism rather than architecture. The existing classifications for mentioned reasons are no longer relevant since the design principles and requirements have changed during the last 20 years. The existing variety of inspiring projects of sustainable architecture have expanded greatly. The literature review and analysis of case studies have revealed specific trends in sustainability aesthetics, as depicted in Figure 5 below.

The aesthetic expression of contemporary sustainable architecture, the role of aesthetics in sustainability certification schemes and the psychological acceptability of the sustainable architecture features have been little researched and deserve separate attention.

Recent classifications of sustainable architecture directions			
Wines (2000)	**Guy and Farmer (2001)**	**Sauerbruch and Hutton (2011)**	**Di Carlo (2016)**
eco-tech buildings	eco-technic (commercial, modern, future-oriented)	Aesthetic language of technology and progress: form follows ecological performance (architecture should develop exclusively from the consideration of ecologically functional form)	Hyper-Technologic: the additive aesthetics of high-tech (aesthetics of super-tech; often of specialized elements, components, of the hyper-trophic green in the form of roof gardens, green roofs, green facades and urban gardens
building-garden			
building-landscape	eco-centric (harmony with nature, decentralized autonomous buildings)		
organic building design (or interpretation of natural forms)	eco-aesthetics (iconic ecological aesthetics)		Baroque Supermannerism: the aesthetics of excess and redundancy (fluid tectonics, born from the masterly use of morphogenetic algorithms with pseudo-organic reference); Bio-Mimeticism: the macro scale aesthetics of artificial naturalism (has sub-groups: the first one aims to study and rehabilitate the performances and the metabolic processes of biological systems in a particular environment. The second group limits itself to simply copying natural forms in a superficial way)
use and interpretation of vernacular technologies and forms	eco-cultural (local, low-tech, vernacular)		
interpretation of historic urban forms (or building in harmony with historic urban environment)		Orientation towards aesthetics of the past (blending classic luxury (e.g. old, monumental buildings) with ecological value that looks like, function lasts long as old ones)	
	eco-medical (passive, non-toxic natural environments for health and well-being)		
	eco-social architecture (flexible, participatory, locally managed architecture)		
		Emphasis on quantifiable aspects and life-cycle of the building (a building is considered as a temporary storage of materials that will become building waste in the future, thus aesthetics is focused only on the technical and quantifiable aspects of building)	Regulatory: an-aesthetic. (The normative, transfigured into a set of numerous and often redundant prescriptive rules, is the an-aesthetic of sustainability)
			Eclectic (hybridize with each morphology)

Fig. 5 Recent classifications of directions of sustainable architecture (Source: author)

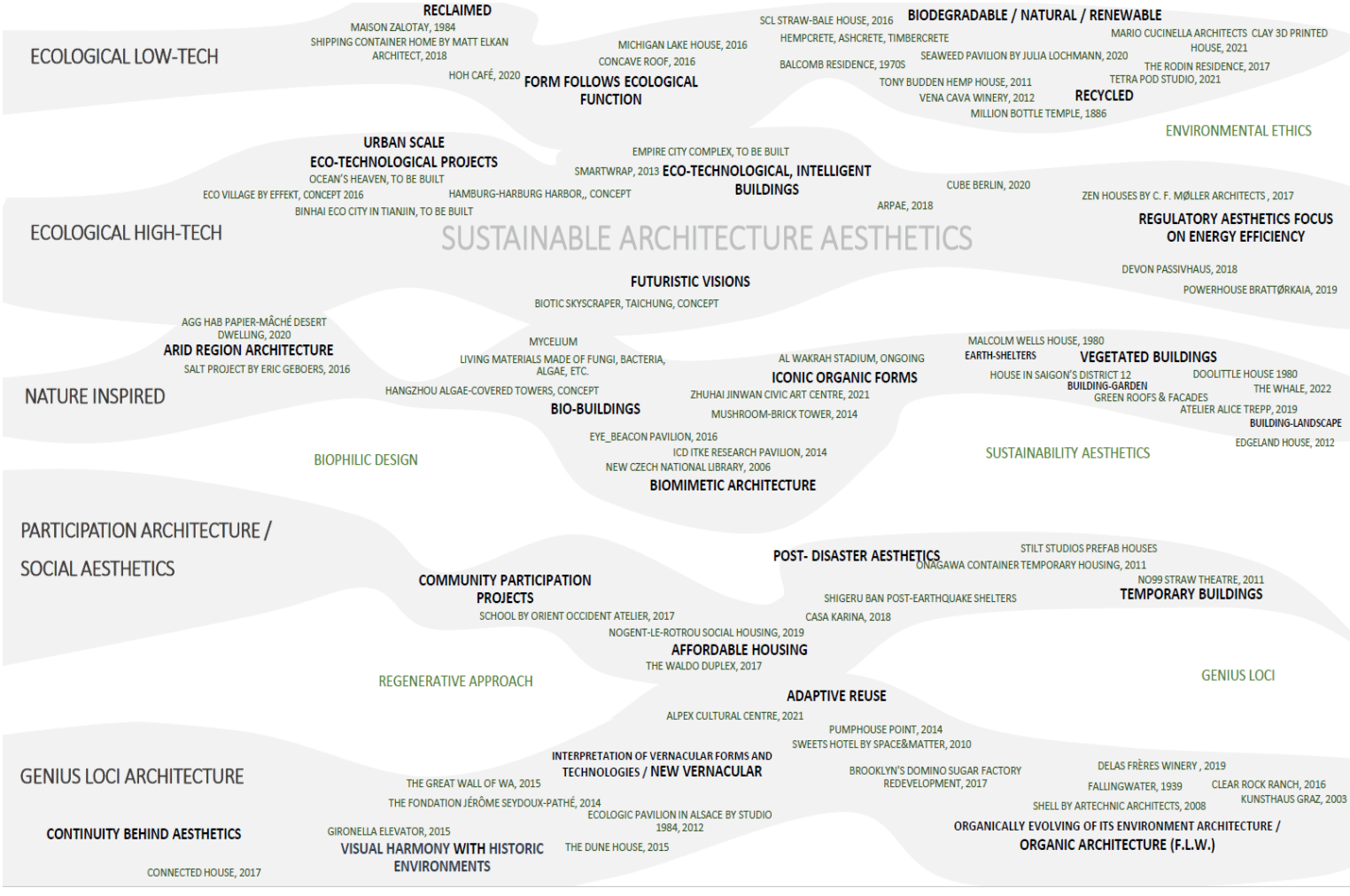

Fig. 6. The variety of sustainable architecture aesthetics (Source: author)

3. REVIEW OF SCIENTIFIC ARTICLES INCLUDED IN THE DISSERTATION

The comprehensive list of articles that are included in this dissertation is presented below:

1. Daugelaite, A., Grazuleviciute-Vileniske, I. (2022). Retrospective Analysis of Sustainable Architecture: Mind-Mapping Development of Ideas and Expression. Journal of sustainable architecture and civil engineering = Darnioji architektūra ir statyba. Kaunas : Technologija. ISSN 2029-9990. eISSN 2335-2000. Vol. 30, no. 1, p. 78-92. DOI: 10.5755/j01.sace.30.1.29829
2. Daugelaite, A., Grazuleviciute-Vileniske, I. (2021). The Relationship between Ethics and Aesthetics in Sustainable Architecture of the Baltic Sea Region. Sustainability. Basel: MDPI. ISSN 2071-1050. Vol. 13, iss. 4, art. no. 2259, p. 1-15. DOI: 10.3390/su13042259.
3. Grazuleviciute-Vileniske, I. Viliūnas, G., Daugelaite, A. (2021). The role of aesthetics in building sustainability assessment. Spatium. Belgrade: Institute of architecture and urban & spatial planning of Serbia. ISSN 1450-569X. eISSN 2217-8066. Vol. 45, p. 79-89. DOI:10.2298/SPAT2145079G.
4. Daugelaite, A., Doğan, H. A., Grazuleviciute-Vileniske, I. (2022). Characterizing sustainability aesthetics of buildings and environments: methodological frame and pilot application to the hybrid environments. Landscape architecture and art. Jelgava: Latvia university of agriculture. ISSN 2255-8632. eISSN 2255-8640. Vol. 19, no. 19, p. 61-72. DOI: 10.22616/j.landarchart.2021.19.06.
5. Grazuleviciute-Vileniske, I., Daugelaite A, Viliunas G. (2022). Classification of Biophilic Buildings as Sustainable Environments. Buildings. Basel: MDPI. ISSN 2075-5309. 2022, vol. 12, iss. 10, art. no. 1542, p. 1-15. DOI: 10.3390/buildings12101542.
6. Daugelaite, A. (2023). Psychological Acceptance of Sustainable Architecture in Lithuania: A Qualitative Study. Journal of Sustainable Architecture and Civil Engineering = Darnioji architektūra ir statyba. Vol. 32 No. 1 (2023), pages 41-57. Kaunas: Technologija.

3.1. Review of scientific article "Retrospective Analysis of Sustainable Architecture: Mind-Mapping Development of Ideas and Expression"

Scientific article "Retrospective Analysis of Sustainable Architecture: Mind-Mapping Development of Ideas and Expression" was published in the *Journal of Sustainable Architecture and Civil Engineering* in 2022. The article was written by Daugėlaitė and Gražulevičiūtė-Vileniškė and is found in volume 30, No. 1, pages 78-92. The scientific contribution of the author of this dissertation lies in carrying out a historical analysis of development of sustainable architecture and its relation to ethical ideas, writing the main body of text, including results and discussion.

The described scientific methods in the research include a literature review, critical analysis, comparative analysis, and systematization. These methods are used to examine and organize existing studies on the history of sustainable architecture and

to highlight key ideas relevant to the recent sustainable design paradigm. Additionally, the study incorporates the use of the mind mapping technique, which aids in brainstorming, deconstructing complex topics, and visually representing relationships between concepts. The application of mind mapping in this qualitative analysis of architecture development serves as an example of its potential use in scientific research. The results of this article complemented this dissertation by providing a comprehensive literature review highlighting historical perspective. This article was helpful to determine the area of the research for the dissertation.

This article presents a historical overview of sustainable architecture, highlighting the interrelation between the evolution of ethical attitudes towards the environment and development of sustainability aesthetics in architecture. The study presents the most characteristic aesthetic directions of sustainable architecture throughout its historical development. The article defines aesthetics in architecture as "a visual and sensory experience that reflects ethical attitudes and values".

The article is structured into six chapters that systematically trace the evolutionary phases of environmentally conscious architecture (*Fig. 5*):

1. Collision between industrial and natural in the 19th and early 20th centuries
2. At the edge of the Modern Movement
3. Environmental awakening in 1960s–1970s
4. The wind of change in 1980s
5. The rise of sustainable architecture in the 1990s and the emerging design complexity
6. Sustainability in architecture as a global phenomenon

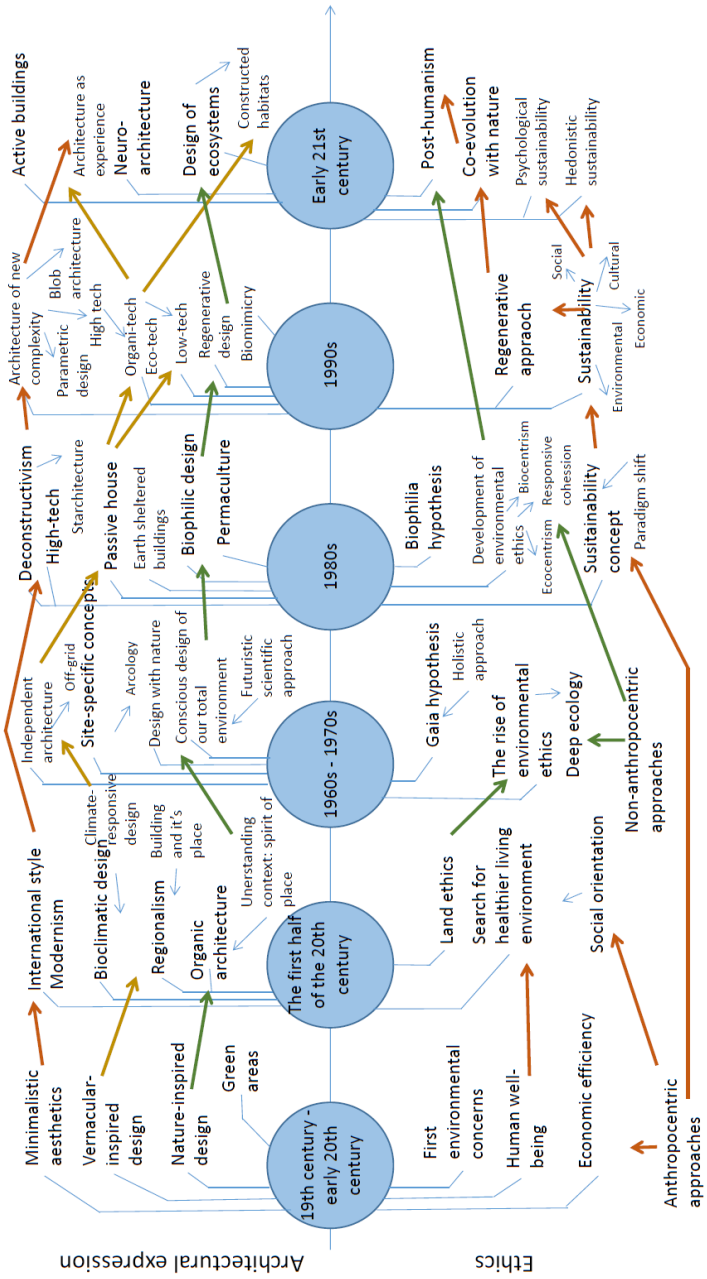

Fig. 7. The timeline of the emergence and development of sustainable architecture, showing the important currents of thought: anthropocentric (orange arrows) and non-anthropocentric (green arrows) in parallel with design (technology-inspired – orange arrows, vernacular technology-inspired – yellow arrows, nature inspired – green arrows); (Source: Daugėlaitė & Gražulevičiūtė-Vileniškė, 2022)

The traces of conscious environmentally responsive design can be traced since the 19th and early 20th centuries that marked a time of significant conflict between emerging industry and traditional ways of life that followed the natural cycles. It is worth to highlight the importance of conscious efforts to change the urban environment to the more environmentally-friendly way because vernacular architecture that existed before the end of 19th century had a wide variety of sustainability features such as the use of locally sourced materials, climate-responsive design, passive solar design, adaptability, deeply rooted in local cultural traditions that promote social sustainability by fostering a sense of community and place.

However, the 19th century brought industrialization with its negative consequences such as miserable living conditions in polluted industrial cities. As a response, environmentally conscious concepts appeared. To illustrate, the British physician Richardson's Hygeia concept proposed green areas of the city, air pollution control, and water and sewage treatment in 1876. The Garden City concept by Howard in 1898 emphasized the differences between polluted urban environments and green garden cities. Nevertheless, that time represented the dominant technocentric and anthropocentric view based on domination of human needs.

The first half of the 20th century is usually characterized by technocentric worldview and the International Style. However, considering the emergence of bioclimatic design that illustrated efforts to design climate responsive buildings, and emergence of surprisingly innovative holistic approaches reveal this period in a different perspective. "F. L. Wright's holistic approach and his concept of "sense of a place", R. Neutra's connectedness with nature – "Nature near", A. Aalto's sensitivity to building in its place. Regionalism and the precautionary principle are like echoes of the later philosopher A. Leopold's "Land Ethic" (1949), reflecting a sensual and reverent attitude towards the environment". Wright's hundred-year-old concepts are highly relevant to the most contemporary regenerative design approaches (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2022).

Repetitive environmental crisis in the 1960s–70s forced architecture and related fields to become more environmentally aware. Buckminster Fuller proposed a holistic concept of 'comprehensive anticipatory design" (1957), which emphasized the need to effectively and consciously design the environment using science and "making Earth's finite resources meet the needs of humanity without disrupting the ecological processes of the planet" (Ryker, 2007). It is possible to find close parallel to the later Brundtland report that defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 1987).

Ecological crisis led to architectural experiments "that included passive and active solar design, the use of wind and integrated energy systems, daylighting strategies" and to more radical and unexpected architectural projects such as Michael Reynold's Earthships – "the off-grid, self- sufficient structures built from recycled waste materials such as old tires, bottles, and cans" or Friedensreich Hundertwasser's "colourful, irregularly shaped, biomorphic architectural designs that very often involved features of the landscape" as a contradiction to "the rigid and calculated ideas of Bauhaus" (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2022).

The 1980s brought significant changes to architecture, including the rise of Deconstructivist Architecture, led by seven promising architects—Peter Eisenman, Frank Gehry, Zaha Hadid, Rem Koolhaas, Daniel Libeskind, Bernard Tschumi, and the firm Coop Himmelblau. These architects have since become highly influential figures in architecture from the late 20th century to today. The holistic approach is where human well-being and environmental protection are equally important.

At the same time, environmentally conscious design concepts such as permaculture, biophilic design, restorative environments, passive houses, and others have emerged. William McDonough's idea of "ecologically intelligent design" considers the complete product lifecycle, including transport, production, durability, use, and recyclability. His design principles were implemented in the first green office building in the U.S. in 1985, and later became known as the Hannover Principles (1992) and the Cradle-to-Cradle concept in 2002. Protest architecture existed such as Malcolm Wells' earth-sheltered buildings, which the architect called "a green alternative to the asphalt society". However, "environmentally conscious design was not yet prevalent in the wider architectural context" (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2022).

During the 1990s, digital technologies like CAD, CAM, and other design methods advanced, opening new architectural possibilities. The emergence of parametric architecture allowed for the creation of organic architectural forms, with Greg Lynn pioneering the use of computers to generate architectural forms, leading to experiments such as the Blob and Folding in architecture. These technological advancements in environmental sustainability and expanded aesthetic expressions have led to a more technologically oriented approach to architectural sustainability, pushing the boundaries of architectural imagination (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2022).

Further, the 1990s were marked by unusual weather conditions and environmental problems that had a direct impact on communities, thereby influencing the international political agenda. That enabled the evolution of sustainable architecture through the work of forward-thinking architects and new design concepts such as Lyle's "12 Regenerative Strategies", Benyus concept of biomimicry, Mang's "definition of the word 'regenerate'" as containing three key ideas: a radical change for the better; the creation of a new spirit; the return of energy to the source, McDonough's and Braungart's "cradle-to-cradle" design principles. The BREAM and LEED certifications brought measurable sustainability criteria to the design and construction (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2022).

The concept of sustainability in architecture has gained widespread acceptance since the turn of the millennium, with the boundaries of sustainability constantly expanding. While the late 20th century idea of sustainability focused on preserving the current situation, the 21st century sees a shift towards restoration, regeneration, and co-evolution with nature. The new sustainability paradigm emphasizes a systemic and holistic approach, rejecting the previously held human-centered approach. The emergence of the concept of psychologically sustainable architecture or "neuro-architecture" has reinforced the view of architecture as a sensory experience (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2022).

The 21st century brought a great diversity in sustainable architecture ranging from small to large-scale projects in various environments, with buildings adapting to the latest technological advances. The need for a new integrative approach to contextual design has emerged, with buildings no longer seen as individual and isolated objects but as interconnected with the surrounding ecology, taking into account regionally specific aspects and natural processes. An innovative integrative approach has emerged, where buildings are seen as inseparably connected to the local ecology. This approach considers regionally specific aspects and natural processes such as proposed by Mangone & Teuffel (2011) in *constructed habitats* (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2022).

"Although there are examples of innovative aesthetics in sustainable architecture, these buildings are exceptional and rare. Currently, most sustainable buildings that receive the highest certification rates from LEED and BREAM, often do not have exceptional aesthetic expression as sustainable buildings. The strong influence of rationality and functionality of modernism is still felt in contemporary architecture. Nevertheless, ten of the most sustainable buildings announced each year by the AIA (AIA, 2019) illustrate that the search for sustainable aesthetic expression is ongoing" (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2022).

3.2. Review of scientific article "The Relationship between Ethics and Aesthetics in Sustainable Architecture of the Baltic Sea Region"

Scientific article "The Relationship between Ethics and Aesthetics in Sustainable Architecture of the Baltic Sea Region" was published in *Sustainability* in 2021. The article was written by Daugėlaitė and Gražulevičiūtė-Vileniškė and is found in volume 13, iss. 4, art. no. 2259, pages 1-15. The scientific contribution of the author of this dissertation consists of data collection and analysis, writing the article, and text editing for the final version.

The scientific methods employed in this research included a systematic literature analysis, case studies of examples involving comparison and classification. The literature review served two main objectives: defining the concepts of sustainable architecture and clarifying the notion of sustainability aesthetics. Various literature sources were searched in scientific databases and general search engines to gather relevant information. Additionally, the research involved analyzing existing classifications of aesthetic expression in sustainable architecture, as well as messages potentially embodied in sustainable buildings. A total of 112 buildings were analyzed, and based on aesthetic similarities, forty distinctive sustainable buildings were selected for further analysis and categorized into eight different prevailing trends. The selected examples were discussed from the perspective of sustainability aesthetics, leading to the formulation of conclusions. This article complemented the literature review of this dissertation and provided a case study analysis of certified as sustainable buildings in the Baltic Sea region. This article was helpful to determine the area of the research for the dissertation and to provide the preliminary classification of sustainable architecture.

The article expands the literature analysis described in the previous one by expanding the contemporary notion of sustainability and sustainability aesthetics in architecture. It also describes recent criticism of the concept as "contemporary architecture both contributes to sustainability and expresses unsustainability" that is related to increased energy and resource overconsumption in the construction industry within the unsustainable cycle. The article reviews the EU legal framework that is currently used for the implementation of sustainable development goals, its encoded relation to ethical ideas as well as aesthetic potential. This research illustrates the existing critique of sustainability certification schemes as "not encouraging the development of some aspects of sustainability, such as architectural aesthetics". The study emphasizes the importance of peculiarities of locality in developing sustainable architecture. Therefore, the case study analysis was specifically conducted in the Baltic Sea region (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2021).

Fig. 8. The variety of sustainable architecture in the Baltic Sea region (Source: author)

The study analyzed examples of certified sustainable buildings in this region between 2016–2020, focusing on three common sustainable building certification schemes – DGNB, LEED, and BREEAM. The study selected 112, later narrowing the research to forty sustainable buildings that exhibited distinctive aesthetics (*Fig. 6*). The study found that existing aesthetic expression classifications were not meaningful for the majority of the analyzed buildings. As a result, the study introduced a

classification of aesthetic trends of certified sustainable buildings in the Baltic Sea region in this way complementing the existing classification systems by Wines (2000), Guy and Farmer (2001), Sauerbruch and Hutton (2011) and Di Carlo (2016). Eight groups of aesthetic expression based on the building's appearance, volume and form, materials, and similarity in architectural style were distinguished in this study (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2021):

1. Industrial aesthetics. It contains buildings with large and mostly monotonous volumes, detached from their contexts, constructed of artificial, synthetic materials, and having low aesthetic value;
2. Large volume minimalism. It contains buildings with large volumes, in which the aesthetic expression is focused on design of the facades;
3. Glass aesthetics. It contains buildings in which glass structures dominate. Usually, they have more vivid compositions and aesthetic solutions;
4. Modernist–functionalist aesthetics. It contains buildings with smaller volumes; their aesthetic solutions are often more dynamic and include more intense rhythms and compositions of facades;
5. Smaller scale, dynamics, and natural materials. Buildings with smaller volumes are found, and the ecological idea is expressed through the use of natural, recyclable materials;
6. Dynamic aesthetics, influenced by postmodernism. This group contains buildings with dynamic aesthetic expressions that can be stylistically associated with the trends of postmodernism;
7. Buildings with clearly expressed curvilinear forms, with characteristic facades. Some of the buildings are close to the so-called “blobism” forms;
8. Rural aesthetics. It contains buildings with small volumes, usually scaled to a single-family house.

This research identified “both the challenge of technocentrism in sustainable architecture and the lack of distinct sustainability aesthetics. At the same time, it showed the importance of the regionality of sustainability aesthetics and its existing potential even in functionalist and minimalist architectural buildings”. The study illustrated that the minimalistic trends are preferred in sustainable architecture of the Baltic Sea region. This can be partly explained by the 20th century traditions of Baltic-Nordic modernists. The region was influenced by Germany where modernism and functionalism flourished in architecture in the early 20th century and this influence is still strongly represented today. This shows that sustainability aesthetics cannot be considered as universal (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2021).

3.3. Review of scientific article “The Role of Aesthetics in Building Sustainability Assessment”

Scientific article “The Role of Aesthetics on Building Sustainability Assessment” was published in *Spatium* in 2021. The article was written by Gražulevičiūtė-Vileniškė, Viliūnas and Daugėlaitė. The article is found in volume 45, pages 79-89. The scientific contribution from the author of this dissertation consists of writing a part of literature analysis, describing architectural theories relevant to

balancing the aesthetic and environmental criteria in the assessment of sustainable architecture, text edition for the final version.

The scientific methods employed in the research include a literature review and its analysis, systematic analysis of national and international legal documents describing sustainability in architecture, also analysis of documents of building certification systems. The study complemented this dissertation by analyzing the definition of a sustainable building through the criteria of four building certification systems (LEED, BREEAM, the Living Building Challenge and WELL), as well as distinguishing four approaches that have the potential to add up to the aesthetic expression of sustainable architecture.

"The role of aesthetics in building sustainability assessment" complements the previous studies by analyzing the definition of a contemporary sustainable building through the analysis of architectural quality criteria of sustainability assessment frameworks and four commonly applied building certification systems (LEED, BREEAM, Living Building Challenge, and WELL). The study illustrated that architectural quality is generally described by "urban integrity, accessibility and mobility, respect for the environment and energy efficiency, quality of construction and well-being, innovation, aesthetic aspect and image, functionality, etc. (European Commission, 2009)" and corresponds to all four sustainability dimensions – cultural, social, economic, environmental (*Fig. 7*). However, the cultural aspects were the least refined in building certification systems (Gražulevičiūtė-Vileniškė et al., 2021).

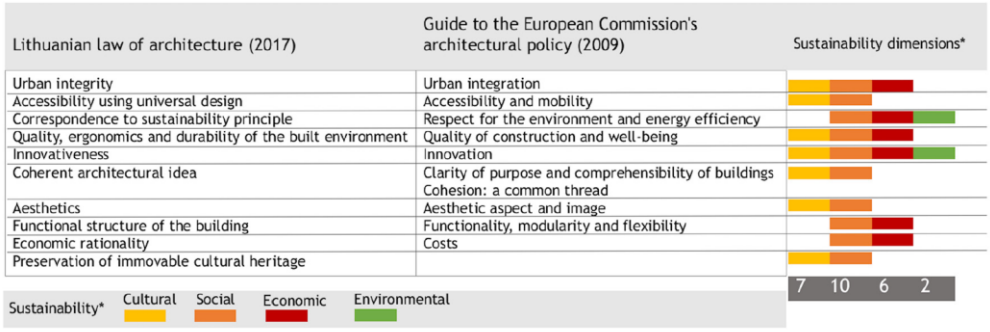

Fig. 9. Architectural quality criteria in regulatory documents (European Commission, 2009; LR Seimas, 2017) and their analysis according to sustainability dimensions (Source: Gražulevičiūtė-Vileniškė et al., 2021)

The study explains the role of aesthetics in commonly used assessment frameworks of sustainable architecture such as the general building sustainability analysis framework by Cole (1999), the HalStar sustainability assessment model (Pearce et al., 2012) and the VERSUS model (Guillaud et al., 2014). Cole's (1999) general building sustainability analysis framework quality criteria are divided into two main groups – human (integration of cultural heritage, indoor environmental quality, etc.) and environmental (use of resources, etc.). Authors demonstrated the potential of integrating aesthetics as one of the human criteria into building sustainability analysis framework created by Cole (1999). While the HalStar sustainability

assessment model includes certain culturally and aesthetically relevant factors like cultural heritage, happiness, motivation, quality, and innovation, the VERSUS model is primarily rooted in identifying strategies and principles from vernacular heritage to shape a sustainable architectural design framework (Guillaud et al., 2014) and has strongly expressed the attention to the cultural dimension by highlighting the importance to preserve cultural heritage including intangible factors as collective memory, cultural identity, sacredness, history, and mythology. The analysis demonstrated that the analyzed sustainability assessment frameworks have some potential of including cultural aspects and aesthetics (Gražulevičiūtė-Vileniškė et al., 2021).

Analysis of quality criteria of LEED, BREEAM, the Living Building Challenge and WELL certification systems illustrated the lack of attention to the cultural dimension that may promote the development of sustainability aesthetics. Nevertheless, LEED and BREEAM have indirect potential to influence architectural aesthetics. Examples of this include how the LEED rainwater management requirement may foster the development of rain gardens or permeable surfaces with specific ecological aesthetics, and how BREEAM's emphasis on climate change adaptation and site ecology enhancement could involve the introduction of vertical greenery with distinctive aesthetic effects, among other possibilities. LEED and BREEAM are "not targeted at the cultural dimension of sustainability, and sustainability aesthetics are not directly encouraged by it". This research graphically illustrated the same problem that was previously noted by Heymann (2012).

The WELL Building Standard prioritizes the well-being of occupants and includes sub-criteria that could enhance the aesthetic expression of buildings through social, environmental, and economic dimensions, but it lacks consideration for the cultural dimension of sustainability, despite some sub-criteria being associated with the biophilic design concept. "It is peculiar that the WELL system, being clearly human-centred, does not include cultural and aesthetic aspects". The criteria reflecting biophilic design have the potential to develop into a synergistic approach that addresses ecology, personal well-being, aesthetics, and connections to place (Gražulevičiūtė-Vileniškė et al., 2021).

The Living Building Challenge 4.0 Standard for new construction (Living Building Challenge, 2020) is the most successful in achieving a balance between sustainability dimensions, reflecting the cultural dimension through "criteria like place and beauty and the sub-criteria human scaled living, beauty & biophilia, and education & inspiration". This certification system can "have a direct impact on the aesthetic expression of design: access to nature, responsible materials etc." (Gražulevičiūtė-Vileniškė et al., 2021).

This study proposes four distinctive theories that can enhance the aesthetic value and individuality of sustainable architecture: sustainability aesthetics, genius loci or spirit of place, biophilic design, and a regenerative approach. These theories can potentially be included in evaluation criteria for sustainable building designs (Gražulevičiūtė-Vileniškė et al., 2021).

3.4. Review of scientific article "Characterizing Sustainability Aesthetics of Buildings and Environments: Methodological Frame and Pilot Application to the Hybrid Environments"

Scientific article "Characterizing Sustainability Aesthetics of Buildings and Environments: Methodological Frame and Pilot Application to the Hybrid Environments" was published in *Landscape Architecture and Art* in 2021. The article was written by Daugėlaitė, Dogan and Gražulevičiūtė-Vileniškė. The article is found in volume No. 19, pages 61-72. Scientific contribution the author of this dissertation consists of writing a part of literature analysis, describing architectural theories and distinguishing the set of features of sustainable buildings.

This study supplements the dissertation by analyzing "possibilities to characterise sustainability aesthetics of buildings and built environments and to develop and test the methodological frame for this characterization". Considering possible development of restorative or regenerative sustainability, synergistic approaches that consider all dimensions of sustainability (social, cultural, economic, and environmental) are needed.

The scientific methods employed in this research consist of qualitative descriptive study, including literature analysis, concept mapping (mind mapping), comparison and systematization. Other methods used were on-site observation, photographic survey, map analysis, graphical analysis, and descriptive analysis. Using the mind mapping technique for research development and visualization was useful for brainstorming, deconstructing complex topics, and determining links between concepts. This study complements this dissertation by distinguishing a set of aesthetic criteria of sustainable architecture and forming a methodology (questionnaire) for evaluating it.

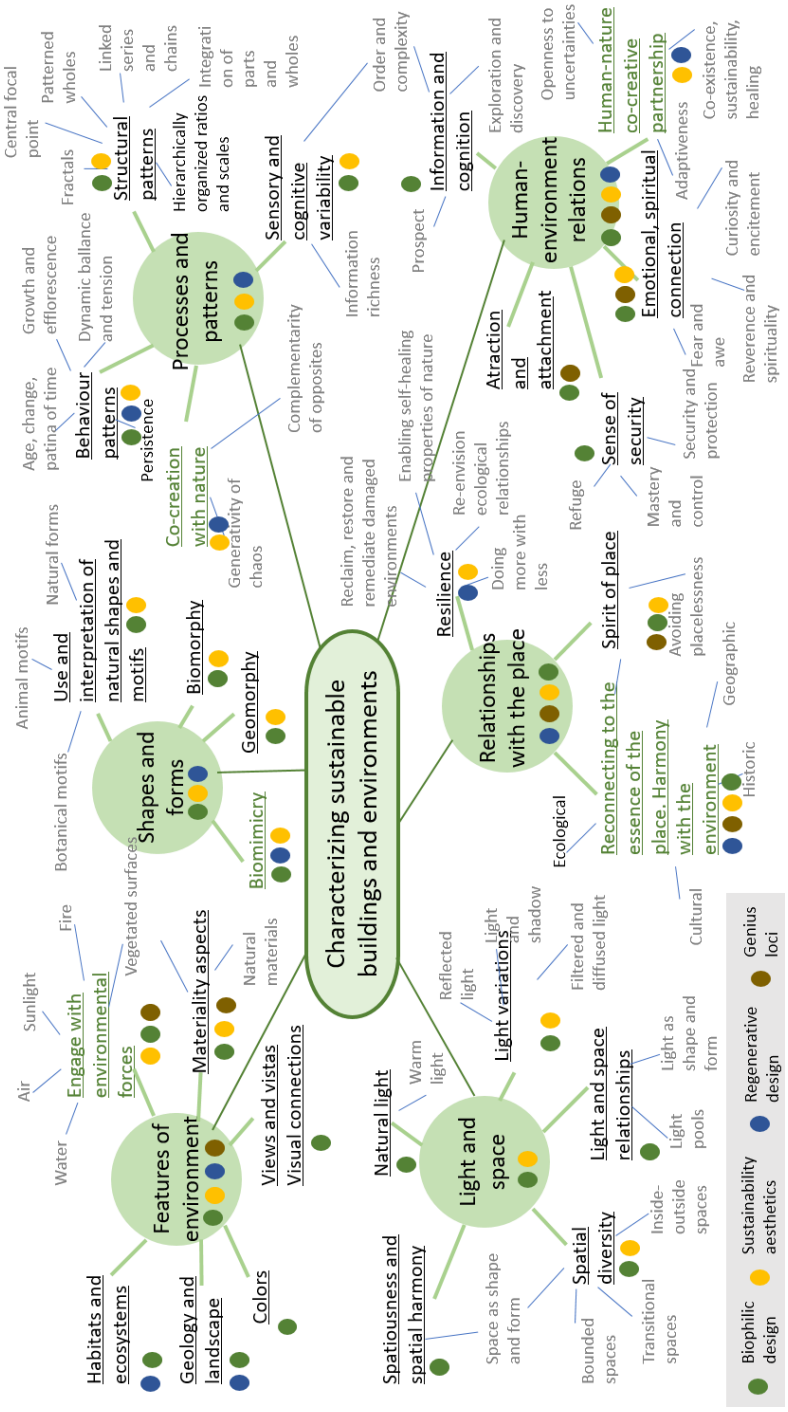

Fig. 10. Concept map demonstrating the interrelations between the existing approaches and the selected criteria for characterizing sustainable buildings and environments (Source: Daugėlaitė et al., 2021)

The study illustrates the emerging importance of the psychological impact of the built environment and the notion of "psychologically sustainable architecture". This encouraged to "distinguish other sensory aesthetic features that have also been described in biophilic design patterns, the genius loci concept, and sustainability aesthetics. Many of these features are intangible, e.g., time and change, interaction of light and shadow, and often involve psychological aspects such as feelings of safety and protection, risk-peril or curiosity". Thus, it is possible to extend the limits of aesthetic perception to more advanced understanding including phenomenological, process, ecological or evolutionary perception as described by DeKay (2012).

The developed criteria for characterizing sustainable buildings and environments are presented in the concept map (*Fig. 8*) and a table with a series of questions for the assessment of aesthetic expression of sustainable buildings and environments (*Table 1*). The most important aesthetic features were distinguished in relation to four theories (biophilic design, sustainability aesthetics, regenerative design, and genius loci) and grouped into the complex system. Six groups of sustainable building qualities were developed: (1) Features of environment, (2) Shapes and forms, (3) Light and space, (4) Relationships with the place, (5) Processes and patterns, (6) Human environment relation – adapted from Kellert et al (2013).

The involved criteria correspond to the main three aspects of aesthetic perception indicated by Coburn et al. (2020): Behavioural-motivational responses (interest, approachability, explorability), Cognitive judgements (complexity, organization, modernity, naturalness, and beauty) and Emotional responses (personalness, hominess, relaxation, comfort, stimulation, uplift, vitality, and valence). As Coburn et al. (2020) indicated, "the most salient psychological experiences in the built environment are likely generated by the integration of cognitive, emotional, and sensory information". The developed analysis tool of sustainability aesthetics could be valuable in developing guidelines for expanding the notion of "aesthetics" as quality criteria of sustainable architecture.

3.5. Review of scientific article "Classification of Biophilic Buildings as Sustainable Environments"

Scientific article "Classification of Biophilic Buildings as Sustainable Environments" was published in *Buildings* in 2022. The article was written by Gražulevičiūtė-Vileniškė, Daugėlaitė and Viliūnas and is found in volume 12, iss. 10, art. no. 1542, pages 1-15. The scientific contribution of the author of this dissertation consists of conceptualization, methodology, resources, writing—original draft preparation, writing— review and editing, visualization.

The scientific methods employed in the research encompass an analysis of literature and architectural design examples (case study on site), a comparison and systematization, as well as an evaluation of architectural objects based on the concept of biophilia. This study complements this dissertation by further elaboration of methodology (questionnaire) prepared in "Characterizing sustainability aesthetics of buildings and environments: methodological frame and pilot application to the hybrid environments" (Daugėlaitė et al., 2021) defining aesthetic criteria. This study tested

the prepared methodology by describing existing architectural objects based on biophilic design.

The biophilia hypothesis suggests that our inherent need to connect with nature is rooted in our history of living in natural surroundings and experiencing its biodiversity. Therefore, connection with nature is still crucial for our physical and psychological health. Despite the proven benefits of nature on human health, our current living environments are becoming increasingly disconnected from nature, which some researchers refer to as “anti-biophilic.” In response, the field of biophilic design has emerged, which seeks to restore human-nature connections and provide the potential benefits of biophilic environments through a positive focus on enhancing nature's ability to improve the quality of human experience and well-being (Gražulevičiūtė-Vileniškė et al., 2022).

Nevertheless, to ensure a comprehensive application of the biophilia concept, it is crucial to avoid oversimplification and reductionism, particularly by limiting it to the mere inclusion of natural elements or representations of nature in architectural objects or urban environments (*Fig. 9*). Although the biophilia concept is already based on sufficient scientific evidence, additional research is necessary to fully understand the methods by which biophilic characteristics can be integrated into architectural structures. The biophilia concept has been identified as one of the most powerful concepts that can enhance the aesthetic qualities of sustainable architecture (Living Building Challenge, 2020; Gražulevičiūtė-Vileniškė et al., 2021; Daugėlaitė et al., 2022). Possibilities of its applications are further developed in this scientific article.

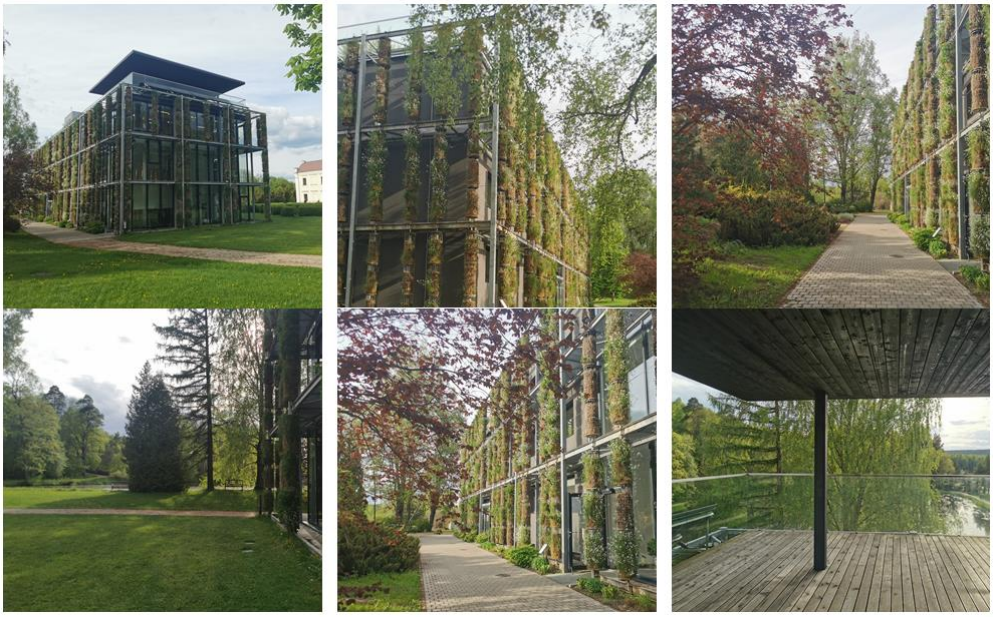

Fig. 11. Vilnius University Kairėnai Botanical Garden’s Green Building-Plant – an example of biophilic architecture in Lithuania (Source: Gražulevičiūtė-Vileniškė et al., 2022)

The study detailed in this article focuses on developing a classification system that connects biophilic qualities with architectural expression and evaluates them based on specific criteria. A set of criteria was adapted from (Daugėlaitė et al., 2022) and further developed in this study by testing the possibilities to evaluate architectural objects. The present study developed a classification system for biophilic architecture, based on Tikkanen's (2021) three types of architecture: mimetic, applied, and organic. The classification system was modified and adapted to classify biophilic buildings according to their architectural expression and biophilic properties. This study provides a useful framework for evaluating aesthetic-sensual features in architectural settings (Gražulevičiūtė-Vileniškė et al., 2022).

The assessment of three building examples in Lithuania using a set of established criteria demonstrated that biophilic trends possess a great potential for developing sustainable environments, including renovation or adaptive-reuse of existing buildings. These findings suggest that architects and designers should consider adopting these qualities to design environments and improve the quality of life for building occupants (Gražulevičiūtė-Vileniškė et al., 2022).

This study suggests a set of aesthetic-sensorial criteria for designing or evaluating a sustainable building. The set consists of "31 questions subdivided into 7 categories—features of environment, materials, visual interest, shapes and forms, light and space, processes/patterns, and human–environment relations—were answered evaluating the answer in the scale from 0 to 2, evaluation 0 meaning that qualities are not present and 2 meaning qualities are clearly expressed." Although, this method is orientated towards qualitative analysis rather than quantitative judgment. It is a form of recommendation or inspiration that allows to enrich the project with missing properties. In this study, field case studies were done as a test of this set of criteria. The analyzed biophilic buildings included many of the listed properties illustrating that a set of criteria could be used in the design practice.

3.6. Review of scientific article "Psychological Acceptance of Sustainable Architecture in Lithuania: a Qualitative Study"

Scientific article "Psychological Acceptance of Sustainable Architecture in Lithuania: a Qualitative Study" was published in the *Journal of Sustainable Architecture and Civil Engineering* in 2023. The article was written by Daugėlaitė and is found in Vol. 32 No. 1 (2023), pages 41-57. This study is an extension of the scientific article "Social – psychological responses to trends of sustainable architecture" (2022) published by 3rd Valencia International Biennial of Research in Architecture. The article was written by Daugėlaitė (Annex 1).

The study presented in both articles aims to investigate how the aesthetics of sustainable architecture (*Fig.10*) is perceived and accepted by both professionals in the field of architecture and the general public. *Fig.10* represents the selected trends for further evaluation. The selected set of architectural directions was prepared to represent diverse variety and different aspects of architectural directions of sustainable architecture. The set included trends that are the most expressive and controversial that could generate discussions within the field. The greater variety of sustainable architecture directions is presented in *Fig. 4.*

The study conducted an online sociological survey to gather data on respondents' preferences towards sustainability in architecture, their opinion towards sustainable architecture trends, and their features.

The scientific methods used in the study involved the preparation and implementation of an online sociological survey conducted by the author. The results of the survey were analyzed in two scientific articles: "Social-Psychological Responses to Trends of Sustainable Architecture" conducted a quantitative analysis of responses to architectural trends by using the NLTK Vader tool and qualitative analysis based on Plutchik's (2001) Wheel of emotions; "Psychological Acceptance of Sustainable Architecture in Lithuania: A Qualitative Study" used statistical calculation tools and compared the opinion between architecture professionals and general public. This study contributed to the dissertation by assessing the aesthetic characteristics of sustainable architecture that were identified in previous articles:

"The Role of Aesthetics in Building Sustainability Assessment" (Gražulevičiūtė-Vileniškė et al., 2021), "Characterizing Sustainability Aesthetics of Buildings and Environments: Methodological Frame and Pilot Application to the Hybrid Environments" (Daugėlaitė et al., 2021), "Classification of Biophilic Buildings as Sustainable Environments" (Daugėlaitė et al., 2022).

Emotional analysis (Daugėlaitė, 2022) showed that the most acceptable and environmentally friendly looking trends were low-tech ecological, vegetated, building landscape, and biophilic buildings (*Fig. 11*). The least acceptable trends were trashy anti-consumerist, dictated by re-used and eco-technological architectural directions.

The majority of respondents in a survey (Daugėlaitė, 2023) supported sustainability in architecture and preferred environmentally friendly solutions based on the newest technologies. However, conventional materials such as bricks, blocks, wood, and stone wool were more commonly chosen over alternative eco-friendly options such as straw, clay, or reused materials.

Vegetated, low-tech ecological, and biophilic designs were the three most well-received trends in sustainable architecture. Respondents appreciated the use of environmentally friendly solutions such as protecting trees and landscapes, saving resources, reducing carbon footprint, using sustainable engineering solutions, and using patterns.

Respondents in a survey agreed that a building's aesthetic quality is enhanced when it is harmonized with the surrounding environment and provides views of distant perspectives. Buildings that adapt to their environment through the use of materials and colors were preferred over contrasting ones. The use of local and natural materials was also highly preferred, and wood and plants were the most popular building materials.

Respondents preferred buildings that adapt to the landscape by their form over those that dominate the landscape by their volume. Creating a variety of spaces within a building was also preferred over monotonous spaces. Natural forms and motifs were favored over strict geometric shapes.

Natural lighting was essential to respondents, while artificial lighting dominating the building was disliked. Spaces with a variety of light, such as

bright-dusk, play of light and shadows, and reflections, were preferred over monotonous ones. Maximizing daylight not only saves electricity but also contributes to the psychological well-being of building users.

The study suggests that aesthetics is a key factor in creating sustainable and psychologically acceptable architecture. Psychological sustainability of architecture may be related to several factors, including the use of natural and local materials, building's integration into the environment, connection with the place, locality, and harmony.

To summarize, these studies suggest that environmental sustainability and eco-friendly architectural solutions are becoming increasingly important to urban residents, particularly those who are highly educated and early middle-aged. Education about the relationship between sustainability and heritage preservation is crucial, as respondents did not associate these two concepts. Additionally, sustainability aesthetics ideas should be integrated into the initial stages of architectural design, and further research on architectural aesthetics and social-psychological acceptability could lead to a more precise definition of aesthetic quality criteria.

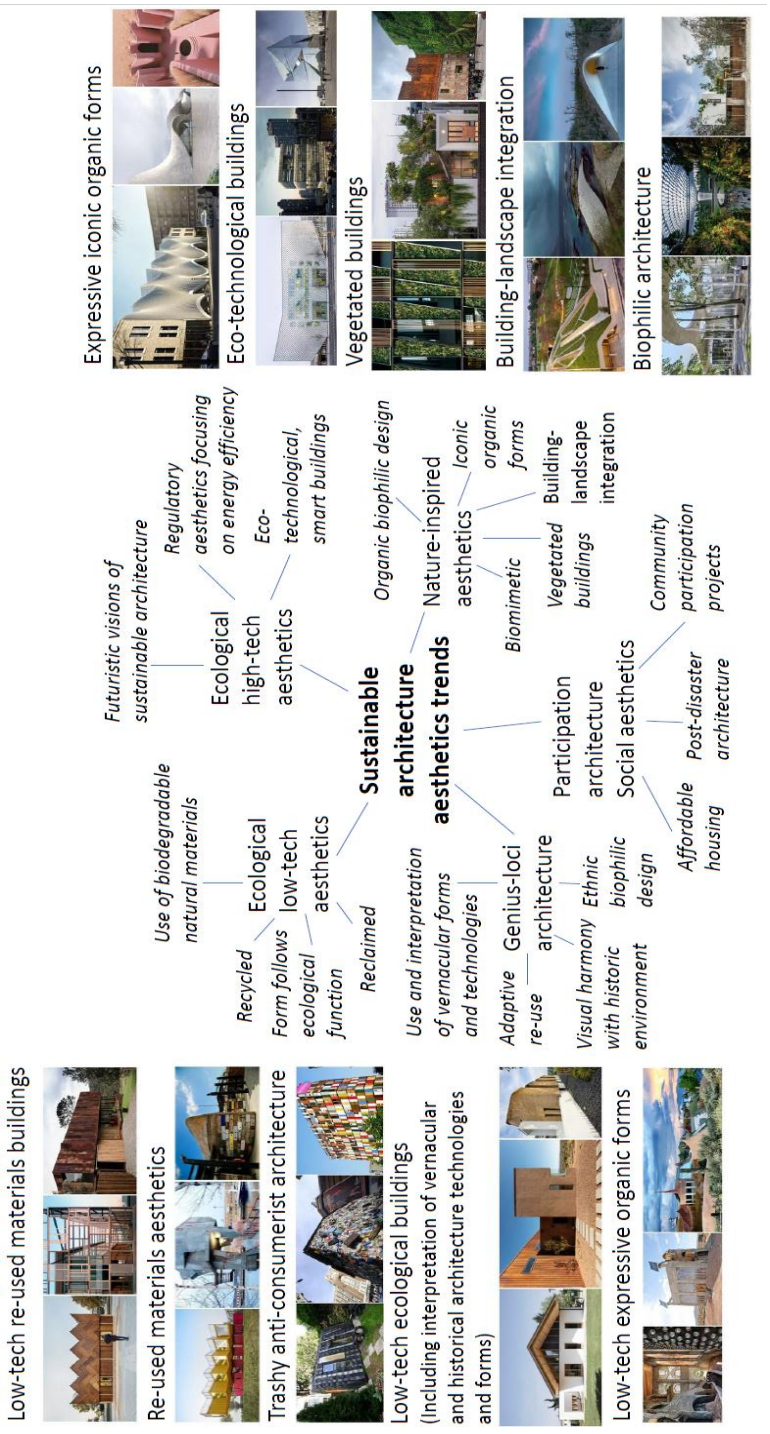

Fig. 12. Mind map of 10 contemporary trends of sustainable architecture selected for further evaluation of social-psychological acceptability (Source: Daugėlaitė, 2022)

Fig. 13. Summary of the emotional evaluation of sustainable architecture trends (Source: Daugėlaitė, 2022)

4. EXAMINING AESTHETIC MEASUREMENT METHODS WITHIN A PROPOSED CONCEPTUAL METHODOLOGICAL FRAMEWORK

In this dissertation, the proposed questionnaire by Daugėlaitė et al. (2021) and its subsequent addition by Gražulevičiūtė-Vileniškė et al. (2022), which aim to evaluate the aesthetics of sustainable architecture, have been enhanced by the introduction of measurable methods to increase objectivity. The basis of a conceptual framework rooted in four key concepts: biophilic design, sustainability aesthetics, regenerative design, and genius loci. These conceptual ideas were organized and structured into a systematic framework and made more tangible by providing specific methods to measure them. This conceptual methodological framework was developed to suggest the way of describing and assessing the aesthetics of sustainable buildings, emphasizing that aesthetics encompass more than just visual perception, it takes into account emotional responses as an important experience in the built environment. Moreover, the series of questions could be helpful in the initial stages of designing architectural objects.

Several influential authors have analyzed people's emotional responses to the architectural appearance of buildings and urban structures. For example, Cullen (1961) in "Concise Townscape" argued that townscape, as a visual art encompassing the arrangement of buildings, roads, nature, and the urban environment, is significantly important in shaping the physical and emotional experience of a city, serving as a fundamental concept for architects, planners, and those concerned with the city's appearance and quality. Thwaites & Simkins (2006) propose a methodology for understanding and valuing people's everyday experiences in their environments, drawing parallels with Cullen's concepts of environmental experiences during travel and having similarities with Lynch's (1960) elements of the urban structure.

Salingaros (2006) suggests parameters for the architectural evaluation of the aesthetic appearance of architectural objects, which include structural order, scale, natural scaling hierarchy, ornament, hierarchical cooperation, the concept of metaphor symbolism, organization, form, and pattern language. Dutta and Adane (2015) analyzed the possible applicability of Salingaros' (2006) parameters, illustrated by existing temples in India. It provides descriptive results. However, Quillien (2006) critiques Salingaros' "Theory of Architecture" (2006) illustrating its limitations as "teaching little about this emotional, possessive, and inspiring reaction to great architecture, or about natural beauty."

Nevertheless, other recent works of Salingaros Biophilia and Healing Environments (2015) and Design Patterns and Living Architecture (2017), derived from Alexander (1977) and revised in 2000 (Salingaros, 2000), scientifically ground emotional and psychological well-being of people in the relation with their connection with living structures and natural patterns found in the built environment. However, it is conceptual theory, which does not provide methods of measurement, although gives valuable insights.

Ode, Tveit & Fry (2008) analyzed landscape aesthetic theories and proposed their grounding by introducing measurable methods. It includes categories of indicators describing landscape features such as complexity, coherence, disturbance,

stewardship, imageability, visual scale, naturalness, historicity, and ephemera. An adaptive approach could be used for building evaluation. Following their approach, specific measurable methods are proposed to ground the methodological framework for describing and evaluating the aesthetics of sustainable buildings.

One of such – videoecology, as defined by Filin in 1989, presents research results that emphasize the negative impact of homogeneous visual environments lacking distinctive features and diversity on human visual perception and psychological well-being. In homogeneous environments, the eye lacks "something to catch" during saccadic movements, leading to an increase in saccade amplitude and, consequently, inefficient eye function. This inefficiency can result in psychological discomfort for individuals. Filin argues that even newborn children show a preference for visual diversity over homogeneous fields, indicating a biological inclination toward varied and engaging visual environments. Videoecology science emphasizes that architectural designs with many identical elements, especially in functional-style buildings, do not fully meet human physiological needs for the visual perception. Such designs can even have adverse effects, potentially "leading to the death of brain cells" (Filin, 1989; Wilkins, 1995). Use of variability principles including different scales in the building's facade enables it to "humanize" visual appearance of the built environment. Although videoecology does not provide an initial measurable index, results can be obtained by performing eye movement testing and could be helpful in analyzing visual complexity and richness of the built structure.

Turner's (1998) SID (Identity index context) theory provides a quantitative measure used to determine the extent to which an architectural object is identical to, similar to, or different from its surrounding context. By applying this Index, one can systematically quantify the level of contextuality, determining whether a structure strongly contrasts (10–20%), is similar to its context (40–60%), or closely similar or identical (close to 100%) to its surroundings (Turner, 1998). Kamičaitytė and Gražulevičiūtė-Vileniškė (2011) suggest expanding Turner's method by additionally evaluating individual properties of the object, such as scale, materials, architectural style or direction, and colors, and then calculating the average of these values to derive an overall contextuality score. This method is valuable to examine the level of contrast of the building, evaluating its integration into the landscape.

Salingaros (2005) proposed a mathematical methodology for assessing the aesthetic, informative, and emotional appeal of architectural compositions, offering a systematic way to evaluate them based on complexity, diversity, harmony, and symmetry in order to create visually appealing and emotionally engaging structures. Karvelytė-Balbierienė (2010) provides an illustrative example of the adaptation of Salingaros' (2005) method to assessing aesthetic potential urban structures, showcasing its significant potential for application in architectural objects. The study suggests several values in evaluated in numbers, such as "T demonstrates the degree of complexity, diversity, information of composition"; "H (harmony) demonstrates correlation of the objects in the composition and degree of the symmetry in the model", "S –expression of the disorder in the structure", C – complexity, L – attractiveness. Salingaros' method provides a measurable outcome; therefore, it is valuable in analyzing visual properties of architectural objects.

Fractal theory, formulated by Mandelbrot (1975), addressed the irregularity and complexity of natural forms, such as clouds, coastlines, etc. with a focus on self-similarity as a core concept. Fractal theory was adapted in architecture by Bovill (1996) and in the following decade fractal theory gained broader usage in analyzing the built environment (Bechhoefer & Appleby, 1997; Makhzoumi &Pungetti, 1999; Burkle-Elizondo et al, 2004; Ostwald, 2014; Lee & Ostwald, 2021). Fractal theory is applied to various aspects of architectural design and urban planning, including understanding the visual qualities of urban spaces, comparing urban skylines, and assessing the geometric complexity of street vistas and historic street plans, architectural elevations, and plans. The importance of the existence of fractals was grounded by Filin (1989), Kellert (2013), Salingaros (2015, 2017), and others. The application of the theory provides measurable results and is suggested to use in analyzing complexity and richness of the architectural object.

Analysis of visual impact and its management is proposed by several guides by BLM (n.d.). BLM (2015) provides recommendations of visually harmonizing landscapes by the use of color and camouflage techniques for built objects in sensitive landscapes to protect visual integrity. BLM provides (BLM manual 8431, n.d.) visual resource contrast rating method. It is an easily adaptable but valuable method and could be measured by, for example, Turner's (1998) SID (Identity index context) theory.

The beauty of night as a part of a built environment and its pollution by artificial lighting is not often considered in sustainable design concepts. Artificial light at night can disrupt natural night sky conditions and may be harmful for certain ecological processes and cultural, historic, scientific, and recreational aspects, which rely on darkness and dark night skies. Sullivan et al. (2023) suggest management techniques of night sky and dark environments that could have additional value of revealing views to elements of nature and strengthening connection with nature.

Space syntax, as formulated by Hillier and colleagues (Hiller et al, 1976; Hillier and Hanson, 1989), is a collection of theories and methods used to study how spatial layouts and human behavior mutually influence each other. It has evolved to predict the impact of architectural and urban spaces on their users based on measurable correlations. Most frequently used for urban analysis such as urban structures (van Nes & Yamu, 2021), however having possibilities to be used in designing buildings. To illustrate, Zaleckis et al. (2022) adapted a space syntax method to evaluate the acceptance of changes in historical buildings' facades, Tarabieh et al. (2019) applied space syntax for analyzing daylight of a typical mosque. While space syntax has broader applications than what could be described in this study, it could, for example, be used for evaluating visual aspects such as spatial hierarchy, fractality, and symmetry within a building.

Among the suggested categories within the conceptual framework, the integration of buildings into the landscape is the most extensively studied, with comprehensive coverage. This field encompasses all the described methods and could include classical landscape assessment approaches such as provided by Bučas (1980, 1989), Purvinas (1983), Budriūnas & Ėringis (2000), and others. However, it is suggested to employ combined landscape quality research methods to effectively

evaluate the visual characteristics of the landscape, as indicated by Kamičaitytė-Virbašienė (2003), which might be potentially adapted to assess architectural objects.

The approach, suggested by Kamičaitytė-Virbašienė (2003), combines the general impression method, where specialists offer their opinions on the visual quality of the landscape, together with structural (computational) analysis. The general impression method relies on subjective assessments of the exprets, while the structural analysis incorporates objective calculative indicators (set of criteria) that are evaluated according to the subjective opinion of experts. The basis of the evaluation consists of the points awarded by subjective experts, based on objective indicators and subjective emotional impressions, as illustrated by, for example, Budriūnas & Ėringis (2000) method.

Kamičaitytė-Virbašienė (2003) emphasizes the need to consider the significance of criteria and suggests integrating coefficients for criteria importance, along with correlations between evaluations and different landscape visual qualities, to determine an overall assessment of the territory. In this way, the points assigned according to the established criteria can be summed up to obtain a general assessment of the territory only after determining the integrated coefficients of the importance of the criteria (in the assessment of experts and non-specialists) and the correlations of the assessments with the landscape of different visual quality. In addition, the relative importance of landscape visual quality criteria for each visual landscape type can be determined as society's priority values. This comprehensive method harmonizes both holistic and structural approaches and facilitates the determination of the relative importance of visual quality criteria for various landscape types, reflecting society's priority values. Kamičaitytė-Virbašienė's (2003) evaluation method is recommended to be adapted as an expert evaluation within the proposed methodological framework for landscape-related questions, while relatively simpler questions can be adequately addressed using the general impression method.

Moreover, an innovative interdisciplinary landscape research approach of evaluating landscape perception offered by Kamičaitytė-Virbašienė et al. (2020), highlights the importance of considering knowledge from sociology, cultural studies, environmental psychology, and geography to provide a holistic understanding of landscape perception. It balances objective and subjective factors, considers cultural influences, and uses a diverse range of research methods to enhance the accuracy and depth of landscape assessments. This approach could be considered in evaluating architectural objects as well.

Although the described authors introduce valuable concepts and methodologies, their approaches have certain limitations when evaluating sustainable architecture. Predominant approaches and methods used are based on visual perception. However, as Coburn at al.'s (2020) study showed, "the most salient psychological experiences in the built environment are likely generated by the integration of cognitive, emotional, and sensory information." Coburn's study highlights the importance of non-visual experiences such as interest, approachability, etc.

Therefore, the suggested concept of methodological framework in this dissertation proposes the inclusion of categories beyond the visual, one of which is the stimulation of exploration and cognition adapted from Kellert (2013).

Furthermore, a common observation among the analyzed theories is their lack of a holistic approach, particularly in their insufficient consideration of the broader living world, including other species or ecosystems. For example, addressing the restoration of damaged environments, which extends beyond human-centric sustainability, is essential. Therefore, the conceptual methodological framework includes evaluation questions such as including "ecosystems and habitats in a meaningful and visible way", highlighting the challenges in objectively measuring this aspect, thereby recommending expert evaluation with percentage values such as:

- Excellent (close to 100%): Represents the highest level of compliance.
- Moderate (40–60%): Signifies a middle or average level of compliance.
- Limited (10–20%): Indicates a minimal or barely satisfactory level of compliance.
- None (less than 10%): Does not have the described properties.

In summary, the suggested conceptual framework, while having its limitations, supports the idea for continuing this research and exploring new ways to evaluate aesthetics in sustainable architecture. It highlights that aesthetics involve more than just visual categories, but also sensual, spiritual, socio-cultural, and subjective aspects suggesting promising directions for future studies and discussions.

Table 1. Assessment criteria of sustainable architecture and their relation to distinguished sustainable architecture trends (adapted from Gražulevičiūtė-Vileniškė et al., 2022; Zafarmand et al., 2003; Kagan, 2011; du Plessis, 2012; Berardi, 2013; Kellert et al., 2013; Browning et al., 2014; Istiadji et al., 2018; Vecco, 2020; Daugėlaitė et al., 2022). Meanings by color: Aesthetic trend **fully implements** / **partially implements** / **has the potential to implement** the defined criteria

	Criteria of architectural expression	**Architectural means / explanation / hint**	**Criteria inherent in the following sustainable architecture trends**									**Special research methods for evaluation**
			Low-tech re-used materials	Re-used materials aesthetics	Trashy anti-consumerist	Low-tech ecological	Low-tech expressive organic forms	Expressive iconic organic forms	Eco-technological buildings	Vegetated buildings	Building-landscape integration	Biophilic architecture	
FEATURES OF ENVIRONMENT	Does the object adapt to local terrain and landscape conditions?	Prioritize real nature over simulated nature										Expert evaluation (Excellent, moderate, limited, none); visual landscape assessment by Salingaros (2005) adapted by Karvelytė-Balbieri enė (2010); Camougflage technique by BLM (2015)
	Does the object express the engagement with environmental forces (water, air, sunlight...) in meaningful and visible way?	Sun, shade, reflections; Integration of waterbodies; rainwater management; Possibilities to feel airflow, etc.										Expert evaluation (Excellent, moderate, limited, none)
	Does the object integrates ecosystems and habitats in meaningful and visible way?	Flora: ecological systems, visual continuity, trees, shrubs, ground covers, habitats, rare plant species, nectar rich vegetation, flowering wild local herbs etc.; Fauna: birds, insects, land animals and reptiles, fish, endangered species, etc. Bird box, bat box, biotope for specified insects										Expert evaluation (Excellent, moderate, limited, none)

	Criteria of architectural expression	Architectural means / explanation / hint	Criteria inherent in the following sustainable architecture trends										Special research methods for evaluation
			Low-tech re-used materials	Re-used materials aesthetics	Trashy anti-consumerist	Low-tech ecological	Low-tech expressive organic forms	Expressive iconic organic forms	Eco-technological buildings	Vegetated buildings	Building-landscape integration	Biophilic architecture	
FEATURES OF ENVIRONMENT	Does the object provide opportunities to seeing, hearing or touching of water?	Naturally Occurring: River, stream, ocean, pond, wetland; Visual access to rainfall and flows; Seasonal arroyos Simulated or Constructed: Water wall; Constructed water fall; Aquarium; Fountain; Constructed stream; Reflections of water (real or simulated) on another surface; Imagery with water in the composition											Expert evaluation (Excellent, moderate, limited, none)
MATERIALS	Does the object integrate natural (and local) materials?	Does the objectintegrate natural (and local) materials?											Expert evaluation (Excellent, moderate, limited, none)
VISUAL INTEREST	Are there visual connections between the object and its environment present?	A view to elements of nature, living systems and natural processes; prospect an unimpeded view over a distance for surveillance and planning; quality views from the outside and inside											Expert evaluation (Excellent, moderate, limited, none)
	Does the object contribute to scenic quality or landscape character?	Architectural object interacts with landscape and forms qualitative wholeness											Expert evaluation (Excellent, moderate, limited, none); Visual landscape assessment Salingaros (2005) adapted by Karvelytė-Balbieri enė (2010); Camougflage technique by BLM (2015); Visual landscape assessment by Kamičaitytė-Virbašienė (2003); Visual landscape assessment - interdisciplinary approach by Kamičaitytė-Virbašienė et al (2020)

	Criteria of architectural expression	Architectural means / explanation / hint	Criteria inherent in the following sustainable architecture trends										Special research methods for evaluation
			Low-tech re-used materials	Re-used materials aesthetics	Trashy anti-consumerist	Low-tech ecological	Low-tech expressive organic forms	Expressive iconic organic forms	Eco-technological buildings	Vegetated buildings	Building-landscape integration	Biophilic architecture	
VISUAL INTEREST	Does the object provide views to elements of nature, living systems and other living things at all?	Naturally Occurring: Natural flow of a body of water; Vegetation, including food bearing plants; Animals; insects; Fossils; Terrain, soil, earth Simulated or Constructed: Mechanical flow of a body of water; Koi pond, aquarium; Green wall; Artwork depicting nature scenes; Video depicting nature scenes; Highly designed landscapes											Expert evaluation (Excellent, moderate, limited, none); Management of night sky by Sullivan et al (2023)
	Does the object correspond to other unique physical features?	Unique site elements are integrated into the design											Expert evaluation (Excellent, moderate, limited, none); Camougflage technique by BLM (2015)
	Is the object harmoniously integrated in landscape / cityscape and looks visually balanced?	Part/whole relationships that may include balance, coherence, concinnity, consonance, orchestration, proportion, symmetry, symphony, unity; Overuse of forms and patterns that may lead to visual toxicity											Expert evaluation; Videoecology by Filin (1989); Turner's (1998) SID (Identity index context) theory; Visual landscape assessment Salingaros (2005) adapted by Karvelytė-Balbieri enė (2010); Camougflage technique by BLM (2015); Visual landscape assessment by Bučas (1980, 1989), Purvinas (1983), Budriūnas & Ėringis (2000), Kamičaitytė-Virba šienė (2003) or Kamičaitytė-Virba šienė et al (2020)
SHAPES AND FORMS	Does the object's design integrate / interpret natural (botanical, animal...) forms and motifs?	Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature											Expert evaluation (Excellent, moderate, limited, none

	Criteria of architectural expression	Architectural means / explanation / hint	Criteria inherent in the following sustainable architecture trends										Special research methods for evaluation
			Low-tech re-used materials	Re-used materials aesthetics	Trashy anti-consumerist	Low-tech ecological	Low-tech expressive organic forms	Expressive iconic organic forms	Eco-technological buildings	Vegetated buildings	Building-landscape integration	Biophilic architecture	
SHAPES AND FORMS	Does the object's design mimic nature's forms (e.g. biomorphic shapes) in a functional way?	Nature abhors right angles and straight lines; The Fibonacci series (0, 1, 1, 2, 3, 5, 8, 13, 21, 34...); the Golden Mean (or Golden Section), a ratio of 1:1.618											Videoecology by Filin (1989); fractal analysis
	Is the object's design based on geomorphic shapes?	Relation to the form or surface features of the earth or landscape											Expert evaluation (Excellent, moderate, limited, none)
	Does the object include spatial hierarchy similar to those encountered in nature?	Nested fractal designs expressed as a third iteration of the base design (i.e., with scaling factor of 3) are more likely to achieve a level of complexity that conveys a sense of order and intrigue, and reduces stress (Salingaros, 2012)											Videoecology by Filin (1989); fractal analysis, space syntax, Salingaros (2015. 2017)
LIGHT AND SPACE	Does the object integrate / provide natural light?	Architectural object provide users with natural lighting options											Expert evaluation (Excellent, moderate, limited, none)
	Is the spatial diversity, variability and interest integrated in the object?	Curving edges; Dramatic shade and shadows; winding paths; partially revealed spaces; Translucent materials; obscuring of the boundaries and a portion of the focal subject											Videoecology by Filin (1989); Visual landscape assessment Salingaros (2005) adapted by Karvelytė-Balbieri enė (2010)
	Does the object create sensitive and cognitive variability and /or richness?	Information-rich, as an intriguing balance between boring and overwhelming											Videoecology by Filin (1989); Visual landscape assessment Salingaros (2005) adapted by Karvelytė-Balbieri enė (2010)

	Criteria of architectural expression	Architectural means / explanation / hint	Criteria inherent in the following sustainable architecture trends										Special research methods for evaluation
			Low-tech re-used materials	Re-used materials aesthetics	Trashy anti-consumerist	Low-tech ecological	Low-tech expressive organic forms	Expressive iconic organic forms	Eco-technological buildings	Vegetated buildings	Building-landscape integration	Biophilic architecture	
LIGHT AND SPACE	Are light quality variations, such as diffused, filtered light, light and shadow, reflections present in the object?	Varying intensities of light and shadow that change over time to create conditions that occur in nature; Naturally Occurring: Daylight from multiple angles; Direct sunlight; Diurnal and seasonal light; Firelight; Moonlight and star light; Bioluminescence; Simulated or Constructed: Multiple low glare electric light sources; Illuminance; Light distribution; Ambient diffuse lighting on walls and ceiling; Day light preserving window treatments; Task and personal lighting; Accent lighting, Personal user dimming controls; Circadian color reference (white light during the day and lack of blue light at night)/ Color tuning lighting that produces white light during the day, and minimizes blue light at night										Expert evaluation (Excellent, moderate, limited, none), space syntax
PROCESSES AJND PATTERNS	Does the object express the process of co-creation with nature?	Construction using mycelium, technologies with algae for energy production and air quality improvement, "bio-concrete" made of moss and beef mushrooms in rainwater and allowing plants to be grown on the facades, salt slabs made of salt, sunflower and algae, bioplastics made of algae, etc.											Expert evaluation (Excellent, moderate, limited, none)
	Does the object express in meaningful and visible way the behaviour patterns characteristic to natural systems and organisms?	Change over time, decaying - changing properties (rustic metal, growing plants, etc)											Expert evaluation (Excellent, moderate, limited, none)

	Criteria of architectural expression	Architectural means / explanation / hint	Criteria inherent in the following sustainable architecture trends										Special research methods for evaluation
			Low-tech re-used materials	Re-used materials aesthetics	Trashy anti-consumerist	Low-tech ecological	Low-tech expressive organic forms	Expressive iconic organic forms	Eco-technological buildings	Vegetated buildings	Building-landscape integration	Biophilic architecture	
PROCESSES AJND PATTERNS	Does the object express the structural patterns related with fractality, centrality, part-whole integration?	Fractality: a fractal is a never-ending pattern. Fractals are infinitely complex patterns that are self-similar across different scales. They are created by repeating a simple process over and over in an ongoing feedback loop. Naturally Occurring: branches of trees, animal circulatory systems, snowflakes, lightning and electricity, plants and leaves, geographic terrain and river systems, clouds, crystals. Centrality describes the action of a central element in its periphery (example: urban center) part-whole integration - relation of object's parts to the whole object itself											Videoecology by Filin (1989); Visual landscape assessment Salingaros (2005) adapted by Karvelytė-Balbieri enė (2010), fractal analysis
	Does the object express the stochastic and ephemeral connections with nature?	Naturally Occurring: Cloud movement; Breezes; Plant life rustling; Water babbling; Insect and animal movement; Birds chirping; Fragrant flowers, trees and herbs. Simulated or Constructed: Billowy fabric or screen; materials that move or glisten with light or breezes; Reflections of water on a surface; Shadows or dappled light that change with movement or time; Nature sounds broadcasted at unpredictable intervals; Mechanically released plant oils											Expert evaluation (Excellent, moderate, limited, none)
	Does the object provide thermal and airflow variability?	Naturally Occurring: Solar heat gain; Shadow and shade; radiant surface materials; Space/place orientation; Vegetation with seasonal densification Simulated or Constructed: HVAC delivery strategy; Systems controls; Window glazing and window treatment; window operability and cross ventilation											Expert evaluation (Excellent, moderate, limited, none)

	Criteria of architectural expression	Architectural means / explanation / hint	Criteria inherent in the following sustainable architecture trends										Special research methods for evaluation
			Low-tech re-used materials	Re-used materials aesthetics	Trashy anti-consumerist	Low-tech ecological	Low-tech expressive organic forms	Expressive iconic organic forms	Eco-technological buildings	Vegetated buildings	Building-landscape integration	Biophilic architecture	
HUMAN -ENVIRONMENT RELATIONS	Does the object maintain / contribute to the spirit of place?	Spirit of the place consists of tangible (buildings, sites, landscapes, routes, objects) and the intangible elements (memories, narratives, written documents, rituals, festivals, traditional knowledge, values, textures, colours, odours, etc.). Does the object connects to the essence of the place in ecological, cultural, historic, geographic dimensions?											Expert evaluation (Excellent, moderate, limited, none)
	Does the object involve restoration of the damaged environment in meaningful and visible way?	Improved ecological situation, surfaces are permeable to water, variety of vegetation, rainwater management (bioswales, raingardens, etc), a section of the courtyard is left for natural succession (that is, to naturally grow and regenerate), composting biodegradable waste; Prioritize biodiversity over acreage, area or quantity											Expert evaluation (Excellent, moderate, limited, none)
	Does the object employ / demonstrate self-healing qualities of nature?	Little maintenance is required, the site is self-operating like in natural places like meadow or forest											Expert evaluation (Excellent, moderate, limited, none)
	Does the object stimulates sense of security in users and viewers perception?	Physical safety; mental safety; refuge - a place for withdrawal, from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead											Expert evaluation (Excellent, moderate, limited, none)
	Does the object stimulate sense of attraction and emotional, spiritual connection with it and its place in users and viewers perception?	E.g., people are taking photographs, collects litter, spends their free time											Expert evaluation (Excellent, moderate, limited, none)

	Criteria of architectural expression	Architectural means / explanation / hint	Criteria inherent in the following sustainable architecture trends										Special research methods for evaluation
			Low-tech re-used materials	Re-used materials aesthetics	Trashy anti-consumerist	Low-tech ecological	Low-tech expressive organic forms	Expressive iconic organic forms	Eco-technological buildings	Vegetated buildings	Building-landscape integration	Biophilic architecture	
HUMAN -ENVIRONMENT RELATIONS	Does the object stimulates exploration and cognition?	The object creates the conditions that differentiate between surprise (i.e., fear) and pleasure, creates a sense of mystery, risk/peril, arouse interest of exploring. Mystery is the promise of more information achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment. E.g. Peek-a-boo windows that partially reveal, Curving edges; Winding paths. Risk/Peril is an identifiable threat coupled with a reliable safeguard. Double-height atrium with balcony or catwalk; Architectural cantilevers; Infinity edges; Façade with floor-to-ceiling transparency; Experiences or objects that are perceived to be defying or testing gravity; Transparent railing or floor plane; Passing under, over or through water; Proximity to an active honeybee apiary or predatory animals; Life-sized photography of spiders or snakes										Expert evaluation (Excellent, moderate, limited, none)
	Does the object stimulate connection with natural systems?	Naturally Occurring: Climate and weather patterns (rain, hail, snow; wind, clouds, fog; thunder, lightning); Hydrology (precipitation, surface water flows and resources; flooding, drought; seasonal arroyos); Geology (visible fault lines and fossils; erosion, shifting dunes); Animal behaviors (predation, feeding, foraging, mating, habitation); Pollination, growth, aging and decomposition (insects, flowering, plants); Diurnal patterns (light color and											Expert evaluation (Excellent, moderate, limited, none)

	Criteria of architectural expression	Architectural means / explanation / hint	Criteria inherent in the following sustainable architecture trends										Special research methods for evaluation
			Low-tech re-used materials	Re-used materials aesthetics	Trashy anti-consumerist	Low-tech ecological	Low-tech expressive organic forms	Expressive iconic organic forms	Eco-technological buildings	Vegetated buildings	Building-landscape integration	Biophilic architecture	
HUMAN -ENVIRONMENT RELATIONS	Does the object stimulate connection with natural systems? (Continued)	intensity; shadow casting; plant receptivity; animal behavior; tidal changes); Night sky (stars, constellations, the Milky Way) and cycles (moon stages, eclipses, planetary alignments, astronomical events); Seasonal patterns (freeze-thaw; light intensity and color; plant cycles; animal migration; ambient scents) Simulated or Constructed: Simulated daylighting systems that transition with diurnal cycles; Wildlife habitats (e.g., birdhouse, honeybee apiary; hedges, flowering vegetation) Exposure of water infrastructure; Step wells for seasonal rainwater storage and social convergence; Natural patina of materials (leather, stone, copper, bronze, wood)										Expert evaluation (Excellent, moderate, limited, none)

	Criteria of architectural expression	Architectural means / explanation / hint	Criteria inherent in the following sustainable architecture trends											Special research methods for evaluation
			Low-tech re-used materials	Re-used materials aesthetics	Trashy anti-consumerist	Low-tech ecological	Low-tech expressive organic forms	Expressive iconic organic forms	Eco-technological buildings	Vegetated buildings	Building-landscape integration	Biophilic architecture		
HUMAN -ENVIRONMENT RELATIONS	Does the object stimulates experience of nature through senses?	Auditory, haptic, olfactory, or gustatory stimuli referring to nature, living systems or natural processes. Naturally Occurring: Fragrant herbs and flowers; Songbirds; Flowing water; Weather (rain, wind, hail); Natural ventilation (operable windows, breezeways); Textured materials (stone, wood); Crackling fire/fireplace; Sun patches; Warm/cool surfaces Simulated or Constructed: Digital simulations of nature sounds; Mechanically released natural plant oils; Highly textured fabrics/textiles that mimic natural material textures; Audible and/or physically accessible water feature; Music with fractal qualities; Horticulture/gardening, including edible plants; Domesticated animals/pets; Honeybee apiary											Expert evaluation (Excellent, moderate, limited, none)

5. DISCUSSION

This dissertation analyzed the development of sustainable architectural expression and its ethical background, examples of sustainable architecture buildings, the role of aesthetics in the assessment of sustainable architecture, existing classifications of sustainable architecture directions and their psychological acceptability.

Further directions of scientific studies could include more specific studies of the distinguished categories and their influence for sustainable buildings aesthetics and feelings of their users as well as possibilities to integrate aesthetic – sensorial quality criteria to building evaluation systems and legal frameworks in this way enriching cultural sustainability dimension. The other relevant questions that were out of the scope of this study involve studying the possibilities of rediscovering sustainability aspects inherited in traditionally built or cultural heritage objects, adaptive-reuse and disassembly of existing buildings, developing regenerative practices for new construction and the potential means to recycle a building when it reaches the end of its lifespan, as well as increase scientific attention of possibilities to bring new environmentally-friendly materials to construction practice.

One of the other valuable future research directions could be the analysis of integration possibilities of sustainable architecture directions with local landscapes considering psychological acceptability and aesthetic aspects. As it was noticed in the scientific article "The Relationship between Ethics and Aesthetics in Sustainable Architecture of the Baltic Sea Region" (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2021), the application of the sustainability concept in architecture requires an assessment of local peculiarities and cultural traditions. Sustainable architecture directions that have the highest potential for this study are genius loci architecture such as new vernacular that uses and interprets of vernacular forms and technologies, biophilic design, nature-inspired aesthetics such as building landscape integration, organic architecture following the ideas of Wright (organically evolving of its environment).

Several Lithuanian scientists have conducted research on the relationship of sustainable architecture and the local landscape, as well as cityscape, also explored the possibilities of implementing prevailing sustainable development trends within Lithuanian cities (Kamičaitytė & Gražulevičiūtė-Vileniškė, 2011; Zaleckis & Kamičaitytė-Virbašienė, 2012; Kamičaitytė-Virbašienė & Gražulevičiūtė-Vileniškė, 2009). Aesthethic-psychological aspects of townscape and architecture integration was analyzed by Kamičaitytė-Virbašienė & Leitanaitė (2005).

Several classical works by Lithuanian scientists, such as Bučas (1988, 2001), Kavaliauskas (1992), and Stauskas (2009), can serve as foundational references for future research aiming to explore universal architectural trends and their relationship with local landscapes.

The literature review highlights a growing interest in sustainability-related issues. However, the number of scientific publications directly related to aesthetics of sustainable buildings or sustainability aesthetics is relatively small compared to the

overall volume of literature on sustainability and the built environment. Emerging innovative studies illustrate the interest in experimenting with previously unknown possibilities in construction and architectural design will expand the possibilities to create sustainable buildings in the near future.

Although the definition of sustainable development was established in 1987 by the Brundtland report, the notions of "sustainability" and "sustainable architecture" are still developing (United Nations, 1987). At present, the concept of sustainability more often includes restorative and regenerative approaches, the development of constructed habitats that foster living environments. There is a growing acceptance of a systemic and holistic approach that recognizes the mutual benefits of coexisting with nature, moving away from the previously dominant anthropocentric perspective that focused solely on human needs.

Although sustainability in the built environment is currently considered as a fundamental necessity, its practical implementation is still challenging. Despite the efforts towards sustainability in the built environment, the architecture industry still faces challenges in adapting the best sustainability practices and methods.

Architecture continues to be associated with significant energy and resource consumption. Despite being rated as sustainable, often buildings are constructed using non-environmentally-friendly materials that pose challenges to follow the circular life-cycle approach. These challenges highlight the ongoing need for continued innovation and advancement in sustainable building materials and practices to address the environmental impacts of the whole construction sector.

While a shift towards restorative and regenerative sustainability has taken place on a philosophical level, attaining the initial stage of sustainable development that aims to minimize harm is often challenging. Furthermore, projects that aim to not only sustain the current situation but to improve it by implementing restorative or regenerative sustainability ideas are still relatively rare and exceptional. The existing sustainability certification systems hardly encourage the emergence of sustainability aesthetics.

In 2015, the United Nations announced Sustainable Development Goals (SDGs) for countries around the world. These goals were accompanied by sustainable development strategies outlined in international and national documents, with many of the SDGs and targets being measurable. Thus, attempts to develop sustainability concepts are often focused on technological challenges, usually highlighting the economic, social, and environmental dimensions of sustainability concepts. However, scholars have emphasized the importance of including the cultural dimension in sustainable development efforts, suggesting that sustainable architecture should not only be seen as a means to achieve environmental sustainability goals but also as an opportunity to create aesthetically pleasing and meaningful spaces that enhance the human experience.

The historical analysis of sustainable architecture, illustrated by the works of visionary architects and philosophers, emphasizes the crucial role of ethical values such as genuine and profound respect for nature, living beings, and non-living entities in our environment as the fundamental driving force in advancing sustainable

development. Further studies are necessary to explore the potential for integrating ethical discourse into education and legal frameworks.

Currently, sustainable architecture is evolving in various directions, encompassing a range of scales from small to large, including both new construction and renovation of existing buildings, including a variety of high-tech and low-tech approaches in various environments. Emerging architectural directions integrate the latest technological advancements and interactive features such as media interfaces, kinetic facades, and independent building envelopes that adjust to temperature and weather conditions. Innovative structures are being developed as "renewable power generators" using cutting-edge technologies such as algae or mycelium, presenting new and unconventional possibilities for sustainable architectural design. On the other hand, in an attempt to express their opposition to consumerism, groups of enthusiasts are exploring possibilities of living off-grid, designing buildings out of reused or recycled materials, vernacular materials such as mud and straw in this way expressing their protest against consumerist society.

This intricate notion of sustainable concept and aesthetic diversity of architectural trends, which often intersect with each other's features, create a challenging yet intriguing opportunity to investigate the aesthetic aspects of sustainability in architecture.

6. CONCLUSIONS

The main conclusions of this dissertation correspond to the raised objectives and the published results:

1. The scientific article "Retrospective Analysis of Sustainable Architecture: Mind-Mapping Development of Ideas and Expression" (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2022) provides a comprehensive literature review and historic analysis of sustainable architecture development. The emergence of the sustainability concept has not only shifted attitudes towards the environment but is also currently transforming aesthetic expression of architecture. The concept of sustainability aesthetics, which embodies a specific aesthetic expression reflecting sustainability ideas, originated in the 1960s and 70s. The movement prioritized social engagement, nature-centric practices, and raising awareness, rejecting art solely for commercial or aesthetic purposes while acknowledging the complex relationship between natural phenomena and human interventions. Sustainable architecture, defined as architecture that is based on the principles and paradigm of sustainability encompassing social, cultural, economic, and environmental dimensions, plays a crucial role in contributing towards the implementation of sustainability goals. Therefore, sustainability aesthetics highlights the importance of creating architectural design that is not only environmentally friendly but also aesthetically pleasing and meaningful, reflecting the values of sustainability and culture of our time. The aesthetic aspects of sustainability in the built environment have received less attention compared to its quantitative performance aspects. Sustainability aesthetics of the built environment still lacks its own aesthetic expression.

The scientific article “The Relationship between Ethics and Aesthetics In Sustainable Architecture of the Baltic Sea Region” (Daugėlaitė & Gražulevičiūtė-Vileniškė, 2021*)* illustrates that the current sustainable building certification schemes do not prioritize architectural aesthetics, resulting in certified buildings lacking distinct aesthetic features. This study suggests that the sustainable architecture in the Baltic Sea region is characterized by a preference for minimalism, which can be attributed to the influence of Baltic-Nordic modernist architectural traditions of the 20th century. This illustrates the importance of the regional specificity of sustainability aesthetics and indicates that sustainability aesthetics cannot be universal and culturally neutral. The majority of analyzed architectural examples encodes an idea that it is possible to maintain the appealing visual appearance of built environments with less environmental impact. A holistic approach, which includes cultural criteria such as aesthetics, should be integrated into certification schemes to promote sustainable architecture that contributes to the preservation of cultural values. The Living Building Challenge serves as an example of such an approach that incorporates aesthetics into its criteria.

2. The scientific article “The Role of Aesthetics in Building Sustainability Assessment” (Gražulevičiūtė-Vileniškė et al., 2021) demonstrated that architectural quality is a multidimensional concept encompassing urban integrity, accessibility, environmental respect, energy efficiency, construction quality, well-being, innovation, aesthetics, and functionality. These dimensions correspond to all four sustainability dimensions – cultural, social, economic, and environmental. However, the study also showed that cultural aspects were the least developed, indicating a need for further attention to cultural sustainability in architecture. The study emphasizes four approaches—sustainability aesthetics, spirit of place, biophilic design, and regenerative approach—as means to enhance the aesthetic quality and distinctiveness of sustainable architecture. These approaches can be considered in the evaluation of sustainable buildings and may contribute to the development of holistic and culturally sensitive sustainability certification schemes, at the same time expanding the concept of aesthetics beyond the boundaries of visual perception.

The scientific article “Characterizing Sustainability Aesthetics of Buildings and Environments: Methodological Frame and Pilot Application to the Hybrid Environments” (Daugėlaitė et al., 2022) developed a set of aesthetical criteria that enables a more comprehensive assessment of the aesthetic expression of sustainable buildings and environments. The developed set of criteria includes categories related to features of environment, materials, visual interest, shapes and forms, light and space, processes or patterns, human – environment relations.

3. The scientific article “Classification of Biophilic Buildings as Sustainable Environments” (Gražulevičiūtė-Vileniškė et al., 2022) introduces additional categories to those criteria and tested its application on three buildings in Lithuania. This set could be used as a guide for architects and designers to incorporate meaningful aesthetic qualities in their designs. The developed criteria hold the potential of creating unique and psychologically sustainable buildings and environments, which can improve the quality of life for building occupants.

4. The scientific article “Social-Psychological Sustainability of Architecture: a Pilot Study” (Daugėlaitė, 2022) identified ten distinct trends having potential to enrich the expression of sustainable buildings, with the most highly regarded trends being low-tech ecological, vegetated, building landscape, and biophilic buildings. The current acceptability of architectural trends that employ recycled and reused materials is low among the distinguished trends due to the materials' insufficient aesthetic and uncertain safety properties; however, if developed further, this approach holds great potential in sustainable architecture. The aesthetic trends that involved the incorporation of high technologies were criticized by the respondents due to their high cost and complexity of construction and maintenance. They also disliked aesthetic features such as nonhuman scale, aggressive domination, and lack of coziness, as well as the potential harm to wildlife such as birds. However, some respondents agreed that this type of building could be indirectly sustainable, depending on the technology used to save resources and energy. These findings suggest that naturalness and durability, as well as environmentally friendly solutions, are important factors in the perception of sustainable architecture. The study revealed that sustainability is perceived as the integration of architectural and engineering solutions, with visual aesthetics playing a significant role. The most valued trends were associated with naturalness, durability, and the use of environmentally friendly practices such as tree and landscape preservation, resource conservation, carbon footprint reduction, sustainable engineering solutions, and sustainable usage patterns.

5. This dissertation introduces a comprehensive methodological framework for describing and evaluating the aesthetic aspects of sustainable architecture. This framework is rooted in four core theoretical concepts: biophilic design, sustainability aesthetics, regenerative design, and genius loci. These concepts have been systematically organized and structured into a comprehensive set of questions in relation with prevailing sustainable architecture trends, each accompanied by proposed methods for both qualitative and quantitative assessment, ensuring objectivity in the evaluation process. Notably, the contemporary understanding of aesthetics encompasses not just visual perception but also emotional and non-visual elements crucial to the environmental experience. Despite its potential limitations, this methodology offers a conceptual framework for evaluating the aesthetics of sustainable architecture. Besides the distinguished aesthetic criteria (*Table 1*), sustainable architecture should include the following features:

- Sustainable energy practices throughout the entire life-cycle of buildings, including material manufacturing, construction of a building, its maintenance and recycling or demolition, also reducing dependence on harmful and wasteful energy sources and practices (such as fossil fuels and incandescent light bulbs);
- Use of renewable energy sources and striving for energy self-sufficiency, where buildings generate as much energy as they use to achieve a net-zero impact;
- Water saving systems (rainwater collection, recycling greywater);
- Using of renewable materials;
- Replacement of conventional material (e.g. concrete to hempcrete, plastics to bioplastics, etc.);

- Using recycled materials and employing adaptable, modular spaces constructed from natural materials that can be conveniently repurposed or recycled;
- Using passive and active design strategies;
- Small environmental footprints (following cradle-to-cradle or life-cycle approach);
- Creating healthy environments for humans (physically and psychologically);
- Integration with the surrounding landscape;
- Native landscaping (trees, plants, and grasses);
- Following green index strategy for designing close environment of the building.

7. SANTRAUKA

7.1. Tyrimo sritis

Pastaruosius kelis dešimtmečius susidomėjimas aplinkosauga auga – aplinkos tausojimas tapo dažnai visuomenėje aptariama tema, o išplėtota darnaus vystymosi koncepcija palietė kone kiekvieną gyvenimo sritį. Darnumo tema ypač svarbi statybos ir architektūros srityse. Šiuolaikinėje architektūroje darnumo aspektai yra laikomi būtinybe, savaime suprantama pastato savybe. Tačiau darnios architektūros kriterijai iki šiol nėra išgryninti, o architektūriniai projektai dažnai apima tik ribotus tvarumo aspektus. Darnumo tema architektūros srityje dažniausiai analizuojama keturiais pagrindiniais aspektais: aplinkosauginiu, ekonominiu, socialiniu ir kultūriniu. Nepaisant to, kad nuo 2015 m. smarkiai išaugo mokslinės literatūros kiekis darnumo architektūroje tema, iki šiol didžiausias dėmesys skiriamas tik technologiniams darniosios architektūros aspektams tyrinėti. Šiuo metu darniosios architektūros ir statybos srityse trūksta mokslinių tyrimų, kuriais būtų galima analizuoti konceptualiuosius, filosofinius ir meninius darniosios architektūros vystymosi aspektus (Daugelaite & Grazuleviciute-Vileniske, 2020).

Dėl vyraujančio techninio-funkcinio požiūrio į darniąją architektūrą jos estetinis potencialas dažnai lieka antraplanis, o šiuolaikinės architektūros objektuose neretai jaučiamas jautrumo kultūrai ir lokalumui trūkumas. Darnioji architektūra turėtų būti vertinama ne tik kaip priemonė siekti aplinkosauginių darnumo tikslų, bet taip pat ir kaip galimybė kurti estetiškai malonias, įkvepiančias ir prasmingas erdves. Estetinių kategorijų įtraukimas į projektavimo procesą yra būtinas siekiant darnumo koncepciją urbanistinėje aplinkoje įgyvendinti visavertiškai. Estetikos svarba architektūroje yra užkoduota pačioje žodžio „architektūra“ reikšmėje – tai „pastatų projektavimo menas ir statybos praktika“ arba „pastato stilius“ (Cambridge University Press, be datos). Menas ir stilius (sinonimiškai – išraiška) besąlygiškai siejami su kultūra ir estetika, tačiau šiuolaikinė architektūros estetikos sąvoka neapsiriboja tik vizualiniu suvokimu. Joje įsipina kultūrinės istorijos ir tapatybės samprata, taip pat yra architektūros estetikos kaip jutiminės, emocinės patirties tyrinėjimų.

Pastatas kaip materialus objektas gali išlikti tūkstančius metų, todėl šiuolaikinės statybos aplinkosauginiai klausimai yra ypač svarbūs. Šeštajame ir septintajame dešimtmečiais kilęs didelis visuomenės pasipriešinimas atkreipė dėmesį į šiuolaikinės „materijos“ keliamas ekologines problemas, kas lėmė darnaus vystymosi koncepcijos

atsiradimą. Oficiali „darnumo“ sąvoka, įtvirtinta Brundtland ataskaitoje 1987 m. (United Nations, 1987), į architektūros ir statybos sritis įnešė moralinį aspektą – etinę atsakomybę ateities kartoms (Daugelaite & Grazuleviciute-Vileniske, 2021). Nepaisant to, prognozuojama, kad šiuolaikinėje statyboje naudojamos šiuo metu populiarios nenatūralios medžiagos ir aplinkai žalingi statybos procesai paliks dideles taršos problemas ateities kartoms (Petkar, 2014). Nepaisant šiuolaikinių darnaus vystymosi koncepcijos įgyvendinimo ribotumų, etinis darnaus vystymosi pagrindas plėtojamas ir toliau. Naujausios etinės idėjos darnumo srityje vadovaujasi nauju požiūriu – regeneraciniu darnumu (angl. *Regenerative Sustainability*). Tai holistinis požiūris, kuriuo siekiama atkurti, atnaujinti ir atgaivinti ekosistemas ir gamtinius išteklius. Taigi darniosios architektūros sąvoka turėtų būti vertinama ne tik kaip techninis ir ekonominis iššūkis, bet ir kaip etinė atsakomybė Žemei bei ateities kartoms, taip pat ir kaip naujos architektūros išraiškos galimybė.

Darnioji architektūra siejama su „darnumo estetika“ – koncepcija mene ir projektavime, kurioje persipina aplinkosaugos vertybės ir estetinės savybės. Darnumo estetika siekia išreikšti idėją, kad kuriami produktai, pastatai ar kraštovaizdžiai gali būti ne tik vizualiai patrauklūs bei įkvepiantys, bet ir tausojantys aplinką. Darnumo estetika apima natūralių medžiagų naudojimą, žaliųjų erdvių ir gamtos elementų įtraukimą, taip pat skatina atsinaujinančių energijos šaltinių integraciją, siekia mažinti atliekų kiekį, taiko gyvavimo ciklo vertinimą. Darnumo koncepcijos įtakoje nauja estetinė išraiška neretai įvardijama kaip „naujoji estetika“ (Von der Leyen et al, 2021), kur architektūros projektai ar net eksperimentai gali stebinti neįprastais rezultatais, kartu skatinti aštrias diskusijas ar netgi sukelti atmetimo reakciją visuomenėje. Darnios architektūros estetikos tyrimai yra svarbūs siekiant išplėtoti darnios architektūros estetikos sąvoką, atskleisti „naujosios estetikos“ apraiškas architektūroje.

Šios disertacijos literatūros apžvalga atskleidžia, kad darniosios architektūros apibrėžimas yra gana miglotas, o darnumo estetikos savybės neapibrėžtos. Nepaisant kultūrinių aspektų įtraukimo į darnų vystymąsi svarbos, šiuo metu daugiausia dėmesio skiriama ekonominiams-technologiniams darniųjų pastatų aspektams. Taip pat trūksta mokslinių straipsnių apie darnumo estetiką, ypač konceptualų, filosofinį ir meninį požiūrį apimančių tyrimų. Ši disertacija prisideda prie darniosios architektūros raidos tyrimų, joje patikslinamas darnumo apibrėžimas architektūros srityje, pagrindinį dėmesį teikiant estetinei raiškai. Disertacija „Darniosios architektūros išraiška ir jos kryptys“ nagrinėja darniosios architektūros raidą, išraišką (kryptis, tendencijas) ir estetines savybes, taip pat galimas ateities perspektyvas.

7.2. Disertacijos tikslas ir uždaviniai

Disertacijos tikslas – papildyti darniosios architektūros estetinio vystymosi tyrimų spektrą, ieškant galimybių kurti estetiškai atpažįstamą ir patrauklią darniąją architektūrą bei pasiūlant kriterijus darniosios architektūros pastatų estetinei raiškai papildyti ir vertinti.

Disertacijos uždaviniai iliustruoja tyrimo struktūrą ir pagrindines mokslinių straipsnių, kuriuose paskelbti jų rezultatai, temas. Disertacijos uždaviniai yra šie:

1. Atlikti literatūros apžvalgą, apimančią darniosios architektūros raiškos apibrėžimą ir raidą bei jos atsiradimą lėmusias etines prielaidas, naudojant laiko juostas ir minčių žemėlapius;
2. Išanalizuoti darniosios architektūros pavyzdžius, daugiausia dėmesio skiriant darniesiems pastatams Baltijos jūros regione, ir nustatyti jų estetinės raiškos iššūkius bei problemas;
3. Išanalizuoti estetikos vaidmenį vertinant darniąją architektūrą, nagrinėjant architektūros kokybės kriterijus ir plačiausiai taikomas darniųjų pastatų sertifikavimo sistemas;
4. Sukurti darniųjų pastatų estetinės raiškos aprašymo ir vertinimo koncepcinę metodiką, pagrįstą biofilinio dizaino, darnos estetikos, regeneracinio dizaino ir *genius loci* (vietos dvasios) teorinėmis koncepcijomis;
5. Atlikti pasirinktų Lietuvos architektūros objektų tyrimą vietoje taikant parengtą koncepcinę metodiką;
6. Papildyti esamą darniosios architektūros krypčių klasifikaciją, pateikiant naują, dabartinę darniosios architektūros krypčių įvairovę atspindinčią klasifikaciją, ir įvertinti jų psichologinį priimtinumą, atliekant sociologinę apklausą ir rengiant gautų duomenų kiekybinę ir kokybinę analizę;
7. Suformuluoti išvadas įvertinant galimybes kurti estetiškai atpažįstamą ir patrauklią darniąją architektūrą.

7.3. Disertacijos mokslinis naujumas

Didėjant visuomenės susirūpinimui aplinkos apsauga, tvarumo klausimai pastaraisiais dešimtmečiais tapo pasauliniu architektūros prioritetu. Deja, darnaus vystymosi mokslinių tyrimų srityje kultūriniam aspektui, įskaitant meninę darniosios architektūros raišką, vis dar trūksta dėmesio (Daugelaite & Grazuleviciute-Vileniske, 2020). Šioje disertacijoje išsamiai nagrinėjamos konceptualios, filosofinės ir meninės šios srities perspektyvos.

Disertacijoje nagrinėjama darnumo koncepcijos reikšmė architektūros estetikai, tiriamos šiuolaikinių pastatų estetikos kryptys ir visuomenės nuomonė architektūros darnumo temomis, apklausiant architektūros srities specialistus ir plačiosios visuomenės atstovus. Disertacijoje darni architektūra tyrinėjama iki šiol mažai nagrinėtu aspektu – siejant architektūros estetiką ir etines nuostatas aplinkos atžvilgiu, analizuojant dabartinius iššūkius ir ieškant galimų ateities vystymosi krypčių.

Taip pat šiame tyrime nagrinėjamos bendros darniosios architektūros idėjos ir aptariama estetikos, kaip architektūros kokybės kriterijaus, svarba. Šis tyrimas pristato naują požiūrį į estetikos architektūroje sampratą, kadangi tiriamos darniosios architektūros koncepcijoje užkoduotos žinutės ir atskleidžiamas unikalus estetikos kaip vizualinės ir patyriminės patirties, atspindinčios tam tikros populiacijos ar visuomenės grupės vertybes, apibrėžimas (Daugelaite & Grazuleviciute-Vileniske, 2022).

Tyrime analizuojami architektūros objektų vertinimo kriterijai, pabrėžiant estetiką kaip vieną iš esminių architektūros kokybės požymių. Darnios architektūros

estetikos sampratos išplėtojimas yra svarbus tikslinant esamus architektūros kokybės kriterijus.

Disertacijoje susistemintos ir išplėtotos esamos darniosios architektūros krypčių klasifikacijos, tyrime pateikiamas koncepcinis metodologinis darniųjų pastatų estetinės išraiškos aprašymo ir vertinimo kriterijų rinkinys, kuris galėtų pasitarnauti kaip pagrindas toliau plėtojant darnios architektūros estetikos sampratą.

Šioje disertacijoje pateiktas filosofinis ir visuomenės nuomone grįstas požiūris, istorinės raidos ir dabartinės darniųjų pastatų vertinimo analizė bei estetinę-jutiminę patirtį apibrėžiantys kriterijai, kurie, tikimasi, galėtų padėti įvairiapusiškai įvertinti darniosios architektūros koncepcijos taikymą architektūros srityje, bei išplėtoti architektūros estetinės kokybės sampratą.

7.4. Disertacijos struktūra

Disertacija parengta straipsnių pagrindu, šeši moksliniai straipsniai publikuoti Scopus Q1-Q2 reitinguojamuose žurnaluose, iš kurių trys žurnalai taip pat reitinguojami Web of Science ir vienas – Index Copernicus. Straipsnių bendraautorių ir leidėjų sutikimai įtraukti sąraše pateiktus mokslinius straipsnius į šią disertaciją yra gauti. Žemiau pateiktas išsamus straipsnių sąrašas disertacijos struktūros eiliškumu:

1. Daugelaite, A., Grazuleviciute-Vileniske, I. (2022). Retrospective Analysis of Sustainable Architecture: Mind-Mapping Development of Ideas and Expression. Journal of sustainable architecture and civil engineering = Darnioji architektūra ir statyba. Kaunas : Technologija. ISSN 2029-9990. eISSN 2335-2000. Vol. 30, no. 1, p. 78-92. DOI: 10.5755/j01.sace.30.1.29829 [Scopus; Index Copernicus; DOAJ] [CiteScore: 0,80; SNIP: 0,433; SJR: 0,212; Q2 (2021, Scopus Sources)] [M.kr.: H 003] [Įnašas: 0,500]. Šios disertacijos autorės mokslinis indėlis – atlikta istorinė darniosios architektūros raidos ir jos santykio su etinėmis idėjomis analizė, parašyta pagrindinė teksto dalis, apimanti rezultatus ir diskusiją.

2. Daugelaite, A., Grazuleviciute-Vileniske, I. (2021). The Relationship between Ethics and Aesthetics in Sustainable Architecture of the Baltic Sea Region. Sustainability. Basel: MDPI. ISSN 2071-1050. Vol. 13, iss. 4, art. no. 2259, p. 1-15. DOI: 10.3390/su13042259. [Social Sciences Citation Index (Web of Science); Scopus; DOAJ] [IF: 3,889; AIF: 4,719; IF/AIF: 0,824; Q2 (2021, InCites JCR SSCI)] [CiteScore: 5,00; SNIP: 1,310; SJR: 0,664; Q1 (2021, Scopus Sources)] [M.kr.: H 003] [Įnašas: 0,500]. Šios disertacijos autorės mokslinis indėlis susideda iš duomenų rinkimo ir analizės, straipsnio rašymo ir galutinės versijos teksto redagavimo.

3. Grazuleviciute-Vileniske, I. Viliūnas, G., Daugelaite, A. (2021). The role of aesthetics in building sustainability assessment. Spatium. Belgrade: Institute of architecture and urban & spatial planning of Serbia. ISSN 1450-569X. eISSN 2217-8066. Vol. 45, p. 79-89. DOI:10.2298/SPAT2145079G. [Scopus; DOAJ] [CiteScore: 0,50; SNIP: 0,210; SJR: 0,155; Q1 (2021, Scopus Sources)] [M.kr.: H 003] [Įnašas: 0,334]. Šios disertacijos autorės mokslinis indėlis susideda iš literatūros analizės dalies, kurioje aprašomos architektūros teorijos, susijusios su estetinių ir aplinkosaugos kriterijų derinimu vertinant darnią architektūrą, ir teksto redagavimas galutinei straipsnio versijai.

4. Daugelaite, A., Doğan, H. A., Grazuleviciute-Vileniske, I. (2022). Characterizing sustainability aesthetics of buildings and environments: methodological frame and pilot application to the hybrid environments. Landscape architecture and art. Jelgava: Latvia university of agriculture. ISSN 2255-8632. eISSN 2255-8640. Vol. 19, no. 19, p. 61-72. DOI: 10.22616/j.landarchart.2021.19.06. [Emerging Sources Citation Index (Web of Science); Scopus] [CiteScore: 0,50; SNIP: 0,362; SJR: 0,283; Q1 (2021, Scopus Sources)] [M.kr.: H 003] [Įnašas: 0,333]. Disertacijos autorės mokslinį indėlį sudaro literatūros analizės dalis, kurioje aprašomos architektūros teorijos ir išskiriami darnių pastatų bruožai.

5. Grazuleviciute-Vileniske, I., Daugelaite A, Viliunas G. (2022). Classification of Biophilic Buildings as Sustainable Environments. Buildings. Basel: MDPI. ISSN 2075-5309. 2022, vol. 12, iss. 10, art. no. 1542, p. 1-15. DOI: 10.3390/buildings12101542. [Science Citation Index Expanded (Web of Science); Scopus; DOAJ] [CiteScore: 3,80; SNIP: 1,372; SJR: 0,565; Q1 (2021, Scopus Sources)] [M.kr.: H 003] [Įnašas: 0,334]. Disertacijos autorės mokslinį indėlį sudaro disertacijos konceptualizacija, metodologija, šaltiniai, pirminės straipsnio versijos rašymas, taip pat straipsnio redagavimas po recenzijos ir vizualizacija.

6. Daugelaite, A. (2023). Psychological Acceptance of Sustainable Architecture in Lithuania: A Qualitative Study. Journal of Sustainable Architecture and Civil Engineering = Darnioji architektūra ir statyba. Kaunas: Technologija. Straipsnis priimtas leidimui.

Publikuoti straipsniai struktūriškai atspindi disertaciją ir iliustruoja, kaip pasiekti tyrimo uždaviniai. Straipsnyje *Retrospective analysis of sustainable architecture: mind-mapping development of ideas and expression* (Daugelaite & Grazuleviciute-Vileniske, 2022) pateikiama išsami literatūros apžvalga. Straipsnis *The relationship between ethics and aesthetics in sustainable architecture of the Baltic sea region* (Daugelaite & Grazuleviciute-Vileniske, 2021) papildo literatūros apžvalgą, pristatytą ankstesniame straipsnyje, ir pateikia sertifikuotų darnių pastatų Baltijos jūros regione analizę. Straipsnis *The role of aesthetics in building sustainability assessment* (Grazuleviciute-Vileniske et al., 2021) analizuoja darnaus pastato apibrėžimą pagal keturių pastatų sertifikavimo sistemų (LEED, BREEAM, „Living building challenge“ ir WELL) kriterijus. Šiame tyrime taip pat išskiriami keturi požiūriai, turintys potencialą sukelti proveržį darnios architektūros estetinės kokybės ir unikalumo srityje: darnumo estetika, vietos dvasia (lot. *genius loci*), biofilinis dizainas ir regeneracinis požiūris. Straipsnyje *Characterizing sustainability aesthetics of buildings and environments: methodological frame and pilot application to the hybrid environments* (Daugelaite et al., 2022) siekiama išskirti darnios architektūros estetinių kriterijų rinkinį ir jos vertinimo metodiką. Ši metodika praktiškai išbandyta ir papildyta straipsnyje *Classification of biophilic buildings as sustainable environments* (Grazuleviciute-Vileniske et al., 2022) tyrimo metu. Psichologinis išskirtinių estetinių darniosios architektūros tendencijų priėmimas ir jos savybės analizuojamos straipsnyje *Psychological Acceptance of Sustainable Architecture in Lithuania: A Qualitative Study* (Daugelaite, 2023). Išsamus mokslinių straipsnių aprašymas pateikiamas III skyriuje *Review of scientific articles included in the dissertation* (anglų k.).

7.5. Diskusija

Disertacijoje analizuojama darniosios architektūros estetikos raida ir jos atsiradimo priežastys – etikos koncepcijos, darniosios architektūros pastatų pavyzdžiai, estetikos vaidmuo vertinant darniąją architektūrą, esamos darniosios architektūros krypčių klasifikacijos ir jų psichologinis priimtinumas. Tolesnės mokslinių tyrimų kryptys galėtų plėtoti išskirtų estetinių savybių įtaką darniosios architektūros išraiškai bei žmonių, leidžiančių laiką tokiuose pastatuose, savijautai. Taip pat galėtų tirti estetinių-juslinių kokybės kriterijų integravimą į pastatų vertinimo sistemas ir vystyti teisinę bazę, taip praturtinant kultūrinę tvarumo dimensiją. Literatūros apžvalga atskleidžia, kad susidomėjimas darnumo temomis auga, tačiau mokslinių publikacijų, tiesiogiai susijusių su darniųjų pastatų estetika arba darnumo estetika, yra mažai, palyginti su bendra literatūros darnumo tema urbanistinėje aplinkoje apimtimi. Nauji tyrimai rodo susidomėjimą eksperimentuoti su anksčiau neegzistavusiomis statybos ir architektūrinio projektavimo galimybėmis, kurios artimiausioje ateityje išplės galimybes kurti darniuosius pastatus bei galimai stipriai pakeis jų estetinę išraišką.

Tolimesni tyrimai galėtų apimti istorinius darnumo aspektus, kurie būdingi kultūros paveldo pastatams ir vietovėms; galimybes pritaikyti esamus pastatus, pakartotinai panaudoti išardant ar perdirbant pastatų dalis bei taikant kitus galimus pastato ar jo dalių pakartotinio panaudojimo būdus pasibaigus jo gyvavimo ciklui; plėtoti regeneracinio, atkuriamojo darnumo sąvokas. Galiausiai, didesnį mokslinį dėmesį būtų galima skirti kuriant naujas aplinkai draugiškas medžiagas ir pritaikant statybos pramonei.

Nepaisant to, kad darnaus vystymosi sąvoka buvo įtvirtinta dar 1987 m. Brundtlando ataskaitoje (United Nations, 1987), „darnumo“ ir „darnios architektūros“ sąvokos iki šiol yra plėtojamos. Šiuo metu darnumo koncepcija vystosi atkuriamojo ir regeneracinio darnumo kryptimis. Sisteminis-holistinis požiūris, pabrėžiantis abipusę gyvenimo išvien su gamta naudą, įgauna vis stipresnę reikšmę ir palaipsniui išstumia ilgą laiką vyravusį antropocentrinį (egocentrinį) požiūrį, tenkinantį vien tik žmonijos poreikius. Darnumo koncepcijos taikymas urbanistinės aplinkos kūrimo procese yra vertinamas kaip savaime suprantama būtinybė, tačiau praktinis darnaus vystymosi principų įgyvendinimas vis dar kelia iššūkių. Nepaisant pastangų taikyti darnumo principus urbanistinėje aplinkoje, vis dar patiriama sunkumų plėtojant šią koncepciją praktikoje – architektūra vis dar siejama su didėjančiu energijos ir išteklių vartojimu. Net ir turintys aukščiausio įvertinimo darnumo sertifikatus ar atitinkantys aukščiausius energinio naudingumo reikalavimus pastatai tik iš dalies atitinka darnumo kriterijus, kadangi jie vis dar dažnai statomi naudojant neekologiškas medžiagas, neatitinkančias žiedinio gyvavimo ciklo principo, o estetinė kokybė neretai yra nepatenkinama. Šie iššūkiai pabrėžia poreikį tobulinti statybines medžiagas ir statybos būdus bei spręsti viso statybų sektoriaus poveikio aplinkai problemą.

Nors filosofiniu požiūriu darnaus vystymosi koncepcijoje pereinama prie atkuriamojo ir regeneruojamojo darnumo, šiuolaikiniame statybos sektoriuje dažnai sunku pasiekti pradinį darnaus vystymosi etapą – nedaryti žalos, nebloginti esamos situacijos (angl. *sustain*). Be to, projektai, kuriais siekiama ne tik išlaikyti esamą

padėtį, bet ir ją pagerinti įgyvendinant atkuriamojo ar regeneruojamojo darnumo idėjas, vis dar yra retenybė, o egzistuojančios darnumo sertifikavimo sistemos beveik neskatina darnumo estetikos plėtojimo.

2015 m. Jungtinės Tautos nustatė pasaulio šalims skirtus darnaus vystymosi tikslus (DVT), kuriuos atspindi tarptautiniuose ir nacionaliniuose dokumentuose pateiktos darnaus vystymosi strategijos, o daugelį DVT ir uždavinių galima įvertinti kiekybiškai. Taigi, darnumo koncepcijos uždaviniai dažnai siejami su technologiniais iššūkiais, dažniausiai akcentuojant ekonominius, socialinius ir aplinkosauginius darnumo koncepcijos aspektus. Tačiau pabrėžiama, kad į darnaus vystymosi koncepciją svarbu įtraukti kultūrinį aspektą, siūloma į darnią architektūrą žvelgti ne tik kaip į priemonę aplinkos tvarumo tikslams pasiekti, bet ir kaip į galimybę kurti estetiškas ir prasmingas erdves, stiprinančias žmogaus jutiminę patirtį. Istorinė darnios architektūros raida, ypač įžvalgių architektų ir filosofų kūriniai, atspindi svarbiausią darnaus vystymosi varomąją jėgą – vidinį norą puoselėti ir saugoti mus supančią aplinką, žmogaus etinių vertybių sistemą, apimančią tikrą ir gilią pagarbą gamtai, gyvosioms būtybėms ir negyvosios gamtos elementams. Siekiant plėtoti darnaus vystymosi koncepciją, svarbu vykdyti tolimesnius tyrimus, ieškant galimybių integruoti etinį diskursą švietimo sistemoje ir teisinėje bazėje.

Per pastaruosius dešimtmečius darniosios architektūros krypčių įvairovė itin išaugo ir apima visą spektrą architektūrinių objektų – nuo mažiausio mastelio pastatų iki megamiestų; tai gali būti naujai statomi pastatai, esamų statinių rekonstrukcija ar kitas pritaikymas renkantis platų spektrą statybos būdų – nuo tradicinių ir pasyvių metodų taikymo statyboje iki aukščiausių technologijų integracijos. Inovatyvios architektūros tendencijos neretai taiko naujausius technologinius pasiekimus ir interaktyvias funkcijas, tokias kaip medijos menas, kinetiniai ar nepriklausomi pastatų fasadai, kurie prisitaiko prie temperatūros ir oro sąlygų. Itin inovatyvūs pastatai kuriami kaip „atsinaujinančios energijos generatoriai“, naudojant pažangiausias technologijas, įtraukiant įvairias eksperimentines medžiagas, pavyzdžiui, dumblius ar grybieną, o tai suteikia naujų ir netradicinių darnaus architektūrinio projektavimo galimybių. Šios architektūrinės krypties priešprieša – grupės entuziastų, siekdami išreikšti savo nepritarimą vartotojiškumui, tyrinėjantys galimybes gyventi visiškai nepriklausomai nuo aplinkinio pasaulio, eksperimentuoja statydami pastatus iš pakartotinai panaudotų ar perdirbtų medžiagų, gamtinių vietoje randamų medžiagų, tokių kaip molis ir šiaudai, taip išreikšdami savo protestą prieš vartotojiškumą. Ši sudėtinga darnios architektūros koncepcijos samprata ir dažnai tarpusavyje persipinančių estetinės išraiškos tendencijų įvairovė kuria sudėtingą, tačiau intriguojančią galimybę atlikti estetinių darnumo aspektų architektūroje tyrimą.

7.6. Išvados

Pagrindinės šio darbo išvados atspindi iškeltus disertacijos uždavinius:

1. Darnumo koncepcijos atsiradimas pakeitė požiūrį į supančią aplinką. Koncepcijos tolimesnis plėtojimas keičia dabartinę estetinę raišką architektūros srityje. Tam tikra estetinės raiškos, atspindinčios darnumo idėjas, samprata atsirado XX a. šeštajame ir septintajame dešimtmečiuose, o vėliau įgavo darnumo estetikos pavadinimą. Šis judėjimas neigė meno kūrimą vien komerciniais ar estetiniais tikslais

ir pabrėžė socialinį įsitraukimą, sąmoningumo ugdymą ir darbo išvien su gamta praktiką, akcentuojant pagarbą sudėtingai gamtos reiškinių dinamikai ir santykiams su žmogumi. Darnioji architektūra apibrėžiama kaip architektūra, pagrįsta darnumo principais, apimanti socialinius, kultūrinius, ekonominius ir aplinkosaugos aspektus ir atliekanti svarbų vaidmenį prisidedant prie darnumo tikslų įgyvendinimo. Darnumo estetikos koncepcija akcentuoja, kad svarbu kurti ne tik aplinkai draugišką, bet ir estetiškai patrauklų bei prasmingą architektūros kūrinį, atspindintį darnumo vertybes ir šių laikų kultūrą. Tačiau kokybiniai darnumo koncepcijos aspektai, įskaitant ir darnumo estetiką, yra mažiau ištirti nei kiekybiniai, todėl mokslininkai pastebi, kad darnumo estetika architektūros srityje vis dar neturi išgrynintos išraiškos.

2. Dabartinėse darnių pastatų sertifikavimo sistemose architektūros estetika neakcentuojama kaip svarbus kriterijus, todėl sertifikuoti pastatai neretai neturi išskirtinių estetinių savybių, suteikiančių unikalumo. Šio tyrimo išvados rodo, kad Baltijos jūros regiono darniajai architektūrai būdingas minimalizmas, kurį galima sieti su XX a. Baltijos ir Šiaurės šalių modernizmo architektūros tradicijų įtaka. Tyrime taip pat nurodoma, kad Vokietijos vaidmuo XX a. pradžioje plėtojant modernizmo ir funkcionalizmo idėjas architektūroje prisidėjo prie šių požiūrių paplitimo regione, išryškinant regioninį darnumo estetikos savitumą ir pabrėžiant, kad darnumo estetika negali būti laikoma universalia ir kultūriškai neutralia. Dauguma analizuotų architektūros pavyzdžių įrodo, kad įmanoma išlaikyti patrauklią urbanistinės aplinkos išvaizdą nekenkiant aplinkai. Siekiant skatinti kultūriškai prasmingos darnios architektūros kūrybą, sertifikavimo sistemos turėtų remtis holistiniu požiūriu, įtraukiant ir kultūrinius aspektus, tokius kaip, pavyzdžiui, sertifikavimo sistema „Living Building Challenge“.

3. Tyrimas parodė, kad architektūros kokybė yra daugialypė sąvoka, apimanti urbanistinį vientisumą, prieinamumą, pagarbą aplinkai, energinį efektyvumą, statybos kokybę, gerovę, inovacijas, estetiką ir funkcionalumą. Šie aspektai atitinka visas keturias tvarumo dimensijas – kultūrinę, socialinę, ekonominę ir aplinkosaugos. Tyrimas parodė, kad pastatų sertifikavimo sistemose kultūriniai aspektai buvo išvystyti prasčiausiai, kas rodo nepakankamą dėmesį kultūriniams darnumo aspektams vertinant architektūros objektus. Tyrime akcentuota galimybė kurti aukštesnės estetinės kokybės darnią architektūrą taikant keturias teorines prieigas: darniosios architektūros estetiką, vietos dvasią (lot. genius loci), biofilinį projektavimą ir atkuriamąjį (regeneracinį) dizainą. Šios koncepcijos gali prasmingai papildyti ir išplėsti estetinės kokybės sąvoką plėtojant holistinį požiūrį vertinant darnius pastatus.

4. Šiame tyrime parengtas estetinių kriterijų rinkinys leidžia išsamiau įvertinti tvarių pastatų ir aplinkos estetinę raišką. Minėtų teorinių prieigų (biofilinis dizainas, atkuriamasis-regeneracinis darnumas, vietos dvasios ir darnumo estetikos koncepcijos) pagrindu sukurtas architektūrinio objekto vertinimo kriterijų rinkinys. Šį rinkinį sudaro kategorijos, susijusios su aplinkos savybėmis, medžiagomis, vizualiniu įdomumu, formomis ir pavidalais, šviesa ir erdve, procesais, žmogaus ir aplinkos santykiais. Šis kriterijų rinkinys galėtų būti naudojamas kaip gairės siekiant išplėtoti darnumo estetikos architektūroje sąvoką, įtraukiant reikšmingas estetines-jutimines savybes kuriant ir vertinant architektūros objektus.

5. Tyrime išskirta dešimt darnios architektūros išraiškos tendencijų, galinčių paįvairinti architektūrinę išraišką. Atliktos apklausos rezultatai rodo, kad Lietuvoje labiausiai vertinamos šios architektūrinės tendencijos: tradiciniu būdu pastatyti (angl. low-tech) ekologiški, apželdinti, susiliejantys su kraštovaizdžiu ir biofiliniai pastatai. Išskirtos architektūros tendencijos, kuriose vyrauja perdirbtos ir pakartotinai panaudotos medžiagos, tyrimo respondentams atrodė mažai priimtinos dėl nepakankamo estetiškumo ir neaiškios medžiagų atitikties saugumo reikalavimams. Vertinant respondentų komentarus, išryškėjo išvada, kad, išplėtojus medžiagų perdirbimo ir pritaikymo architektūroje galimybes, sukūrus estetišką ir saugų produktą, šios tendencijos būtų vertinamos itin pozityviai. Estetines tendencijas, susijusias su aukštųjų technologijų taikymu, respondentai kritikavo dėl didelių išlaidų ir sudėtingos statybos bei pastatų priežiūros. Respondentams nepatikusios pastatų savybės – nežmogiškas mastelis, agresyvus dominavimas ir jaukumo trūkumas, taip pat galima žala laukinei gamtai, pavyzdžiui, paukščiams, kurie neretai žūsta, atsitrenkę į dideles vitrinas. Tačiau kai kurie respondentai sutiko, kad aukštųjų technologijų pastatai galėtų būti netiesiogiai tvarūs, įdiegus technologijas, leidžiančias taupyti energiją ir kitus išteklius. Darnumo sąvoką respondentai suprato kaip architektūrinių ir inžinerinių sprendinių vienovę, akcentuojant estetišką pastato išvaizdą. Pozityviausiai vertinamos tendencijos buvo susijusios su natūralumu ir ilgaamžiškumu, naudojamais aplinkai draugiškais sprendimais, pavyzdžiui, medžių ir kraštovaizdžio apsauga, išteklių taupymu, inovatyvių inžinerinių sistemų naudojimu.

6. Šioje disertacijoje pateikiamas koncepcinis metodologinis darniųjų pastatų estetinės išraiškos aprašymo ir vertinimo kriterijų rinkinys, skirtas darnios architektūros estetinėms savybėms vertinti. Šis rinkinys grindžiamas keturiomis pagrindinėmis teorinėmis koncepcijomis: biofiliniu dizainu, darnumo estetika, regeneraciniu dizainu ir vietos dvasios koncepcija. Šiose koncepcijose pateiktos idėjos buvo susistemintos į išsamų klausimų rinkinį. Siekiant objektyvumo, kiekvienam klausimui buvo pasiūlyti metodai rezultatams išmatuoti kokybiškai ir kiekybiškai. Akcentuojama, kad šiuolaikinė estetikos samprata apima ne tik vizualinį suvokimą, tačiau ir emocines kategorijas bei kitus nevizualinius veiksnius, kurie yra svarbūs aplinkos patyrimui. Nepaisant galimų ribotumų, ši metodika pateikia konceptualų būdą įvertinti darnios architektūros estetiką.

Be išskirtinių estetinių kriterijų, šiuolaikinė darnioji architektūra turėtų pasižymėti žemiau išvardintomis savybėmis:

- Tvariu energijos vartojimu viso pastato gyvavimo ciklo metu (medžiagų gamyba, statyba, pastato priežiūra, pernaudojimas ar griovimas): siekis naudoti kuo mažiau aplinkai kenksmingos energijos šaltinių (iškastinio kuro, kaitrinių lempučių, prietaisų „budėjimo režime“ ir pan.); siekis naudoti kuo daugiau atsinaujinančių energijos šaltinių (saulės kolektoriai, pasyvios šildymo, vėsinimo ir vėdinimo sistemos); siekis pagaminti tiek energijos, kiek jos suvartojama;
- Vandens taupymo sistemos (lietaus vandens surinkimas, pilkojo vandens perdirbimas);
- Atsinaujinančių medžiagų naudojimas;
- Įprastinių medžiagų pakeitimas (pvz., betono į kanapių betoną, plastiko į bioplastiką, pagamintą iš dumblių, ir t. t.);

- Perdirbtų medžiagų naudojimas;
- Natūralių medžiagų, lengvai keičiami moduliniai pastatai ar jų dalys, kurias galima lengvai išardyti ir vėl panaudoti arba perdirbti;
- Pasyvaus ir aktyvaus dizaino principų taikymas;
- Mažas aplinkosauginis pėdsakas (laikantis viso gyvavimo ciklo metodikos);
- Sveikos aplinkos žmonėms kūrimas (fiziškai ir psichologiškai);
- Integracija į esamą kraštovaizdį;
- Vietinių rūšių naudojimas želdiniams (medžiai, augalai ir žolės);
- Žaliojo indekso strategijos laikymasis projektuojant artimą pastato aplinką.

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Retrospective Analysis of Sustainable Architecture: Mind-Mapping Development of Ideas and Expression

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Retrospective Analysis of Sustainable Architecture: Mind-Mapping Development of Ideas and Expression

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Abstract

This research focuses on the historical development of sustainable architecture. The study highlights the dynamic interrelation between ethics and aesthetics, it identifies the key concepts, trends that are relevant today in order to achieve harmonious co-existence between humans and nature. The article consists of six chapters that chronologically highlight the important developmental turns of environmentally oriented architecture: 1-collision between industrial and natural in the 19th and early 20th centuries, 2-at the edge of the modern movement, 3-environmental awakening in 1960s – 1970s, 4-the wind of change in 1980s, 5-the rise of sustainable architecture in 1990s and the emerging complexity of design, 6-sustainability in architecture as a global phenomenon. The concluding section summarizes and generalizes the findings. It also presents the existing problems, offering insights for the future development. The methodology of the research includes literature review, critical analysis, comparative analysis, and systematization. The mind mapping technique and timeline construction are applied as tools in the study to extract the core ideas and developmental shifts from the linear historical analysis.

Keywords: sustainable architecture, sustainability, environmental ethics, architectural expression, aesthetics, mind mapping.

Introduction

Currently, the urgent need to reduce negative ecological impacts require a rethinking of our interaction with the environment. Some researchers and thinkers note that even the current sustainable development paradigm is essentially limited and that it is no longer sufficient to maintain the *status quo* (Ehrenfeld 2008).

M. Skjonsberg (2011) compared architecture to science fiction: both have always been progressive in inventing ideas for the future. These days, there are a variety of concepts that go beyond the conventional paradigm of sustainable development and propose alternative approaches in the field of architecture. Scientific studies (Istiadji et al. 2018; Delancey 2004; Berardi 2013) have shown that the sustainability paradigm is shifting towards a systemic, dynamic, organic, holistic and non-linear approach. The emerging concepts of resilient, restorative, regenerative architec-

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ture and others illustrate the effort to restore the lost connection with the natural world and to develop the co-existence between humans and nature in the urban environments of the future. Aesthetics has always played an important role in expressing beliefs throughout the history of architecture, and so it is interesting to examine the impact of evolving environmental attitudes on the expression of architecture. In order to better understand these dynamic processes, it is worthwhile not only to look at current development in the field of sustainable buildings, but also to analyze the past - the history of the development of what can be called environmentally friendly, responsible or sustainable architecture.

Visual experience is the first and probably the most powerful way of perceiving, appreciating and evaluating the built environment. The intuitive sense of aesthetics depends on individual perception, cultural background, beliefs, etc. Aesthetics can even be considered as "a form of knowledge that is gained through the senses" if we follow A. G. Baumgarten, the 18th century philosopher who coined the term "aesthetics" (Lee 2011, p. 7). M. Skjonsberg (2011, p. 23) follows the Greek notion of aesthetics and argues that ethics and aesthetics are interrelated because the visual sense of aesthetics and the feelings of "justice, well-being and satisfaction are all included in our sensorial sphere." Therefrom, this study defines aesthetics in architecture as a visual and sensory experience that reflects ethical attitudes and values of a particular group or population. This research focuses on the historical development of sustainable architecture and highlights the interrelation between ethics and aesthetics. Therefore, the aim of this study was to demonstrate how the aesthetics of sustainable architecture has evolved over time in relation to ethical attitudes towards the environment. To achieve this aim the following tasks were carried out:

- to highlight the changes in ethical attitudes towards the environment that have had an influence on the development of aesthetics of sustainable architecture;
- to present the most characteristic aesthetic directions of sustainable architecture in the course of its historical development;
- to reveal the influence of ethical attitudes towards the environment on the aesthetics of sustainable architecture.

Material and methods

The review paper is divided into six chapters that chronologically highlight the important developmental turns of environmentally oriented architecture from the onset of collision of the industrial and the natural in the 19th century to sustainable architecture as a global phenomenon in the 21st century. This study demonstrates both relevant twists and trends in the development of sustainable architecture based on analysis of literature and examples and the benefits of visualization techniques in research and how they can complement linear historical studies.

The methodology of the research includes a literature review, a critical analysis, a comparative analysis and a systematization. There are already valuable studies on the history of sustainable architecture (Attia 2018; Tabb and Deviren 2014; Wines 2000, 2019), however this study uses the mind mapping technique and the construction of timeline to systematize the analyzed material and highlight the key ideas that have emerged throughout the development of sustainable architecture and are relevant to the recent sustainable design paradigm. Mind mapping is the technique used in brainstorming and idea generation allowing deconstructing complex topics by creating graphical representation of constituent subtopics and related themes (Kernan, 2017); moreover, it allows easier determining and perceiving links between concepts; it is convenient for visual representation as well. C. Tattersall et al (2007) discussed the possibilities to use mind mapping in scientific qualitative research for such purposes as transcriptions of qualitative interviews and other types of analysis of qualitative data. This study is the example of mind mapping technique application in the qualitative analysis of development of architecture.

Results and discussion

Collision between industrial and natural in the 19th and early 20th centuries

The 19th and early 20th centuries saw a sharp collision between emerging industry and traditional ways of life that responded to nature. Reactions to the changing conditions and patterns of life took place in all areas of life and creativity, including art, architecture, urbanism, philosophy, technological achievements, etc. The reactions related to the built environment consisted of a variety of approaches ranging from anti-urban and anti-industrial sentiments to urban utopias and concepts of ideal industrial settlements (Samalavicius 2008), which gradually caused the emergence of industrialization and prefabrication, as well as modernism in architecture and urban planning.

J. Wines (2000, p.22) argues that at that time the Arts and Crafts and Art Nouveau movements were the last architectural trends "to celebrate the relationship between the building arts and natural forms." Both short-lived movements, which were quickly displaced by Modernism, could be compared with contemporary biophilic design approach, which suggests using biomorphic forms and patterns, naturality of materials in origin or form, complexity and order (Browning et al. 2014), connections with vernacular and rural aesthetics and craftsmanship in the case of the Arts and Crafts movement.

However, the Arts and Crafts and Art Nouveau were dedicated to please the middle and upper classes; meanwhile, workers lived in miserable conditions in the polluted and crowded industrial cities. These negative consequences of expanding industrialization and urbanization on the quality of life led to the emergence of environmentally conscious concepts in the 19th century (Zaleckis and Vitkuviene 2011). For example, the British physician B. W. Richardson was one of the first to describe the concept of an imaginary city of health – Hygeia (1876). He raised the issues of air pollution control, water and sewage treatment, proposed green areas of the city - avenues of streets and public gardens (Richardson 1876). In 1898, E. Howard's Garden City concept and its implementations in Welwyn and Letchwort emphasized the differences between crowded, polluted, unhealthy urban environments and attractive, green garden cities. Green spaces have become associated with better living conditions at that time (Alexandri 2007). The dominant aesthetic features of the numerous implemented garden cities were the small settlement scale, traditional English housing architecture and greenery (Díez-Medina and Monclus 2018).

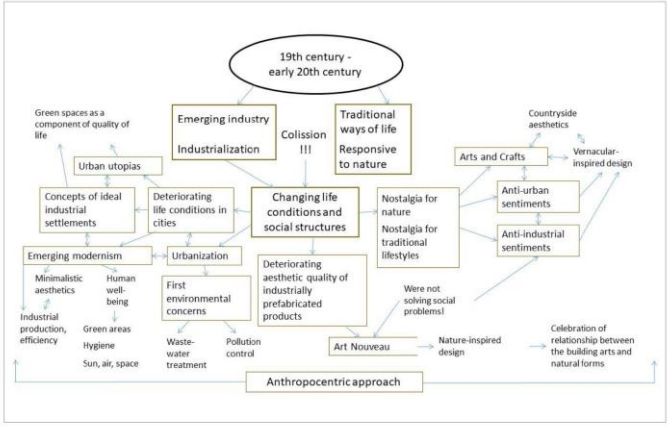


Fig. 1

Mind mapping of the development of architecture in the 19th - early 20th centuries illustrates underlying anthropocentric concerns and emerging trends of a nature-inspired, vernacular-inspired and minimalist aesthetics

In summary, both nature inspired (e.g. Art Nouveau) and environmental quality-oriented (e.g. Garden city) trends were based on the anthropocentric approach, dominated by human needs – aesthetic pleasure in the first case and health and productivity in the second (Fig. 1). Progressive industrialization - the Machine Age, represented the dominant "technocentric and anthropocentric view of human habitat" (Wines 2000, p. 16). However, it is interesting to note that nature-inspired, vernacular-inspired, and greenery-oriented design trends that had emerged in this collision between industrial and natural will continue to reappear throughout the 20th and 21st centuries.

At at the edge of the Modern Movement

Although the first half of the 20th century and the post-war years can be characterised by the mechanistic-reductionist approach to the environment, the technocentric worldview, and the International Style, interesting environmental architectural and ethical approaches have emerged beside this mainstream movement - bioclimatic design, Organic architecture, Regionalism, reverence towards nature and the spirit of the place (Fig. 2). The paradigm of bioclimatic architecture exemplifies the first conscious considerations about climate responsive design - its emergence in the early 20th century became the starting point for the development of environmentally friendly modern architecture (Istiadji et al. 2018; Attia 2018). Bioclimatic projects included experimentation with building orientation, solar shading, passive cooling strategies, solar technologies (Watson 1998) and were usually focused on the search for better hygienic conditions in buildings and healthier environment. Despite the initial attempts to ensure favorable microclimatic conditions both inside buildings and outdoors, the concept of bioclimatic architecture was defined only in 1963 by architect V. Olgyay (Bondars 2013).

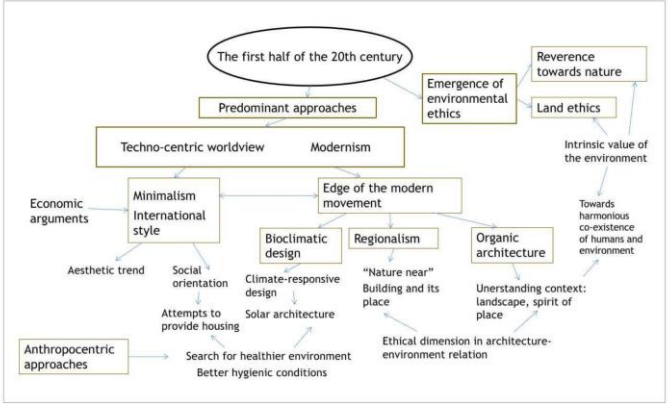


Fig. 2

Evolution of architectural expression at the edge of the Modern movement and the emerging environmental ethics in the first half of the 20th century

Moreover, the works of some architects at that time embodied the emerging architectural philosophy that introduced an ethical dimension into to the relationship between architecture and the environment. F. L. Wright's holistic approach and consideration of the sense of place, R. Neutra's (1989) connectedness with nature – "Nature near", A. Aalto's sensitivity to building in its place. Regionalism and the precautionary principle (Speck 2012) were like echoes of the philosopher's A. Leopold's (1949) "Land Ethic", reflecting a sensual and reverent attitude towards the environment. The concept

of Organic architecture by F. L. Wright stands out in this period. According to J. Wines (2000, 22-23 p.), F. L. Wright's "work shaped the fundamental principles of integrating architecture with its context in this century" and is still relevant to contemporary perspectives on sustainability, biophilic design and other environmentally friendly design patterns (Sassi 2006; Brophy and Lewis 2011; Browning et al. 2014). According to S. Graff (2018), F. L. Wright believed in "a sustainable ecosystem comprising nature, the built environment, and human life, in which each component supports the other components and all thrive as a result." It is worth recalling F. L. Wright's philosophy: a unifying element between ethical values and aesthetic qualities of the built environment – "the Spirit" or the "Third dimension" – as he called the sense of a place. It illustrated not a thing itself, but the character of a thing, that responds to the surrounding environment and has the intrinsic value (Graff 2018).

To some extent, those century-old concepts of F. L. Wright reflect the idea of sustainable co-evolution of the natural and human worlds (including the built environment), that is the key concept of regenerative design - the latest and, at the moment, somewhat futuristic trend in architectural design. However, although some architectural pioneers considered the wider context of the human-nature relationship, the dominant trend of this period was bioclimatic architecture and solar design. These architectural projects exemplify an understanding of climate, as well as active and passive design strategies (Watson 1998). These trends were dominant until the environmental crisis reached its peak in the 1960s and 1970s.

Environmental awakening in 1960s - 1970s

Environmental awareness had already taken root in architecture and related fields during the environmental crisis of the 1960s - 1970s. For example, in 1957, inventor, architect, designer and futurist Buckminster Fuller proposed the holistic concept of "comprehensive anticipatory design science," which insisted on the "effective application of the principles of science to the conscious design of our total environment, making Earth's finite resources meet the needs of humanity without disrupting the ecological processes of the planet" (Ryker 2007). Landscape architect Ian McHarg (1969) encouraged professionals to "design with nature".

Increasing concerns about endangering ecosystems, dwindling natural resources, and pollution led to a stronger environmental movement in the 1960s and 1970s, with awareness-raising publications such as R. Carson's book "Silent Spring". The 1960s youth movement in America was the first wave of the Green movement (Wines 2000; Istiadji et al. 2018). The first Earth Day was celebrated in April, 1970. Radical ideas of a non-anthropocentric environmental ethics had emerged in early 1970s. Norwegian professor A. Naess developed the concept of deep ecology, in which he raised ideas of the total interconnectedness of humans, other living things, and the environment (Wines 2000; Levesque 2016). J. Lovelock formulated the Gaia hypothesis in 1972, in which he defined the Earth itself as a self-regulating living system (Radfor 2019). In 1972 United Nations Conference on the Human Environment was held in Stockholm. This conference signaled the birth of environmental diplomacy and acknowledged that economic development and environmental impact are inseparable as well as proposed the concept of ecological development (Chasek, 2020).

Internationaly acknowledged ecological development ideas and the oil crisis in the US in 1973 and 1979 encouraged the search for architectural innovation in terms of clean energy and energy independence. This led to architectural experiments that included passive and active solar design, the use of wind and integrated energy systems, daylighting strategies (Borasi et al. 2009; Donoff 2016). Ecological housing ideas were explored in many unexpected ways in the 1970s by amateurs, ecological communities, and professionals (Sho 2008). For example, M. Reynolds designed Earthships, the off-grid, self- sufficient structures built from recycled waste materials such as old tyres, bottles, and cans (Mead 2020; Sho 2008); (Sho 2008; Miller 2016). The overall architectural aesthetics of such experiments could very often be described as small-scale, handmade, irregularly shaped, and emphasising the use of recycled and natural materials.

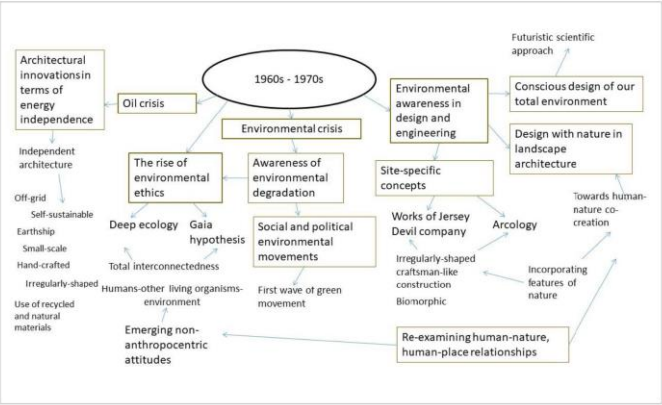


Fig. 3

Environmental awakening and its influence on the development and expression of architecture, leading to the emergence and spread of environmentally conscious design approaches and some radical, eccentric architectural experiments

Other radical architectural experiments of the period reexamined human-nature and human-place relations. In 1969, architect P. Soleri introduced the concept of Arcology – the fusion of architecture and ecology. He implemented this concept in an experimental, compact, car-free eco-city that persists today as an urban laboratory (Eidt 2013; Arcosanti n.d.). Jersey Devil company promoted site-specific, design inspired by the eco-movement. By designing and building themselves, they proposed on the one hand radical, on the other – simple approach to vernacular, craftsman-like way of construction (Sisson 2016).

To sum-up, in the 1960's and 1970's, holistic and non-anthropocentric environmental ideas, beside the ecological crisis, stimulated a series of architectural and even urban design experiments as an emerging radical and eccentric alternative to the prevailing technocentric modernistic worldview and designs (Fig. 3).

The wind of change in 1980s

Non-anthropocentric and holistic views continued to develop in the field of environmental ethics during this period. P. Taylor argued that every entity existing in nature, whether it has a consciousness or not, itself has intrinsic value and deserves moral respect. T. Regan stood for animal rights (Brennan and Lo 2015). W. Fox (2007) introduced the theory of "responsive cohesion," which placed moral priority on the preservation of ecosystems and the biophysical world. The establishment of and growing memberships in environmental organisations such as Greenpeace, Environmental Action, the Sierra Club, Friends of the Earth, and others illustrate the increased attention to the need on environmental protection in society (Wines 2019). The 1984 German exhibition Grün Kaputt expressed criticism of the aesthetic degradation of the built environment, reflected in a loss of greenery, uniformity of architecture, and synthetic building materials (Werthmann 2007).

Ecological design ideas began to occur in emerging architectural environmentally conscious design concepts, such as permaculture, biophilic design, restorative environments, passive house, and others. The permaculture design system was offered in 1978 by B. Mollison and D. Holmgren. They proposed design patterns based on a holistic approach where human well-being and environmental protection are equally important (Istiadji et al. 2018; Nelson 2016). E. O. Wilson for-

mulated the Biophilia hypothesis (1984), which became the basis for biophilic design. S. Van der Ryn and P. Calthorpe suggested creating buildings and communities that are sensitive to place, climate, and the flow of human interactions (Calthorpe and Van der Ryn 1986). S. Owens, in her book "Energy, Planning and Urban Form" (1986) explained different scales of sustainability ranging from global to product scale. W. Feist built the first passive house in 1988 (Feist 2014). American architect M. Wells began designing environmentally-friendly and visually almost invisible underground and earth-sheltered buildings, which he called "green alternative to the asphalt society" (Steinfeld 2003). The architectural work of another American architect, W. McDonough, was based on his concept of "ecologically intelligent design", which includes aspects of manufacture, use, and disposal: the selection of raw materials, the transportation of materials to the factory, the manufacturing process, the durability of the goods produced, the usability of the products, and the potential for recycling (Wines 2019). He was the author of the first green office in the U.S. - Environmental Defense Fund Building in New York City, built in 1985. W. McDonough's design process later became the Hanover Principles (1992) and the Cradle to Cradle concept in 2002 (Vale and Vale 2014; McDonough n.d.; Braungart and McDonough 2002; Wines 2019).

Research and institutionalisation of the concept of "sustainability" also began during this period. The Rocky Mountain Institute was founded in 1982 by A. Lovins and H. Lovins as a research centre dedicated to sustainability studies and was based on the "whole system" approach, with a particular focus on innovations for energy and resource efficiency (Wines 2019). The terms "sustainability" and "sustainable development" became common knowledge in 1987, when the World Commission on Environment and Development (WCED) published a report with the official title "Report of the World Commission on Environment and Development: Our Common Future", also known as "Brundtland Report". This report presented the concept of "sustainable development" - development that meets the needs of the present without compromising the ability of future generations to meet their own needs - and its guiding principles as they are commonly understood today. It is evident that the definition of sustainability clearly reflects the human interest side (Istiadji et al. 2018) and could be referred to as an anthropocentric approach.

Architectural expression in general also underwent changes in the late 1980s. In 1986, the Architectural Review published a monographic number entitled "The New Spirit" that showed a sense of the new cultural climate (Puglisi 2009). In 1988, Ph. Johnson together with M. Wigley organised the exhibition titled "Deconstructivist Architecture" at the Museum of Modern Arts (MoMA). They published an exhibition catalogue that gathered the works of seven promising architects - P. Eisenman, F. Gehry, Z. Hadid, R. Koolhaas, D. Libeskind, B. Tschumi, and the firm Coop Himmelblau (led by W. Prix). These architects shared similar approaches and achieved similar results (Fiederer 2017). Along with their contemporaries, they brought "an extraordinary impulse to contemporary architecture" (Puglisi 2009, p. 63) and "proved to be some of the most influential architects of the late 20th century to the present day" (Fiederer 2017). Accompanied by technological innovations, the so-called Starchitecture became the dominant architectural movement. Some critics note selfishness, egotism, ecological neglect and ignorance of the context in their iconic architecture, as well as manipulation with the term "green" and its use only in ways that do not compromise the aesthetic expression of Starchitecture (Stephens 2009). Nevertheless, it can be stated that the aesthetic experimentation of architects in the 1980s expanded the scope of architectural expression and this emerging freedom of expression could later be taken up by ecologically conscious architects.

In summary, the 1980s can be seen as a period of change in many areas related to sustainable architecture: philosophy, environmentalism, architectural trends, design principles and technical possibilities (**Fig. 4**). However, environmentally conscious design was not yet prevalent in the architectural context in the 1980s.

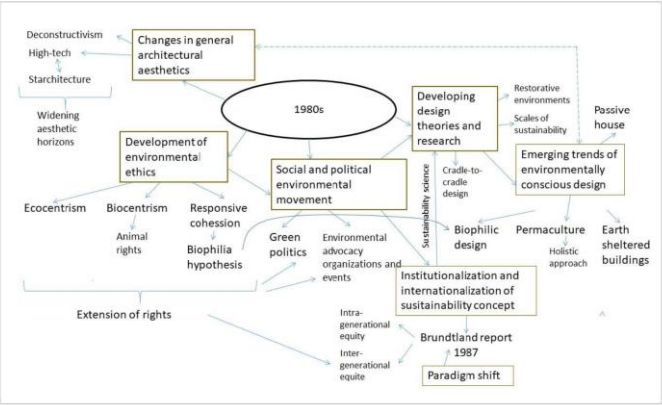


Fig. 4

Emerging trends of environmentally conscious design reflected ethical paradigm shift in the development of societies and illustrated the climate of expanding horizons of aesthetic expression in architecture

The rise of sustainable architecture in the 1990s and the emerging design complexity

In the early 1990s, environmental problems in the form of unusual weather patterns, soil pollution, droughts, oil spills, and increased incidence of disease were directly felt by the societies and became a major concern on the international political agenda (Wines 2000; Istiadji et al. 2018). The definition and understanding of sustainable architecture evolved during this period through the work of forward-thinking architects and new design concepts. S. Van der Ryn and S. Cowan presented a set of ecological design principles that can be applied in buildings, landscapes, cities and technologies (Van der Ryn and Cowan 1995). O. Arup's thoughts on "total design" focused on the building as a whole. The integrative design practice of O. Arup himself exemplified the collaboration between architects and engineers and how the building design team should work to achieve a "more complex whole" (Mang 2001; Uihlein 2016). Indeed, sustainable design and architectural design in general turned to increasing complexity during this period.

Since the 1990s, the advances of digital technologies, tools and design methods such as computer-aided design (CAD), computer-aided manufacturing (CAM), building energy calculation programs including dynamic space and daylight analysis, improved environmental technologies, etc., led to the emergence of new, almost unlimited possibilities in architecture (Wines 2000; Puglisi 2009; Tabb and Deviren 2014; Maciulis 2013). Both the spread of the concept of sustainability and technological advances brought new approaches to architectural expression and aesthetics. High-tech architecture, which developed in the late 1960s (Jencks 1995), acquired new eco-tech and organi-tech features (Tabb and Deviren 2014).

High-tech with its directions, such as slick-tech (emphasised hyperbolization of surface aesthetics), embodied the zeitgeist reflected in the adaptation and use of high technologies for engineering, production, and even architectural expression (Maciulis 2013; Davies 1988). To illustrate, the eco-tech trend intermingles high technologies and paradigm of sustainability. However, Ch. Jencks argues that technology and machine aesthetics "still predominate over nature and the organic," so it cannot be said that high-tech architecture has shifted into organi-tech. Rather, it has been a "slide" in that architectural direction (Jencks 1995). Another direction of technical aesthetics

can be traced in the evolving architecture of this period – low-tech hybrids that developed in the 1990s (Tabb and Deviren 2014). Low-tech were mostly small-scale residential buildings, that, although not new in 1990s, followed passive design strategies such as natural ventilation, controlled solar gain, night cooling, rainwater collection, etc., as well as use of local materials. Low-tech hybrids usually incorporated both high-tech and low-tech solutions (Maciulis 2013; Shari 2018).

Some visionary architectural sustainability concepts of the 1990s based on the properties of natural systems are still influential today. For example, the regenerative design concept of J. T. Lyle (1994), professor of landscape architecture, provided "12 regenerative strategies" – practically tested ecological design strategies for water use, land use, energy use, and building design. P. Mang (2011) illustrates the definition of the word "regenerate" as containing three key ideas: a radical change for the better; the creation of a new spirit; the return of energy to the source. In 1997, biologist J. Benyus introduced the concept of biomimicry – "a practice that learns from and mimics the strategies found in nature to solve human design challenges" (Biomimicry Institute 2021). Biomimicry was introduced into the the field of architecture, in which attempted to mimic both natural processes and forms. For example, W. McDonough's and M. Braungart's "cradle-to-cradle" design principles model a waste-free, closed-loop design life-cycle (Wines 2019). The BREAM (1990) and LEED (1998) certifications brought some measurable criteria to the design and construction of environmentally conscious buildings (Smith and Parmenter 2016).

Meanwhile, parametric architecture opened new possibilities in creating organic architectural forms. The first architect to use computers to generate architectural forms was G. Lynn, who is famous for his "blob" and later for "folding in architecture" - experiments driven by computer generated forms. The architectural expression of "blobby" buildings has an organic, amoeba-shaped building form, an undulating, curvilinear building design (Craven 2020). Unlimited possibilities of architectural imagination and organically shaped experiments also appeared in virtual space. The expression of architecture became possible outside the physical world. Digital software and advanced fabrication methods enabled the opportunities of complex biomimetic and biomorphic architectural forms that were previously impossible.

The expression of ecological aesthetics has expanded greatly since the 1990s. The influence of earlier earth-sheltered structures led to a literal greening of architecture. Horizontal and vertical vegetation was often used in sustainable architectural projects. Vegetation systems of buildings have created habitats for wildlife - insects and birds, in addition to their other benefits such as mitigating the heat island effect, created habitats for wildlife – insects and birds. Thinking about how wildlife can live in dense urban structures brings us closer to implementing human-nature co-evolution in urban settlements (Tabb and Deviren 2014).

In summary, the 1990s brought increased design complexity, new forms and the search for sculptural, irrational forms (Lupeikis 2007) and their applications in design (Tabb and Deviren 2014). The emphasis on ecological dimensions of architectural design and innovations of environmental technologies led to a more technologically oriented architectural sustainability, while aesthetic expression expanded the earlier boundaries of architectural imagination (**Fig. 5**).

Sustainability in architecture as a global phenomenon

Sustainability in architecture has become a global phenomenon since the turn of the millennium, in which the horizons of sustainability are constantly expanding. If the concept of sustainability in the 20th century expressed the idea of preserving (literal meaning of the word "sustain") the current situation – not causing more damage, the 21st century expresses the need to go beyond sustaining towards restoration of damage, regeneration of systems and co-evolution with nature (Berardi 2013; Robinson and Cole 2015). "The new sustainability" approach discussed by A. D. Istiadji et al. (2018) demonstrates the ongoing shift in the sustainability paradigm. The systemic - holistic ap-

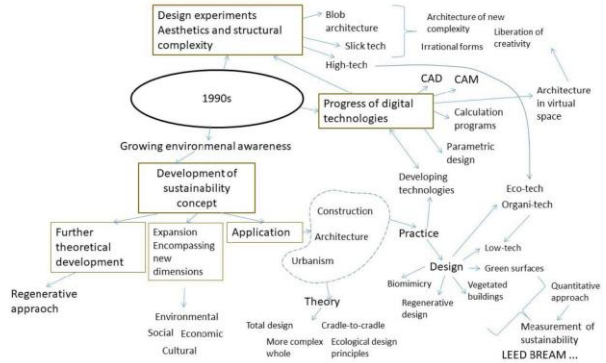


Fig. 5

Application of the concept of sustainability in construction, architecture and urbanism, influenced by the progress of digital technologies and the emerging architecture of new complexity

proach, which takes into account the mutual benefits of living with nature, is gaining acceptance in place of the long-prevailing anthropocentric approach that satisfies only the needs of the human race. U. Berardi (2013) encourages thinking in larger contexts by emphasising the importance of the interrelationship between the building and its environment. The influential architect B. Ingels in his TED lecture entitled "Hedonistic Sustainability" (2011) encouraged architects to become "designers of ecosystems" that encompass ecology, economy and resources (Ingels 2011). Network thinking that encompasses architecture, landscape, technology, culture, nature and ecology becomes crucial for the development of sustainable living environments where buildings are only one part of the larger whole (Tabb and Deviren 2014).

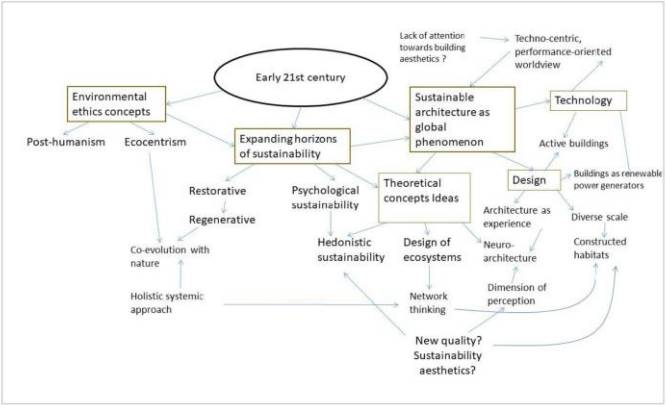
The understanding of architecture as a sensory experience is reinforced in new considerations of the sustainability paradigm, which includes the dimension of perception and brings the notion of psychologically sustainable architecture (Lindal and Hartig 2013; Ramzy 2015; Bond 2017). M. Bond (2017), in his article in BBC Future, summarizes the research of neuropsychologists, psychologists, architects and urban planners who have studied the relationship between the environment and people and introduces the term "neuro-architecture" (Lindal and Hartig 2013). M. Bond argues that little attention is still paid to the potential cognitive effects of the environment on humans in the design of buildings and urban structures, even though we already know their psychological significance (Bond 2017).

The diversity of sustainable architecture has greatly expanded, ranging from small to large scales, from new construction to renovation of existing structures, both high-tech and low-tech, in various environments. Architectural trends blend together and adapt the newest technological advances. Buildings become active in time – media, hypersurfaces, kinetic architecture, independent building envelopes mediate temperature, reacting to light or rain (Cao 2019). Practices of energy autonomous architecture are spreading rapidly – innovative buildings become "renewable power generators" (Droege 2012; Sobek 2018).

While sustainable design used to focus mostly on advancing form, materials and technology of individual buildings, projects of much a larger scale began to emerge. The 21st century has brought with it the need for a new integrative approach to contextual design, where buildings are no longer

Fig. 6

Sustainable architecture is becoming a global phenomenon in the early 21st century. The sustainability concept is evolving towards restorative, regenerative approaches and living environments as constructed habitats; however, the expected qualitative aesthetic turn of sustainable architecture seems to be hindered by quantitative technocentric performance-oriented approaches



considered as individual and isolated objects. G. Mangone and P. Teuffel (2011) suggested redefining buildings as "constructed habitats" that are interconnected with the surrounding ecology. The built and natural environment, people as well as other living organisms, regionally specific aspects such as "surrounding topography, indigenous vegetation, cultural history, and territorial idiosyncrasy" (Wines 2008), and even natural processes are considered as an integrated whole in recent thinking on sustainable architecture. Large number of new experimental eco-settlements, such as the eco-city in Montecorvo, Spain by MVRDV in collaboration with GRAS (2008), Solar City, Linz, Austria (2001-2005), reflects a more systematic approach. China claims to be developing 285 eco-cities – one of which is Tianjin. However, detailed research revealed that "eco" is often used as a trendy cliché for marketing purposes. To illustrate this, W. Shepard compared Tianjin and London in measurable sustainability criteria. His study showed that London outperformed Tianjin as an eco-city, although we do not consider London as an eco-city (Shepard 2017). The question is what can be called a truly sustainable building or city and whether they reflect the concept of sustainability through their aesthetics.

Although the aesthetic and coevolutionary importance of the built environment has been highlighted in many studies, the focus on reducing use of energy and other resources still overshadows aesthetic and psychological dimensions of sustainability. Some initiatives such as Living Building Challenge (2000), seen as an extension of LEED, presented the exact standards to measure sustainability. It deals with seven performance categories: Site, Water, Energy, Health, Materials, Equity and Beauty, and finally included ethic, aesthetic and co-evolutionary principles in the evaluation of sustainable design.

There are a variety of aesthetic classifications (Wines 2000; Guy and Farmer 2001; Sauerbruch and Hutton 2011, Di Carlo 2016 and others) that show the diversity of trends and the difficulties in classifying sustainable buildings according to artistic expression. Although, there are examples of innovative aesthetics in sustainable architecture, these buildings are exceptional and rare. Currently, most sustainable buildings that receive the highest certification rates from LEED and BREAM, often do not have exceptional aesthetic expression as sustainable buildings. The strong influence of rationality and functionality of modernism is still felt in contemporary architecture.

Nevertheless, ten of the most sustainable buildings announced each year by the AIA (AIA 2019) illustrate that the search for sustainable aesthetic expression is ongoing.

Conclusions

This study has highlighted the important twists and turns in the development of sustainable architecture, from the first environmental concerns to emerging environmentally conscious design trends and to sustainable architecture becoming a global phenomenon (**Fig. 7**). The mind mapping and timeline construction techniques that complemented these linear historical studies allowed us to distinguish prevailing anthropocentric and alternative non-anthropocentric currents of thought that had influenced each other and the expression of environmentally conscious architecture. The timeline shows that both currents were constantly expanding the field of moral concerns.

The study enabled to distinguish several reflective periods whose influence was important for the development of sustainable architecture: the period of bioclimatic architecture in the 1900s-1960s, the experimental architecture of the 1960-1970s, the period of change in the 1980s, the establishment of sustainability in the1990s, and the current trends since the 2000s. The eco-friendly architectural trends that have emerged still exist today, though they are often heavily influenced by modernist trends. The mind-mapping technique and the construction of a timeline allowed us to group the aesthetic trends of environmentally friendly and sustainable architecture into several evolving trends (**Fig. 7**): nature-inspired architecture and technology-inspired architecture (considering both advanced and vernacular technologies). These trends tend to influence and converge with each other and integrate in the projected future development in the human-nature co-creation of constructed habitats. It should be noted, however, that contemporary sustainable buildings certified and highly rated by LEED or BREEAM often lack distinctive and meaningful architectural expression. Nowadays there are almost unlimited opportunities for architects to express their creativity, whether in a physical or virtual space. Therefore, the study of sustainable architecture aesthetics can trace important trends or exceptional examples of how architects envision the pursuit of sustainability, and provide successful design strategies that can be used as a further source of inspiration.

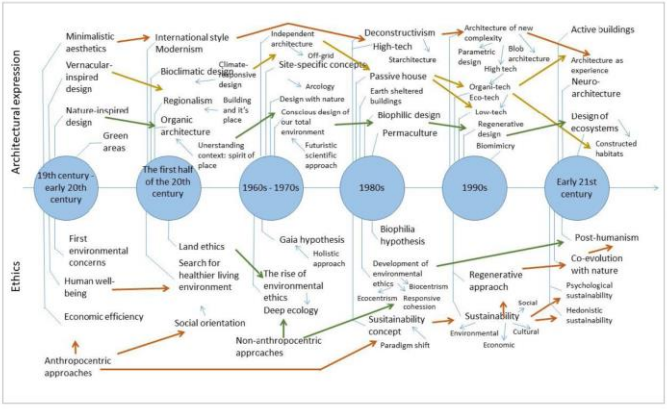


Fig. 7

Timeline of the emergence and development of sustainable architecture, showing the important currents of thought (anthropocentric (orange arrows) and non-anthropocentric(green arrows)) and design (technology-inspired (advanved technology inspired – orange arrows, vernacular technology inspired – yelow arrows) and nature-inspired (green arrows)) moving towards the foreseen integration in the co-creation of humans and nature in the constructed habitats

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The Relationship between Ethics and Aesthetics in Sustainable Architecture of the Baltic Sea Region

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Abstract: Architecture, as a mean of art and as a factor that physically shapes the environment, undoubtedly serves as a form of expression of ethical attitudes. It combines ethical values and responsibility for solving environmental problems with aesthetic qualities of the built environment. The holistic approach is gaining ground in the paradigm of sustainability, where architectural concepts such as biophilic, biomimetic, resilient, restorative, and others reinforce the idea of coexistence between humans and nature. In the 21st century, sustainability has become a global phenomenon; therefore, contemporary architecture is expected to reflect the idea of sustainability in its expression. This study explores the relationship between ethics and aesthetics in sustainable architecture in practice. Furthermore, this study attempts to illustrate how the architectural expression of certified sustainable buildings in the Baltic Sea region reflects the trends of sustainability within an ethical paradigm. The research question of this study is as follows: what are the prevailing aesthetic trends and are environmental ethical values expressed in the sustainable architecture of the Baltic Sea region? The study of examples of sustainable architecture was carried out by analyzing the three main databases of certified sustainable buildings—Deutsche Gesellschaft für Nachhaltiges Bauen (DGNB), Leadership in Energy and Environmental Design (LEED) and Building Research Establishment Environmental Assessment Method (BREEAM). The study found eight predominant groups of aesthetic expressions of sustainable buildings and the absence of a distinctive architectural expression that could be considered as sustainability aesthetics. It can be hypothesized that the lack of aesthetic distinctiveness of certified sustainable buildings could be related to the absence of cultural, aesthetically oriented criteria in building sustainability rating systems.

Keywords: sustainable architecture; the Baltic Sea region; aesthetics; sustainability aesthetics; building sustainability certification systems; certified sustainable buildings

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1. Introduction

Sustainability is currently recognized as the most important development trend in societies. It is finding its way into almost all scientific disciplines and fields of practice, including construction and architecture. Although there are numerous definitions of sustainability [1], the so-called Bruntland definition, with its call for the inclusion of intra-generational and intergenerational equity [2], is the most widely accepted. Architecture as a physical shaping factor of our environment, embodying energy and materials as well as expressing our values, undoubtedly serves as a mirror of the sustainability state of societies [3]. Some researchers even claim that contemporary architecture both contributes to sustainability and expresses unsustainability [4–6]. According to Hill [5]), with the rise of modernism, architecture has become one of the most significant commodities and a site of commodity accumulation.

Currently, architecture is associated with increased energy and resource consumption. Based on the full life cycle approach, the global building sector is assumed to be responsible for: half of all extracted materials, half of all energy use, one-third of water

use, and one-third of waste generation [7]. Grant [4] identifies contemporary architecture's links to overconsumption in relation to competitive status-seeking and with the unsustainable cycle of resource-intensive consumption and labor. The identified links between contemporary architecture and unsustainability together with a general understanding of the environmental impact of architecture and the associated construction industry have led to an ongoing commitment by the architectural profession to sustainability or the so-called "green imperative for sustainability in architecture" [8,9]. Since the World Congress of the Union of International Architects in 1993, the concept of sustainability has been increasingly applied by the architectural profession, including world-renowned architects such as Richard Rogers. In 1993, the Congress promulgated the declaration, which emphasized that sustainable design should become a normal practice [8].

Furthermore, contemporary legal frameworks in numerous countries and supranational entities, such as the European Union (EU), and even the global development paradigm dictate that some aspects of architectural sustainability are enforced by law. Institutions that make the achievement of sustainability in the fields of architecture and construction becomes "inevitable", as Jauslin [10] states. Take, for example, the global United Nations Sustainable Development Goals—SDGs [11]. At least seven of them relate directly to the sustainability of living environments and buildings, in particular: SDG 3—Good health and well-being; SDG 6—Clean water and sanitation; SDG 7—Affordable and clean energy; SDG 11—Sustainable cities and communities; SDG 12—Responsive consumption and production; SDG 13—Climate action; SDG 15—Life on land.

Sustainability concerns of living environments reflect the need for solutions in regional and urban planning, and architectural design. Although the SDGs generally reflect ethical values, SDG 11 holds aesthetic potential. SDG 11 focuses on making cities and human settlements inclusive, safe, resilient and sustainable, where sustainability aesthetics can be an important quality criterion [12,13]. The European Commission is on track to develop a common framework for assessing the sustainability performance of buildings to integrate the building sector into the EU's evolving circular economy [7]. Increasing energy performance requirements for buildings are being enforced by law in EU member states [14]. Moreover, the general perception of architecture in EU member states is evolving in line with the sustainability paradigm. For example, the current Lithuanian Law of architecture defines the principle of sustainability as one of the quality criterion of architecture [15].

The achievement of many of the Sustainable Development Goals and objectives is quantifiable, which may give the impression that it is primarily a technological challenge. However, Fox [8] emphasizes sustainable development as an ethical category. Moldovanova [16] also highlights that sustainability includes an ethical dimension. However, in her opinion, the concept of sustainability ethics has received less attention in the literature on sustainable development issues. Moreover, in the field of environmental ethics, of which the sustainability concept is an integral part, there is a wide range of approaches—from anthropocentric to eco-centric ones [3]. The concept of sustainability is constantly evolving to include restorative and regenerative concepts [17].

Considering the aforementioned shift of the sustainability paradigm, the literature on sustainable design, as well as the number of projects and realizations labeled as "green", "sustainable" and "ecological" is increasingly growing. Sustainability certification schemes such as BREEAM and LEED have accelerated this process in recent decades. However, some architectural critics and researchers [18] note that sustainability certification schemes do not encourage the development of some aspects of sustainability, such as architectural aesthetics, which often remains ignored. This makes the aesthetic expression of sustainable buildings a relevant research object.

Furthermore, regional peculiarities are undoubtedly relevant to sustainable architecture, including climatic and material aspects, aesthetic expression, and the links with the context of buildings. Some authors even identify a sense of place, or the so-called spirit of the place, as an imperative for environmental ethics [19] and the aesthetics of sustainable architecture. Considering the relevance of regionality, this research focuses on the ethics

and aesthetics of sustainable architecture of the Baltic Sea region. In this research, the Baltic Sea region is considered as a territory that includes countries that have coastlines along the Baltic Sea: Denmark, Estonia, Latvia, Finland, Germany, Lithuania, Poland, Russia, Norway, and Sweden. The research question of this study was formulated as follows: What are the prevailing aesthetic trends and are the environmental ethical values expressed in the sustainable architecture of the Baltic Sea region?

2. Materials and Methods

To answer the research question, the methodology, including a literature review (synthesis and analysis) and the case studies of examples (comparison and classification) was formulated. The literature review was used for the two main objectives: to define the concepts of sustainable architecture and to clarify the notion of sustainability aesthetics. Literature sources were searched in the main scientific databases—Scopus and Web of Science, using the keywords "sustainable architecture" and "sustainability aesthetics". An additional search was conducted using general search engines. This additional search uncovered valuable articles and monographs in the professional press that were not included in scientific databases.

The definition of sustainable architecture was formulated based on the general literature on sustainability [2] and research in the fields of architecture [20,21], design [22], and landscape [23]. The definition of the notion of sustainability aesthetics was based on the ideas of Kagan [6]. The existing classifications of aesthetic expression of sustainable architecture [24–26] and the messages potentially embodied in sustainable buildings [5,24,26] were also analyzed. The features of sustainability aesthetics identified by Kagan [6], such as complexity and complementarity of opposites, serve as the analytical approach for the selected examples of certified sustainable buildings.

The analysis of the examples focused on the territory of the Baltic Sea region, which includes the following countries: Denmark, Estonia, Latvia, Finland, Germany, Lithuania, Poland, Russia, Norway, and Sweden. The sustainable building certification schemes used internationally in this region are Deutsche Gesellschaft für Nachhaltiges Bauen (DGNB), Leadership in Energy and Environmental Design (LEED), and Building Research Establishment Environmental Assessment Method (BREEAM). The databases of these schemes were selected as a source of examples of certified sustainable buildings for the analysis. The time-frame for the analysis was defined as 2016–2020 (except in the case of BREEAM, where some earlier examples were included). The aesthetic expressions of a total of 112 buildings, mainly for public and commercial use, were analyzed.

Based on the aesthetic similarities of the collected buildings, forty distinctive sustainable buildings were selected for further analysis and divided into eight categories representing different prevailing trends. The selected examples were discussed from the perspective of sustainability aesthetics. Finally, the conclusions were formulated.

3. Results

3.1. Defining the Sustainable Architecture

The definition of sustainable architecture or sustainable architectural design is quite complex. According to Marchand et al. [22], sustainable design "involves reconsidering the way objects are thought about, developed, produced, distributed, used, reused, recycled, and disposed". They stated that sustainable design objects have a broader social-cultural impact and promote new ways of living. Musacchio [23] identified six dimensions of environmental sustainability: environment, aesthetics, ethics, equity, experience, and economy. These two contributions from the fields of architectural design and landscape management show that sustainability is not limited to resource consumption or energy conservation. It can be considered that sustainable architecture is entirely based on the principles of sustainability. These principles include the pursuit of material and immaterial well-being, equity for present and future generations, justice within and between societies, protection and promotion of cultural and biological diversity, precaution in decision-making, and

recognition of the interdependence of phenomena [2]. Architectural sustainability is programmed at the initial project development stage—it begins with an idea and continues throughout the building's life cycle: design, site preparation, construction, demolition or renovation. A sustainable building is not only durable, long-lasting, and environmentally friendly, but also contextual, aesthetic, and psychologically acceptable. Sustainable architecture promotes the sustainable development of the environment and society, including the conservation of resources and energy, as well as social cohesion, to contribute to the improvement of the quality of life in a broader sense [21].

According to Heymann [18], sustainability certification does not stimulate the evolution of the aesthetic expression of sustainable buildings towards a more coherent representation of the ethical values of sustainability. The definitions of sustainable architecture presented in this research allow us to conclude that, as there is a "green imperative for sustainability in architecture" [8,9], an aesthetic imperative should exist in sustainable architecture to the same extent. Sustainable architecture not only contributes to environmental, social, and economic sustainability, but also has a high aesthetic quality and recognizability. This encouraged analysis of the links between ethics and aesthetics in sustainable architecture both from a theoretical point of view and the manifestations of these links in actual sustainable buildings.

3.2. Aesthetics of Sustainable Architecture

The term "aesthetics" was coined in the 18th century by the German philosopher Alexander Baumgarten, who defined aesthetics as the science of sensory perception [27]. Hill [5] states that the contemporary debate on aesthetics, including architectural aesthetics, can be characterized by the separation between the perceiving subject and the world of objects around them. According to him, this clear separation emerged in the dawn of modernity and currently the term "aesthetics" can refer to both the subjective experience and the properties of the object.

Marchand et al. [22] also agree that the terms "aesthetics" or "aesthetic qualities" are usually associated with which object is perceived by the senses. In relation to aesthetic experience, the term "aesthetics" refers to some aspects of the cognitive response. In the first case, it is focused on the properties of a particular object; in the second, it is concerned with the experience of those properties, which may also be influenced by assumptions or preconceptions of the subject that is not directly related to the object. In contemporary aesthetic theories, however, attempts can be traced to seek the relationship between subject and object in aesthetic experience. For example, British anthropologist, sociologist, linguist, and expert in many other fields G. Bateson, defined aesthetics as a response to connecting patterns. He defined the percipient's aesthetic priority as the mind's ability to recognize features similar to those of another system it has encountered. According to G. Bateson, a characteristic questions of aesthetics would be: "How are you related to this object or entity? What structures connect you?" [6]. Researchers emphasize that the phenomenon of sustainable development still lacks a new, recognizable aesthetic language [24]. Few precise definitions of sustainability aesthetics can be found in the academic literature. In many cases, descriptions of the artistic expression of objects, trends or classifications of sustainable architecture are presented without specifically defining what the aesthetics of sustainability is. A specific description of the aesthetics of sustainability was provided by Kagan [6]. He derives this definition from G. Bateson's concept of aesthetics as a response to connecting patterns and argues that this aesthetics focuses on relationships and processes and are based on a sensitive response to connecting structures at many levels. Following G. Bateson, Kagan [6] suggests focusing not only on the immediately visible differences between the elements of the lifeworld, but to looking at the metastructure that binds the lifeworld together.

In this way, the aesthetics of sustainability is encouraged to emphasize the complementarity of opposites. This new language of sustainability aesthetics should not be afraid of complexity and should be based on complex and dynamic networks of life in the envi-

ronment and the social, political, and economic complexities of modern societies, open to the creative forces of chaos and unexpected outcomes.

A. Marchand et al. [22] note that the aesthetics of sustainability stimulates not only changes in the aesthetic quality of the objects around us, but also changes in the meanings associated with the aesthetic properties of our environment, including objects. Aesthetics becomes an important cultural aspect in the definition of sustainable architecture (Figure 1).

Figure 1. What properties define sustainable architecture in line with sustainability dimensions? (Image by authors based on 1—[20], 2013; 2—[28]; 3—[29]).

The debate about what is sustainable architecture is ongoing, and the aesthetics of sustainable architecture is not only associated with green roofs and adobe or straw buildings, but also with high-tech systems, such as solar panels, building automation systems, and double facades [30]. Guy and Farmer [25] emphasized that sustainable architecture is a "contested concept". Researching the expression and development of sustainable architecture, they observed the characteristic "technocentrism" that disregards the sensitivity to place and culture. Guy and Farmer [25] distinguished eco-technical (future-oriented architecture), eco-centric (autonomous, recycled architecture in harmony with the natural environment), eco-aesthetic (iconic buildings), eco-cultural (architecture sensitive to the cultural context and using local traditions), eco-medical (architecture of natural materials focused on health, quality of life and well-being), and eco-social (community-based architecture) expressions of sustainable architecture. Recognizable architectural aesthetics undoubtedly characterize each of these trends.

Sauerbruch and Hutton [26] distinguish several approaches to sustainable architecture and its aesthetics: (i) a quantitative approach that focuses primarily on energy and cost reduction, and on listing sustainability criteria and certification. In this case, the question of the aesthetics of the building is left aside and focused mainly on quantifiable, technical aspects—the building is not treated as an architectural object, but as a temporary stage of a larger life cycle, a certain "storage" of building materials to be recycled or reused in later stages of the cycle; (ii) the desire to recreate and interpret the aesthetics of the past, of historical architecture, which is considered inherently sustainable; (iii) the pursuit of the most ecologically efficient forms, "form follows ecological function". The so-called "solar architecture" or "solar aesthetics" [31], "passive house" or "passive design"[32], where the form of the building aims to adapt to the environment and use renewable energy sources as efficiently as possible, can also be attributed to this concept. Biomimetic design [26,33], in which objects are designed with biomorphic forms, can also be classified in this trend. In the latter case, the basic idea is a building that looks and functions like a living organism, but, as M. Sauerbruch and L. Hutton [26] note, the synergy with nature often remains only as an intention, and the result can be called biomorphic formalism.

There is considerable discussion in the literature about what values are expressed through the aesthetics of sustainability [5,24,26]. According to Hill [5], architecture should express more than the social status of the owner or the talent of the architect. Meyer [34] observes that the aesthetics of sustainability should bear witness and highlight aspects of the current environmental crisis, the architecture of buildings should reflect the public interest in ecology and environmental concerns inherent in modern culture [26]. In addition to revealing the ecological crisis through architectural aesthetics, there is another trend—the creation of highly aesthetically appealing ecological products and environments [24,26]. In this case, architecture can literally become an advertisement for alternative lifestyles, demonstrating that a reduction in consumption does not necessarily mean a reduction in quality [26].

3.3. Environmental Ethics and Aesthetics of Certified Sustainable Buildings in the Baltic Sea Region

Environmental ethics is a branch of environmental philosophy [35]. It is "focused on the complex human-nature relationship that manifest in environmental problems such as the loss of species and wildlands; air, land, and water pollution; overpopulation; and resource scarcity" [29]. Environmental ethics emerged in early 1970s as a result of the search for a more respectful approach to the environment and its components—living and non-living organisms.

Ongoing changes in the ethical dimension of architecture reveal new attitudes about how we behave in our environment. Currently, there are a variety of concepts that are slowly expanding the anthropocentric concept of sustainable development and proposing future approaches to holistic architecture. Scientific studies (e.g., [20,36,37]) show the ongoing shifts in the sustainability paradigm towards systemic, dynamic, organic, holistic, and non-linear approaches. Emerging concepts of resilient, restorative, regenerative architecture, and others highlight the aspiration to restore the lost connection with the natural world, as well as to develop coexistence between humans and nature in the urban environments of the future.

These trends are reflected in certification schemes of sustainable buildings. For example, the Living Building Challenge (LBC) certification system, seen as an extension of LEED, has introduced criteria of equity and beauty into the evaluation of sustainable architecture. Beauty is defined there as "celebrating design that uplifts the human spirit". Although, it is almost impossible to define beauty, biophilic design is highlighted as a mean to createg beautiful buildings: "The key to creating beautiful buildings is to embrace a biophilic design process that emphasizes that people and nature are connected and the connection to place, climate, culture and community is crucial to creating a beautiful building" [38]. However, this certification system is rarely used in the Baltic Sea region. The certification systems that are applied internationally in this region are DGNB, LEED, and BREEAM (Table 1).

The question arises as to what are the prevailing aesthetic trends and are environmental ethical values expressed in the sustainable architecture of the Baltic Sea region. In order to obtain answers, further research was conducted. Sustainable buildings were analyzed by searching three main databases of certified sustainable buildings—DGNB, LEED and BREEAM. The search criteria included certified new construction buildings in countries of the Baltic Sea region in 2016–2020 (except in the case of BREEAM, where some earlier examples were included). The main difficulty in the search was the lack of visual information on the projects, especially in the LEED and BREEAM databases; this required additional research on each project to find visual references and assess the aesthetic expression. Consequently, the search became rather selective. However, the aim remained to collect as many examples as possible.

The number of buildings analyzed reached 112. The selection process included: the BREEAM certification database [40] has numerous certification cases in the all countries analyzed; however, visual information is not included in the database itself. Therefore,

14 buildings (new construction)—5 from Norway, 1 from Sweden, 2 from Lithuania, 2 from Russia, 4 from Poland—were selected for the further investigation.

Table 1. Certification systems that are the most usually applied in the Baltic Sea region, [26,30,39–42]).

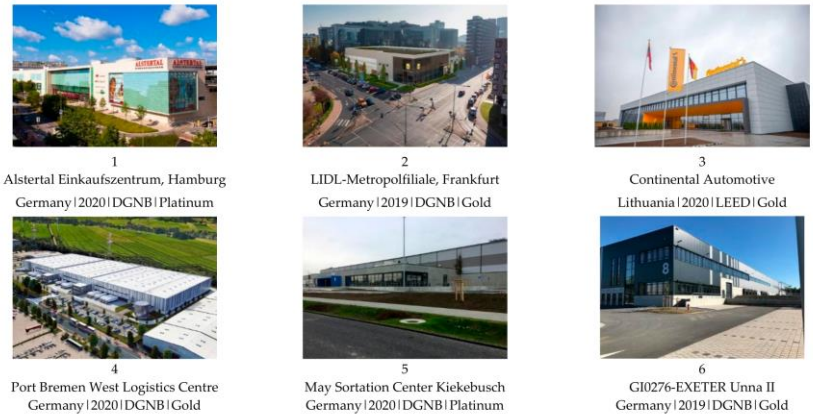
No.	Certification System	Origins	Focused on	Certificate Rating (Highest-Lowest)
1	BREEAM (Building Research Establishment Environmental Assessment Method)	United Kingdom 1990	energy, health and wellness, innovation, use of the soil, materials, management, pollution, land use and ecology, transport and waste	Outstanding Excellent Very good Good Pass Acceptable
2	LEED (Leadership in Energy and Environmental Design)	USA 1998	location and transport, sustainable sites, efficiency of water use, energy and atmosphere, materials and resources, internal environmental quality, innovation and processes, regional priority credits	Platinum Gold Silver
3	DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen)	Germany 2007	holistic approach, life cycle, sociocultural and functional, environmental, economic, site, technical and process quality assessment	Platinum Gold Silver Bronze

The LEED certification database [43] included examples in all countries; however, the lack of visual information limited the study. A total of 35 buildings were selected for further study: 1 in Norway, 3 in Sweden, 3 in Finland, 1 in Russia, 2 in Estonia, 3 in Latvia, 4 in Lithuania, 13 in Poland, 4 in Germany, and 1 in Denmark.

In the DGNB certification database [44], examples in Norway, Sweden, Finland, Russia, Estonia, Latvia, and Lithuania were not found; due to the large number of certified buildings in Germany, buildings certified in Silver were removed from the search. A total of 4 buildings in Poland, 1 in Denmark, and 336 in Germany were distinguished and the search was narrowed down to 63 buildings, selecting the most characteristic and representative examples.

It was not possible to classify those selected certified sustainable buildings according to the existing aesthetic expression classifications (for example, classifications of Guy and Farmer [25] or Sauerbruch and Hutton [26]). In this case, the classification according to the existing systems was not meaningful, as the majority of the analyzed buildings could be assigned to quantitative [26] or eco-technical [25] approaches or even had no explicit sustainability-related aesthetics and could be assigned to general architectural styles such as functionalism, minimalism or international style.

The group of buildings, distinguished by wooden architecture and smaller scale clearly stands out in the context of the other buildings analyzed. It was also possible to distinguish a group with more expressive curvilinear shapes of public and commercial buildings. From this initial analysis, the need arose to introduce an additional classification of the aesthetic trends of the certified sustainable buildings of the Baltic Sea region in order to capture the more subtle diversity of architectural expression within the stylistic current that can be broadly described as minimalism. In developing this classification, consideration was given to the overall aesthetic appearance of the building, its volume and form, materials that determine aesthetic expression, and adherence to commonly known architectural styles. Consequently, eight groups of aesthetic expression of certified sustainable buildings of the Baltic Sea region were distinguished, which are presented and described below (Figures 2–9). Kagan's [6] definition of sustainability aesthetics was used to further analyze the grouped architectural examples.



1
Alstertal Einkaufszentrum, Hamburg
Germany | 2020 | DGNB | Platinum

2
LIDL-Metropolfiliale, Frankfurt
Germany | 2019 | DGNB | Gold

3
Continental Automotive
Lithuania | 2020 | LEED | Gold

4
Port Bremen West Logistics Centre
Germany | 2020 | DGNB | Gold

5
May Sortation Center Kiekebusch
Germany | 2020 | DGNB | Platinum

6
GI0276-EXETER Unna II
Germany | 2019 | DGNB | Gold

Figure 2. First group—industrial aesthetics. It contains buildings with large and mostly monotonous volumes, detached from their contexts, constructed of artificial, synthetic materials, and having low aesthetic values (image source: [43,44]).

7
Sundhedshuset, Vejle
Denmark | 2016 | LEED | Gold

8
Business Centre Penta
Lithuania | 2018 | LEED | Gold

9
Business Garden Warsaw Building 7 | Poland | 2017 | LEED | Platinum

10
Landshuter Allee 8–10, München
Germany | 2019 | DGNB | Gold

11
Gdynia Waterfront-Courtyard Marriott | Poland | 2016 | LEED | Gold

12
Kapelanka 42 B, Krakow
Poland | 2018 | LEED | Gold

Figure 3. Second group—large volume minimalism. It contains buildings with large volumes, in which the aesthetic expression is focused on design of the facades (image source: [43,44]).

13
Powerhouse Brattørkaia | Norway | 2019 | BREEAM | outstanding

14
Neubau Halle 3C, Nürnberg
Germany | 2019 | DGNB | Platinum

15
AutomationCenter | Germany | 2017 | DGNB | Platinum

16
50Hertz
Netzquartier | Germany | 2016 | DGNB | Platinum, Award Diamond | LEED | Gold

17
Neva Towers T2
Moscow | Russia | 2019 | LEED | Gold

18
SKYSAWA Building A
Poland | 2016 | BREEAM | outstanding

Figure 4. Third group—glass aesthetics. It contains buildings in which glass structures dominate. Usually they have more vivid compositions and aesthetic solutions (image source: [43–45]).

19
Bürogebäude in Hybridbauweiseshopware AG
Germany | 2020 | DGNB | Gold

20
FrankenCampus 146, Nürnberg
Germany | 2020 | DGNB | Gold

21
Business Garden Riga Building C
Latvia | 2020 | LEED | Platinum

22
Business centre 135
Lithuania | 2016 | BREEAM | outstanding

23
ALEA 101 Geschäftshaus
Germany | 2016 | DGNB | Platinum

24
Motel München
Germany | 2019 | DGNB | Gold

Figure 5. Fourth group—modernist–functionalist aesthetics. It contains buildings with smaller volumes; their aesthetic solutions are often more dynamic and include more intense rhythms and compositions of facades (image source: [40,43,44]).

25
Ny Horten videregående skole
Norway | 2019 | BREEAM | outstanding

26
Neubau Eisbärhaus Bauteil C
Germany | 2020 | DGNB | Platinum

27
Zedler-Institut Fahrradwelt
Germany | 2020 | DGNB | Platinum | Award Climate Positive

28
Eisbärhaus Bauteile A+B
Germany | 2020 | DGNB | Platinum

29
Akademie der GIZ am Campus Kottenforst
Germany | 2019 | DGNB | Gold

30
Hiukkavaaran monitoimitalo
Finland | 2017 | LEED | Gold

Figure 6. Fifth group—smaller scale, dynamics and natural materials. Buildings with smaller volumes are found, and the ecological idea is expressed through use of natural, recyclable materials (image source: [40,43,44]).

31
Neubau Bürohaus Lister Dreieck
Germany | 2020 | DGNB | Platinum

32
Einzelhandelsobjekt Nürnberg Breite Gasse
Germany | 2019 | DGNB | Gold

33
Smart Building Center-W.P.I.P
Poland | 2016 | LEED | Platinum

Figure 7. Sixth group—dynamic aesthetics, influenced by postmodernism. This group contains buildings with dynamic aesthetic expressions that can be stylistically associated with the trends of postmodernism (image source: [43,44]).

34
Aquis Plaza Aachen
Germany | 2018 | DGNB | Gold

35
ESO Supernova
Germany | 2018 | DGNB | Gold

36
Erweiterung ServiceZentrum Volksbank Mittelhessen
Germany | 2016 | DGNB | Gold

37
Minto, Mönchengladbach
Germany | 2016 | DGNB | Platinum

38
Arabeska, München
Germany | 2016 | DGNB | Platinum

39
Business Garden, Warsaw Building 5
Poland | 2017 | LEED | Platinum

Figure 8. Buildings with clearly expressed curvilinear forms, with characteristic facades. Some of the buildings are close to the so-called "blobism" forms (image source: [43,44]).

40
Holthaus, Enkenbach-Alsenborn
Germany | 2018 | LEED | Platinum

Figure 9. Eighth group—rural aesthetics. It contains buildings with small volumes, usually scaled to a single-family house (image source: [43]).

The first group analyzed—industrial aesthetics—reflects a technocentric, functionalist approach. This group can even be classified under the regulative aesthetic approach according to Di Carlo [24]. This is a normative, quantitative approach that focuses primarily on energy and cost reduction. The main aesthetic features of this group are a lack of sensitivity to place and culture, and a lack of engagement with the environment mixed with functionalist architectural expression. This group does not currently exhibit sustainability aesthetics potential. However, even utilitarian buildings can achieve sustainability symbolism and ecological functions through means such as green or brown roofs or vegetated facades.

The second group—large volume minimalism—and the fourth group—modernist-functionalist aesthetics—are quite similar groups, where the main difference is scale. Both groups also reflect a technocentric approach that is evaluated in terms of quantifiable sustainability assessment. Attempts to find aesthetic solutions for architectural compositions are usually limited to a moderate, minimalist, and often rigid facade aesthetics, which is usually based function of the building. Sustainability aesthetics of these architectural

trends can potentially be developed by reconceptualizing ecological, biological, and cultural relationships through the inclusion of natural features and spaces that can enhance social cohesion and viability, through the use of natural materials, and through engagement with environmental forces such as wind, water, and sunlight.

The third group—glass aesthetics—is mainly based on a technocentric approach. The dominance of glass structures and complex volumetric compositions determines the aesthetic language, which reflects the technology and progress of the 21st century. However, the relation with nature is not expressed, despite the transparency properties of glass. This group's aesthetic sustainability potential can be strengthened in this group through the creation of and an improvement of relations with nature and society.

The fifth group—buildings characterized by smaller scale, dynamism, and the use of natural materials— emphasizes the the pursuit of ecological aesthetics. Building forms remain minimalist and sometimes formal. The selection of natural materials and landscape solutions around the building creates a sense of relational architectural expression that is closer to nature and shows an attempt to demonstrate an ecological approach. However, the materials used do not vary—the facades are usually finished with wood cladding. Although technocentrism plays an important role, efforts to reflect ecological ideas through the aesthetics of the building are evident. In general, sustainable aesthetic features such as relation-centered approaches, attention to complexity, and complementarity of antagonisms are found in this group. The potential of sustainability aesthetics is high when these features are emphasized.

The sixth group—architecture with dynamic aesthetics reflecting postmodern styles—shows an aesthetics that seems more connected to the ideas of the recent past and does not reflect the ideas of the sustainable future. Tehcnocentrism remains as the main focus point in terms of sustainability in this group of buildings. However, aesthetic sustainability potential can be seen here in the attention to complexity that is naturally inherent in the architectural language of postmodernism, full of stylistic and cultural references.

The seventh group—architecture, with dominant aesthetic compositional features of curvilinear forms—can be associated with the idea of organic forms that, but these are not clearly expressed. Architectural composition here is more complex, and architecture expresses new technological possibilities; however, ecological aesthetics as organic or biomimetic architectural approaches are weakly expressed. The potential of sustainability aesthetics of this group is high if the relation-centered approach, such as relationships with the landscape, the cityscape, attention to complexity, and complementarity of antagonisms is strengthened.

The eighth group—rural aesthetics—reflects the orientation towards aesthetics of the past indicated by Sauerbruch and Hutton [26]. Relationships to local traditions and culture play an important role here. Aesthetic expression is regionally dependent, and the main feature of sustainability aesthetics is the complementarity of antagonisms from the point of view that sometimes new architecture acquires traditional aesthetic expressions that are accompanied by added ecological value. A relational approach to landscape, communities, and the spirit of the place can also play important role in further development of this style.

4. Discussion and Conclusions

Architecture is both a form of art and a factor that physically shapes our environment. It influences virtually all dimensions of sustainability. At present, the field of architecture is confronted with major contradictions. On the one hand, it is associated with the increasing consumption of energy and resources; on the other hand, it is responsible for the implementation of a sustainable and ecological design paradigm. Nevertheless, the concept of sustainability as an ethical paradigm has evolved from its original definition as a human-centered approach to a holistic approach of human–environment co-creation.

This study examines how the architectural expressions of 112 recent buildings, which are certified as sustainable and located in the Baltic Sea region, reflect ethical trends in sustainability. This research allowed us to identify both the challenge of technocentrism

in sustainable architecture and the lack of distinct sustainability aesthetics. At the same time, it showed the importance of the regionality of sustainability aesthetics and its existing potential even in functionalist and minimalist architectural buildings.

At first glance, it can be observed that the analyzed buildings of the Baltic Sea region, certified according to LEED, BREEAM or DGNB, lack distinct architectural features that could be called sustainability aesthetics, as they are focused on normative and technical aspects of energy and cost reduction [26]. This may be a consequence of the fact that aesthetic requirements are not included in the criteria of most sustainable building certification schemes. It can be concluded that the technocentrism problem of sustainable architecture identified by Guy and Farmer [25] is present in the analyzed context. It is also possible to agree with the opinion expressed by Di Carlo [24] regarding the lack of aesthetic language of sustainable architecture. One of the possible solutions to this problem could be the requirement to apply the holistic approach in certification schemes for sustainable buildings A good example of this solution is the Living Building Challenge certification scheme, which integrates not only environmental, economic, and social sustainability criteria, but also cultural criteria, including aesthetic quality.

A unified approach to assessing and reporting the sustainability performance of buildings is currently being developed at European Commission [7]. It consists of three themes—resource and environmental performance; health and comfort; and cost, value and risk. It is evident that cultural factors, including architectural aesthetics, are barely present in this framework. Although architectural aesthetics can alternatively be considered as an area outside of sustainability debate and assessment, it cannot be denied that the primary focus of attention, effort, and resources to achieve the environmental and economic goals of sustainability assessment programmes influences architectural aesthetic outcomes. This calls for further and more detailed investigation of the interrelationships between the criteria systems applied in different sustainability certification schemes for buildings and the aesthetic expressions of the certified buildings.

The case studies conducted allowed us to classify sustainable buildings of the Baltic Sea region into eight groups according to their aesthetical expressions: (1) industrial aesthetics, (2) large volume minimalism, (3) glass aesthetics (4) modernist–functionalist aesthetics, (5) smaller scale, dynamics, and natural materials, (6) dynamic aesthetics that reflects postmodernism, (7) curvilinear forms, and (8) rural aesthetics. This classification allowed us to identify connections and potential of sustainability aesthetics. For example, groups of functionalist and minimalist buildings and glass structures can still create meaningful and fruitful ecological, biological, and cultural relationships by incorporating natural features and spaces that can strengthen social cohesion and viability through the use of natural materials and by engaging with environmental forces such as wind, water, and sunlight. The complexity and presence of multiple and sometimes contradictory cultural references in the architectural language of postmodernism, as seen in some examples, has the potential to be integrated into the development of sustainability aesthetics. The long tradition of timber construction in the Baltic Sea region as well as a relational approach to landscape, communities, and the spirit of the place in the rural architecture can be seen as promising developments in sustainability aesthetics.

This research confirmed the importance of regionality and cultural context in the architectural expression of sustainable buildings. The fact that the aesthetic expression of the analyzed and certified as sustainable buildings of the Baltic Sea region does not conform to the existing typologies of sustainable architecture styles. It is more oriented towards minimalism, which can be partly explained by Baltic-Nordic modernist architectural traditions on the 20th century. Germany was one of the cradles of the modern movement and functionalism in architecture in the early 20th century and this approach is still strongly represented in the region today. This shows that sustainability aesthetics cannot considered as universal and cultural. Regional characteristics and the spirit of a particular place play an important role.

To conclude, it can be asked what messages are encoded in the architectural expression of the analyzed certified sustainable buildings. According to the analysis of the literature, these messages range from exposing ecological crises, to demonstrating interest in ecology, to creating highly attractive objects and environments, intended to promote ecologically oriented attitudes and behaviors. The analyzed examples do not correspond to any of these trends. The exception is the examples of wooden architecture, which convey the message of comfortable and healthy living. The majority of the analyzed examples actually communicate the message that the visual status quo of the built environment can be maintained with less environmental impact. This situation is actually far from the change in aesthetic language of architecture predicted by Heymann [18].

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THE ROLE OF AESTHETICS IN BUILDING SUSTAINABILITY ASSESSMENT

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This theoretical study examines the role of aesthetics in the assessment frameworks of sustainable architecture. The article is organized into two main sections: a general literature review and the results. The results section encompasses an analysis of the place of aesthetic quality in the understanding of sustainable architecture, and an overview and discussion of the general sustainable building assessment frameworks and the main sustainable buildings certification systems (LEED, BREEAM, WELL, Living Building Challenge), identifying the existing and potential place of cultural sustainability and aesthetics in them. Finally, four architectural theories holding the potential for balancing human and environmental criteria in the assessment of sustainable architecture are presented. These theories are: sustainability aesthetics, genius loci, biophilia, and a regenerative approach. The conclusion was made that these approaches hold the potential for the breakthrough of aesthetic quality and uniqueness of sustainable architecture.

Key words: **sustainability, sustainable architecture, sustainable building, sustainability assessment, aesthetics, sustainability aesthetics.**

INTRODUCTION

Since the second half of the 20th century, sustainable development has emerged as an alternative to the predominant socio-economic development of humanity (Lozano, 2008). Buildings and built environments in general are a crucial part of the human habitat and make considerable social, economic, and environmental impact. Therefore, the building sector and architecture are given considerable attention in sustainability research and strategies. In this research *sustainable architecture* is considered as architecture that is fully based on the principles of sustainability, such as the pursuit of material and intangible prosperity, justice for present and future generations, justice within and between societies, protection and promotion of cultural and environmental biodiversity, precautious decision-making, and recognition of the interdependence of phenomena (Throsby, 2002). Architectural sustainability must be programmed during the development phase of a project and occur throughout its life cycle; sustainable architecture must not only be sustainable, long-lasting and environmentally friendly, but also contextual, aesthetic and psychologically acceptable (Kamicaityte-Virbasiene and Grazuleviciute-Vileniske, 2011). *Architectural quality* is the aim of both architects and societies as a whole and includes such aspects as urban integrity, accessibility and mobility, respect for the environment and energy efficiency, quality of construction and well-being, innovation, aesthetics and image, as well as functionality and flexibility, costs etc. (European Commission, 2009). It is evident that the expression of a building and the *aesthetics of architecture* have constituted a fundamental part of architectural quality since antiquity (Stauskas, 2009). However, with the rise of environmental and energy saving concerns in the building sector, energy-related requirements are greatly increasing and becoming the main focus of designers and engineers. Meanwhile, some authors identify the negligence towards aesthetics, which is an integral part both of architectural

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sustainability and general architectural quality, in the design of sustainable buildings and their assessment (Wines, 2002; Heymann, 2012). With this in mind, the article focuses on the role of aesthetics in sustainable architecture. The aim of this study is to carry out theoretical research based on a literature analysis and to determine the importance of aesthetics in the definition of sustainable architecture, as well as to define the role of aesthetics in the existing sustainable architecture assessment frameworks. This study is organized according to the following framework: 1) a general literature overview in order to reveal the relevance of the research and the existing research gap related to building aesthetics and sustainability; 2) an analysis of the place of aesthetic quality in the understanding of sustainable architecture; 3) an analysis of the existing general sustainable architecture assessment frameworks and sustainable buildings certification systems (LEED, BREEAM, WELL, Living Building Challenge), including an analysis of current and potential places of cultural sustainability and the aesthetics in them; and 4) the identification and discussion of architectural theories relevant to the integration of aesthetic criteria in the assessment of sustainable architecture and balancing them with the existing environmental criteria. These theories include: *biophilic design*, focusing on the direct and indirect use of natural systems, processes, and materials in the design of the built environment (Kellert *et al*., 2008; Gillis and Gatersleben, 2015); *sustainability aesthetics* - the expression of underlying ecological attitude in design; *sense of place (genius loci)* - the intangible quality of a place, determining its distinctiveness and expressing it in the tangible qualities of the environment (Vecco, 2019); and *regenerative design* - a movement that strives towards harmonious human-environment co-evolution and the development of built environments as ecosystems (Dekay, 2012).

LITERATURE REVIEW

There are numerous definitions of the sustainability concept due to its wide and general character. There were already 70 different definitions of sustainable development recorded in the literature by 1992 (Lozano, 2008). A similar situation can be identified in the environmentally oriented architecture and construction sectors. Numerous definitions, such as green architecture, sustainable architecture, ecological architecture, green buildings etc. exist and are used interchangeably with one another (Wines, 2002; Berardi, 2013). This proliferation of terms reflects the imperative for sustainability in architecture (Lee, 2011) and the endorsement of this principle by the architectural community (Fox, 2000). According to Fox (2000, p. 5-6), the "1993 World Congress of the Union of International Architects declared that they would commit themselves individually and professionally to place environmental and social sustainability at the core of their practices and professional responsibilities".

The term "sustainable architecture" generally implies that such architecture is based on the paradigm and principles of sustainability in the social, cultural, economic and environmental spheres, and it definitely contributes to the implementation of sustainability goals. Increasing interest in the topic is revealed by a quantitative literature review using the keywords "sustainable architecture" in major scientific databases (Table 1). Since the 1980s the number of published papers on this theme has increased from several to hundreds and thousands. The field of engineering dominates in sustainable architecture research.

The literature review revealed two distinctive trends in research developments on sustainable architecture that relate to the theme of this study. The first trend is the analysis of architectural expression and aesthetics in the context of building sustainability. Researchers raise and try to answer questions such as: is there a distinctive aesthetic face of sustainable architecture? Does the sustainability paradigm influence architectural aesthetics and how? (Cucuzzella, 2015); what trends in sustainable architecture and the built environment can be distinguished? (Guy and Farmer, 2001; Wines, 2002; Sauerbruch and Hutton, 2011; Di Carlo, 2016); how can sustainability aesthetics be defined (Kagan, 2011) and experienced? (Dekay, 2012). The second relevant research trend relates to the development, analysis and comparison of building sustainability assessment frameworks, systems and tools. As these assessment approaches and tools are constantly developed and improved, the number of such studies is growing, several of which can be mentioned. Cole (1999) discusses the existing building sustainability assessment systems, the approaches towards the formulation of criteria and indicators, and the general building sustainability assessment frameworks. Todd *et al*. (2001) present a comparison of building sustainability assessment tools. Al Waer and Sibley (2005) present an overview of building sustainability assessment methods and trends. Poveda and Lipsett (2011) provide a comprehensive assessment of existing approaches, strategies, models, appraisals, and methodologies in this field. The general literature review revealed the gap between the research trends in sustainable architecture mentioned above, and the gap between aesthetics and sustainability assessment. Thus, the following research questions can be asked:

- Is aesthetic quality a part of sustainable architecture?
- What role does aesthetics play in building sustainability assessment frameworks?
- What are the possibilities of including the aesthetic dimension in building sustainability assessment?

RESULTS

The place of aesthetic quality in the understanding of sustainable architecture

The notion of sustainability is expanding beyond the triad of social-economic-environmental factors (Berardi, 2013) and the cultural dimension of sustainability is emerging in research and international documents (United Cities and Local Governments, 2010; Moldavanova, 2014; Meireis and Rippl, 2019). The emerging cultural dimension of sustainability introduces such themes as aesthetics and artistic qualities into the frame of discussion based on sustainable architecture. For example, Berardi (2013) underlines that cultural perception and inspiration are integral aspects of sustainable buildings. Accordingly, such buildings should increase "social equity, aesthetics

Table 1. Quantitative literature overview using keywords "sustainable architecture" in the Scopus and Web of Science databases

Scopus database search						
Total number of sources: 7382						
Years	Number of sources	Main keywords	Dominant author	Dominant field	Dominant country	Dominant source
1983 - 1987	6	Architecture (3)	Levine, R.S. (2)	Engineering (6)	-	Wescon Conference Record
1988 - 1992	5	Architecture (2)	Glass, C.J. (1)	Engineering (3)	USA (3)	Journal of Architectural Education
1993 - 1997	31	Architecture (7)	Wu, J.S. (2)	Engineering (16)	UK (5)	Corporate Environmental Strategy
1998 - 2002	109	Sustainable development (43)	Farmer, G. (2)	Engineering (61)	USA (26)	Places
2003 - 2007	697	Sustainable development (381)	De Weck, O. (6)	Engineering (452)	USA (208)	International Journal of Engineering Education
2008 - 2012	1746	Sustainable development (899)	Zeiler, W. (9)	Engineering (900)	USA (345)	World Applied Sciences Journal
2013 - 2017	2688	Sustainable development (1279)	Mileto, C. (14)	Engineering (1666)	USA (370)	Xi'an Jianzhu Keji Daxue Xuebao/ Journal of Xi'an University of Architecture and Technology
2018 - 2021	2102	Sustainable development (858)	García-Soriano, L. (7)	Engineering (1067)	USA (218)	Journal of Materials Science and Technology
Web of Science database search						
Total number of sources: 4358						
Years	Number of sources	Main keywords	Dominant author	Dominant field	Dominant country	Dominant source
1990 - 1994	13	Architecture (5)	Blake J. (1)	Architecture (5)	USA (4)	Architecture
1995 - 1999	52	Energy fuels (22)	Jain K. (2)	Energy fuels (22)	USA (13)	Journal Of Urban Technology
2000 - 2004	117	Architecture (32)	Oktay D. (3)	Engineering (45)	USA (24)	Energy And Buildings
2005 - 2009	346	Architecture (97)	Lehmann S. (5)	Environmental studies (108)	USA (74)	Journal Of Green Building
2010 - 2014	1090	Architecture (245)	Gambardella C. (18)	Engineering (451)	China (162)	Applied Energy
2015 - 2019	2294	Green sustainable science technology (416)	Gambardella C. (12)	Engineering (681)	USA (258)	Scientific Reports
2020 - 2021	446	Green sustainable science technology (135)	Kim Y. (5)	Science technology other topics (156)	China (73)	International Journal Of Engineering And Geosciences

improvements, and preservation of cultural values" (Berardi, 2013, p. 76), along with other aspects. The sustainability framework developed by Musacchio (2011), which is applicable to landscapes as well as architecture, contains factors related to: the environment, economics, equity, aesthetics, experience, and ethics. Thus, it also reflects the complexity of sustainable architecture and the presence of both tangible and objective, and intangible and subjective dimensions in it, such as aesthetics and a sense of place.

However, some researchers have noticed biases in the approaches towards sustainable buildings, such as an overly eco-centred approach, managerialism and technoctaric control (Berardi, 2013). Indeed, with multiple regulations and certification systems, construction is increasingly

viewed as a process and the focus is on the life cycle of the building (Sauerbruch and Hutton, 2011). On one hand, it is helpful to better understand and manage the environmental and other impacts; on the other hand, less tangible and more subjective aspects, such as a sense of place, aesthetics and artistic quality can be lost in such a broad and managerial approach.

According to some researchers, a certain level of sustainability appears to be inevitable in the architectural and building fields as a matter of professional commitment as well as of governing policies (Fox, 2000; Jauslin, 2011). Accordingly, all architecture could become sustainable. Thus, it is worth looking at the understanding of general architectural quality and what role sustainability plays in it. The criteria that determine architectural quality have been under consideration since antiquity's Vitruvius triad (Stauskas, 2009). Stauskas distinguished the functional and cultural contents, form, environment and technical-economical aspects as determinants of architectural quality. Sets of architectural quality criteria are presented in national and international regulations as well. For example, the guidelines to the architectural policy of the European Commission (European Commission, 2009, p. 4-7) distinguish urban integration, accessibility and mobility, respect for the environment and energy efficiency, quality of construction and well-being, innovation, aesthetic aspect and image, functionality, modularity and flexibility, costs, and cohesion as the common thread, in this particular case meaning "the establishment of a symbolic common thread linking all the buildings and building clusters occupied by the Commission". Similar criteria are, for example, distinguished in the Lithuanian Law of Architecture (Lietuvos Respublikos Seimas, 2017) (Table 2).

environmental aspects. In order to better understand the role of aesthetics in building sustainability and the potential of the sustainable architecture movement to influence the aesthetic expression of buildings (Heymann, 2012), the existing building sustainability assessment frameworks are analyzed in the following sub-section.

The potential place of aesthetics in the assessment frameworks of sustainable architecture

In a further analysis of the links between the sustainability and aesthetics of architecture, it is worth examining the frameworks of general sustainable architectural analysis and sustainable building certification systems, which are gaining increasing importance due to the growing number of societal challenges and the impact of sustainable architecture.

Several general models – the general building sustainability analysis framework by Cole (1999), the HalStar sustainability assessment model (Pearce *et al.*, 2012) based on five capitals, and the VERSUS model based on the qualities of vernacular architecture (Guillaud *et al.*, 2014) were selected for analysis. These models go beyond the basic Bruntland model of three overlapping dimensions (Lozano, 2008) and they target the built environment. The selected models are rather diverse and thus reflect the spectrum of understanding of building sustainability.

The general building sustainability analysis framework by Cole (1999) encompasses sustainability criteria, which are subdivided into two categories - human (indoor environmental quality, maintenance, prosperity, cultural heritage integration, etc.) and environmental (resource use, ecological loadings etc.). Bearing in mind the concept of

Table 2. Architectural quality criteria in regulatory documents (European Commission, 2009; Lietuvos Respublikos Seimas, 2017) and their analysis according to sustainability dimensions

Lithuanian law of architecture (2017)	Guide to the European Commission's architectural policy (2009)	Sustainability dimensions*
Urban integrity	Urban integration	
Accessibility using universal design	Accessibility and mobility	
Correspondence to sustainability principle	Respect for the environment and energy efficiency	
Quality, ergonomics and durability of the built environment	Quality of construction and well-being	
Innovativeness	Innovation	
Coherent architectural idea	Clarity of purpose and comprehensibility of buildings Cohesion: a common thread	
Aesthetics	Aesthetic aspect and image	
Functional structure of the building	Functionality, modularity and flexibility	
Economic rationality	Costs	
Preservation of immovable cultural heritage		
		7 10 6 2
Sustainability*	Cultural Social Economic Environmental	

An analysis of architectural quality criteria according to sustainability dimensions (Table 2) reveals that these criteria encompass all four dimensions, although human dimensions (cultural, social, economic) clearly dominate over the environmental dimension. The analysis reveals the mutual integration process: the cultural dimension (including aesthetics and the sense of place) is increasingly becoming a part of the concept of sustainable architecture and sustainable building. Meanwhile, the understanding of architectural quality increasingly encompasses

any building as a process with a life-cycle, the framework encompasses the dimension of time. According to Al Waer and Sibley (2005), "time scale is one of the most important factors in assessing sustainable development due to the changing nature of the performance criteria and the appearance of new ones over a period of time". The model demonstrates the possible different scales of sustainability assessment, ranging from the building materials up to the global scale. "Scale is obviously the critical dimension in relation to building environmental performance within the

context of sustainability, architecture and urban planning" (Al Waer and Sibley, 2005). This framework demonstrates the potential of integrating aesthetics as one of the human criteria (Figure 1) into building sustainability assessment. The different scales represented by the model make it possible to consider the aesthetics in the neighborhood and cityscape contexts as well.

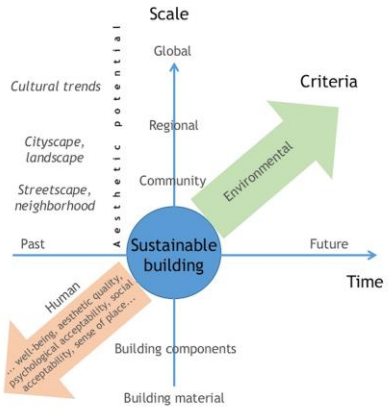


Figure 1. General building sustainability analysis framework by Cole (1999) and its potential for the integration of aesthetics into building sustainability assessment. (Source: Figure by the authors is adapted from Cole (1999) and Al Waer and Sibley (2005) by adding potential human criteria)

The HalStar sustainability assessment model was developed by the English engineering firm Halcrow. The company's goal is to encourage people to lead an increasingly sustainable lifestyle by trying to look at the problem from all possible perspectives: from small-scale to massive projects. The significant development of the company's infrastructure has also led to the development of theoretical models to address sustainability issues. This model demonstrates sustainability as the balance between five dimensions or capitals - natural, social, human, manufactured and financial. This model considers the life cycle of the project under evaluation and includes the dimension of time by identifying short-term, medium-term, and long-term time-frames (Pearce *et al.*, 2012). Moreover, similar to the model by Cole (1999), this model contains scale: global, regional, local, and client. Although this model does not explicitly distinguish the cultural dimension or aesthetics in particular, it includes some culturally and aesthetically oriented factors, such as cultural heritage, happiness and motivation, quality and innovation. These factors are dispersed in the following fields: social, human, and manufactured capital.

The VERSUS model for the analysis and assessment of sustainable architecture was developed by partner institutions from Portugal, Spain, Italy, and France, with the support of the Culture Programme of the European Union. This model was based on "the identification of strategies and principles within vernacular heritage, in order to define a conceptual approach for sustainable architectural design" (Guillaud *et al.*, 2014). The model has three sustainability dimensions - environmental, socio-cultural, and socio-economic. The environmental dimension encompasses five criteria or principles: to respect nature, to be appropriately situated, to reduce pollution and waste materials, to contribute to the quality of health, and to reduce the effects of natural hazards. The socio-cultural dimension encompasses the following criteria: to protect the cultural landscape, to transfer construction cultures, to enhance creativity, to recognize intangible values, and to encourage social cohesion. The criteria of the socio-economic dimension are: to save resources, to extend the lifetime of buildings, to optimize construction efforts, to promote local activities, and to support autonomy. It is evident that the VERSUS model has a strongly expressed cultural dimension acknowledging the importance of the sustainability of preserving cultural heritage, and such intangible factors as collective memory, cultural identity, sacredness, history and mythology. Respect for the cultural landscape (cityscape) might include some aesthetic considerations; meanwhile the creativity criterion explicitly mentions beauty (Guillaud *et al.*, 2014).

In order to understand better the potential to include aesthetics in building sustainability analysis, it is worth looking at actual building sustainability certification systems, which are practical undertakings in evaluation and decision making (Poveda and Lipsett, 2011). This overview of popular certification systems was prompted by the claim of some researchers that these tools are discouraging, or at least do not encourage aesthetic experiments and innovations in the field of sustainable architecture. For example, Heymann (2012) notes that the LEED certification system "serves to uphold a pre-existing aesthetic; or, perhaps better, does not serve substantially or directly to take an existing aesthetic ideal apart". According to Sauerbruch and Hutton (2011), the existing certification systems focus heavily on technical and quantifiable aspects, and such aspects as beauty and aesthetics are viewed skeptically in circles linked with sustainable building certification.

The most popular certification systems - LEED, BREAAM, WELL - and the Living Building Challenge were selected for the overview (Tables 3 to 6). LEED Interior Design + Construction (U.S. Green Building Council, 2020) appears to balance the social, economic, and environmental sustainability dimensions. However, environmental concerns are predominant in this system (Table 3). The only sub-criterion, quality, and the criterion innovation can be attributed to the cultural sphere. Some sub-criteria targeted at environmental and economic dimensions can have potential synergistic effects on the aesthetic expression of buildings: sensitive land protection, reduced parking footprint, protected or restored habitat, open space, rainwater management, heat island reduction, renewable energy, daylight etc. For example, the rainwater management requirement can encourage the creation of rain gardens or permeable surfaces on a site with particular ecological aesthetics, and daylight requirements can influence architectural form and the character of interiors etc. It is

possible to summarize that the LEED certification system can influence the aesthetic expression of architecture, although it is possible to agree with D. Heymann (2012) that this system does not encourage aesthetic and cultural breakthrough in sustainable architecture.

This study identified the dominance of environmental and economic concerns over social and cultural ones in BREEAM International New Construction 2016 technical standards (BREEAM, 2016) (Table 4). Only the sub-criterion innovation can be clearly attributed to the cultural sphere. Some sub-criteria targeted at the environmental and economic dimensions can have a potential synergistic effect on the aesthetic expression of buildings: visual comfort, life cycle impacts, designing for durability and resilience, adaptation to climate change, and enhancing site ecology. For example, adaptation to climate change and site ecology enhancement can include creating vertical greenery with particular aesthetic impacts, etc. Only the sub-criterion visual comfort and the criterion innovation can be directly linked with architectural aesthetics. In summary, the BREEAM certification system is not targeted at the cultural dimension of sustainability, and sustainability aesthetics are not directly encouraged by it. However, it is neccessary to mention, that both LEED and BREEAM include innovation as a criterion, which is also considered as one of the general criteria of architectural quality, as demonstrated in the sub-section above. Thus, it can be expected that innovation can be expressed not only in technologies, but also in distinctive aesthetic language.

Table 3. Analysis of the LEED building certification system according to sustainability dimensions. Criteria with aesthetic potential or impact are marked in green (Source: U.S. Green Building Council, 2020)

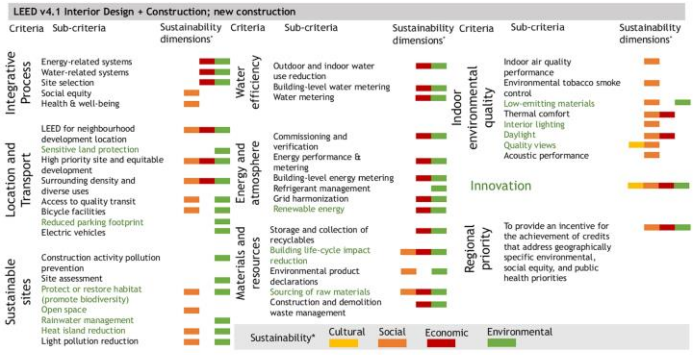
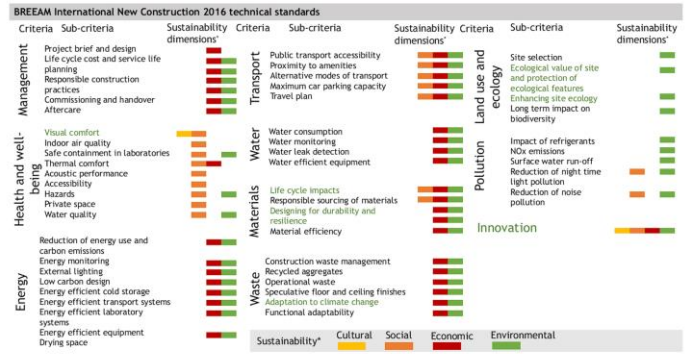


Table 4. Analysis of the BREEAM building certification system according to sustainability dimensions. Criteria with aesthetic potential or impact are marked in green (Source: BREEAM, 2016)



In comparison with the LEED and BREEAM systems, the WELL Building Standard version 2 (WELL, 2020) is basically socially oriented (Table 5). This system is oriented at the well-being of building occupants; however, the cultural dimension of sustainability is also omitted here. Only the criterion innovation and the sub-criterion nature and place can be linked with the cultural sphere and aesthetics. Some sub-criteria targeted at social, environmental and economic dimensions can have a potential synergistic effect on the aesthetic expression of buildings: visual lighting design, day light strategies, nature and place, restorative spaces, and enhanced access to nature. These sub-criteria can be directly linked with the biophilic design concept (Kellert *et al.*, 2008), which is currently growing in popularity. It is peculiar that the WELL system, being clearly human-centered, does not include cultural and aesthetic aspects. However, the biophilic design-oriented criteria can evolve into a synergistic approach simultaneously targeting ecology, personal well-being, aesthetics and connections to place.

The Living Building Challenge 4.0 Standard (new construction) (Living Building Challenge, 2020) system is most successful at achieving a balance between the sustainability dimensions compared to the other systems analyzed in this paper (Table 6). The cultural dimension here is reflected by the criteria place and beauty and the sub-criteria human scaled living, beauty & biophilia, and education & inspiration. It is possible to see clearly in this system that some material and wellness-related criteria can have a direct impact on the aesthetic expression of design: access to nature, responsible materials etc. This system underlines the importance of place, which is both a cultural and ecological concept. Moreover, the implementation of the beauty & biophilia sub-criterion can have synergistic positive effects on all the sustainability dimensions as mentioned above.

Architectural theories relevant to balancing the aesthetic and environmental criteria in the assessment of sustainable architecture

The integration of sustainability into architectural quality criteria, the rise in popularity of certification systems and the overall global sustainability agendas demonstrate that certain aspects of architectural sustainability are inevitable. However, the question still remains of how to avoid a merely techno-centrist or eco-centrist approach, and to balance the social, cultural, economic and environmental aspects of sustainable architecture. Moreover, some authors note the current lack of and need for a particular aesthetic language of

Table 5. Analysis of the WELL building certification system according to sustainability dimensions. Criteria with aesthetic potential or impact are marked in green (Source: WELL, 2020)

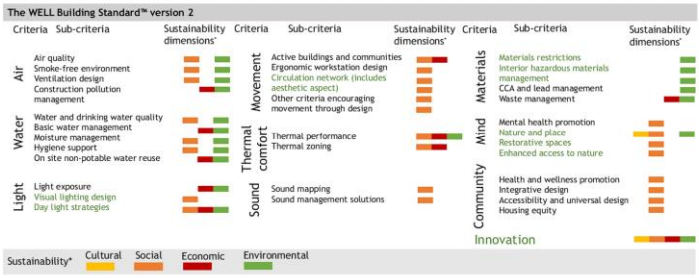
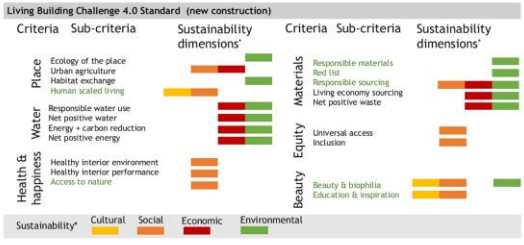


Table 6. Analysis of the Living Building Challenge building certification system according to sustainability dimensions. Criteria with aesthetic potential or impact are marked in green (Source: Living Building Challenge, 2020)



sustainability (Kagan, 2011; Heymann, 2012; Di Carlo, 2016). The lack of cultural criteria in sustainability certification systems and the emphasis of environmental and economic dimensions might be the causes of the slow development of sustainability aesthetics. Below we distinguish and discuss four architectural theories that hold the potential of balancing the human and environmental criteria and could potentially become a part of sustainable architecture assessment systems: sustainability aesthetics, spirit of place (*genius loci*), biophilic design, and a regenerative approach.

Sustainability aesthetics. The notion of sustainability aesthetics (Kagan, 2011) has evolved from the environmental movement and ecological art that started in the 1960s and 1970s. Such art relied on natural materials, natural and social processes, and creativity based on the mutual interaction of humans with nature and society. The human-nature co-creation approach also emerged in landscape architecture in this period (McHarg, 1969). The results of ecological art were particularly complex, dynamic, open aesthetics based on sometimes radical environmental ethics. Several authors have defined what the term sustainability aesthetics actually means. According to Kagan (2011), it focuses on "relationships and processes and is based on a sensitive response to connecting structures at many levels". Kagan emphasizes the following qualities and features of sustainability aesthetics: reconciliation, complementarity of opposites (focusing on the visible diversity, complexity and differences and metastructure connecting the living world), openness to the creative power of chaos, unexpectedness of results, interest in "complex and dynamic life networks in the environment and the social, political and economic complexity of modern societies". It is evident that this aesthetics draws a lot from environmental art, which is more flexible than architecture or urbanism. However, it can be presumed that sustainability aesthetics reveals and emphasizes the intrinsic beauty of our connectedness to ecosystems and sustainable systems and holds potential for the built environment as well.

Shrivastava (2011), working in the field of sustainability research, notes that radical behavioral and organizational changes are necessary in order to achieve global sustainability. He states that this change first of all requires a change in human consciousness, "the emotional change in human-nature relationships". He urges us to employ the human capacity for art to achieve this transformation, and even bases this claim on the idea that arts serve the evolutionary functions of humanity. In this context the sustainability aesthetics of architecture can even stimulate the further development of harmonious human-nature relationships.

Spirit of place (genius loci). I. Brook (2000) identifies the sense of place or the so-called spirit of place, also known as *genius loci,* as an imperative for environmental ethics. This idea links the cultural and environmental realms in environmental ethics, which often tends to concentrate on the radical biocentric and ecocentric approaches. The VERSUS model discussed above also includes protection of the cultural landscape and recognition of intangible values as characteristics of sustainable architecture. The Living Building Challenge certification system includes the criterion of place, WELL includes the sub-criterion nature and place. Place in its nature integrates both natural and cultural aspects. Thus, place and *genius loci* can become the drivers both for ethical, environmentally friendly construction and the aesthetics of sustainable architecture in a particular place. *Genius loci,* which is seen as intangible, and place which is mainly viewed as tangible, and their actual inseparability (Vecco, 2019), reveal that both spatial aspects and intangible ones matter for the sustainability of architecture. The importance of understanding the intangible dimension in the context of sustainability even transcends the question of architecture and is receiving the increasing attention of researchers (Grant, 2010; Vecco, 2019). Grant (2010), analyzing the potential of sustainability aesthetics, emphasizes the general necessity of replacing the current consumer culture with alternative value systems. Sustainability is often viewed as a behavioral problem (Grant, 2010; Shrivastava, 2011), which invites us to consider consumption and production from the psychological/behavioral perspective. Grant (2010) supports the idea that "the problem of material overconsumption is rooted in the lack of skilled consumption" and presents a literature overview on less tangible and more sustainable forms of consumption, so-called "resource-light and resource-free activities", which "require a more cultivated mind" including increasing the role of artistic creation, fostering appreciation in daily life and general intellectual culture like reading a good book, listening to music or intelligent conversation, etc. Harper (2012) mentions anti-consumption or at least minimal consumption in the context of sustainability aesthetics. The empathetic involvement in a place, grasping its *genius loci* and sensitive architectural development, are forms of skilled sustainable consumption and production. Nevertheless, *genius loci* as an asset nowadays is often ignored (Petrusonis, 2018). Vecco (2019) proposes a three-fold process: rethink, protect and transmit the place and its spirit. She asserts that this process needs to be circular and incremental, and the role of sustainable design and sustainable heritage preservation cannot be underestimated in this process.

Biophilic design. The biophilic design concept is an evolving environmental awareness and human well-being targeted design approach. It encourages the direct and indirect use of natural systems, processes, and materials in the design of the built environment (Kellert *et al.*, 2008; Gillis and Gatersleben, 2015). Biophilic design is based on the biophilia hypothesis, formulated in the 1980s by ecologist and sociologist Wilson (1984). This hypothesis maintains the "innate emotional affiliation of human beings to other living organisms" (Wilson, 1993).

Moreover, the physical and psychological well-being benefits of human-nature connections have been proven by numerous studies (Gillis and Gatersleben, 2015). The biophilic approach is increasingly integrated into building sustainability assessment. For example, the Living Building Challenge includes the sub-criterion of beauty and biophilia. The WELL system includes the sub-criteria nature and place, restorative spaces, and enhanced access to nature, all of which recall the biophilic approach, and all of these sub-criteria are placed under the criterion mind, focusing

on human psychological well-being. However, it is necessary to note that biophilic design can enhance human well-being and create aesthetically pleasing restorative environments, and at the same time positively influence the ecology of a place. Moreover, DeGroff and McCall (2016) identify two trends of the biophilic approach: one oriented towards biological systems and the other incorporating traditional practices for forming ethnic environments. This makes it possible to create various biophilic designs in harmony with the *genius loci* of a place.

Regenerative approach. Currently, attitudes towards sustainability are developed within the context of restorative and regenerative movements in the field of sustainability (Brown *et al*., 2018), with reference to regeneration as a feature of natural systems. The aim of these approaches is no longer to sustain the *status quo*, but rather to move towards the restoration of the damage done by human activities. New concepts also strive towards the harmonious built environment as ecosystems (Dekay, 2012), as well as towards achieving the properties of natural systems in man-made products and environments. Berardi (2013) distinguishes the aspects of biological and regenerative approaches towards sustainable architecture, ranging from the behavior of building materials to the building-environment and building-society interaction in his literature review. The following are examples of a regenerative approach in practice: developing building materials that would function as biological nutrients circulating through the world's systems in cycles; and considering and creating a building as a "live system with dynamic flows with nature", as "an active entity which is designed to help a metabolism of human beings that regenerates the built environment within the natural capital". This perspective of buildings as ecosystems and living entities would make it possible to move beyond the currently trendy biomorphic formalism (Sauerbruch and Hutton, 2011), when nature becomes an inspiration solely for the building form, and achieves integrated human-environment benefits including recognizable aesthetic quality.

CONCLUSIONS

Sustainable architecture, according to its definition, should be based on the paradigm and principles of sustainability involving social, cultural, economic and environmental dimensions; it definitely contributes to the implementation of sustainability goals. The dimension of cultural sustainability should be strengthened within the fields of both sustainable architecture and general sustainability. This leads to the conclusion that sustainable architecture must contribute to social equity, aesthetic qualities of the environment and the preservation of cultural values. Therefore, aesthetics must be considered as an integral part of architectural sustainability.

Architectural quality in general is determined by such criteria as urban integrity, accessibility and mobility, respect for the environment and energy efficiency, quality of construction and well-being, innovation, aesthetic aspect and image, functionality, etc. (European Commission, 2009). An analysis of architectural quality criteria through the sustainability perspective revealed that architectural quality criteria encompass all four sustainability dimensions. However, a lack of attention given to the cultural aspects while developing sustainable architecture was noticed.

An overview of selected general sustainable architecture assessment models – general building sustainability analysis framework by Cole (1999), the HalStar sustainability assessment model (Pearce *et al*., 2012) and the VERSUS model based on the qualities of vernacular architecture (Guillaud *et al*., 2014) – demonstrated that these diverse models have room for cultural aspects and aesthetics, even if these aspects are not always explicitly identified.

Analysis of the most popular certification systems – LEED, BREAAM, WELL and Living Building Challenge – according to sustainability dimensions and a search for the possible integration of cultural aspects and aesthetics in building sustainability assessment revealed the general predominance of environmental and economic aspects. However, some promising possibilities for expanding the cultural dimension and including integrated, synergistic, aesthetic and environmental criteria based on the biophilic approach were distinguished.

This research has revealed a paradoxical situation: while cultural aspects and aesthetic expression are an integral part of the sustainable architecture concept, they are not so eagerly incorporated into sustainable building assessment approaches. The results of the research suggest that the lack of cultural criteria in sustainability certification systems and the emphasis on the environmental and economic dimensions might be the causes of the slow development of sustainability aesthetics, as identified by some researchers. Another problem identified by this study is the lack of balance between human and environmental criteria. Consequently, four categories that hold the potential for balancing human and environmental criteria and could potentially become a part of sustainable architecture assessment systems were distinguished: sustainability aesthetics, spirit of place (genius loci), biophilic design, and a regenerative approach. The research maintains that these approaches hold the potential for breakthrough in the aesthetic quality and uniqueness of sustainable architecture.

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Characterizing sustainability aesthetics of buildings and environments: methodological frame and pilot application to the hybrid environments

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Abstract. Growing environmental awareness and emerging design and performance requirements related with the implementation of sustainability goals inevitably have an influence on construction, architecture, urban design and the development of our built environment in general. This influence is reflected both in the increasingly efficient ecological performance of built structures and the growing array of related technologies, and in the aesthetic expression of these environmentally conscious designs. The aesthetic expression of sustainability concept and values is sometimes referred to as sustainability aesthetics. The aim of this research is to develop and test a methodological framework for characterizing the sustainability aesthetics of the built environments. The elaborated methodological framework integrates biophilic design, sustainability aesthetics, regenerative design and genius loci as the most promising approaches, allowing the integration of human and environmental concerns. To test the framework, we selected historic built environments that reflect long-lasting sustainable co-existence between humans and their environment and represent hybrid characteristics of both architectural and urban space. One of the purposes selecting these environments for the case study was to determine the features of an organically evolved sustainability aesthetics that could become a valuable source of inspiration for architectural design and management of the built environments.

Keywords: sustainability aesthetics, hybrid environments, biophilic design, regenerative design, *genius loci*

Introduction

Relevance of research

Growing environmental awareness has raised new challenges for architecture and urbanism of the 20th and 21st centuries. Currently terms "sustainable", "green", "ecological" and many others are used daily in scientific literature and media to characterize contemporary built environments. In some cases the "sustainability" label is used for marketing purposes [8]. Vague definition of what sustainable buildings and environments are, causes many scientific discussions [2]. However, the newest debates [2] consider sustainable development as a way of thinking or the direction rather than a single, strictly defined term. Moreover, as C. Owen and K. Dovey [27] note, "sustainability is not a field with institutional boundaries like architecture", yet is straddles multiple fields including architecture, engineering, urbanism, ecology etc. Herewith, building or any other structure could be considered as sustainable if it is built in an ecologically oriented way that reduces its impact over the environment [2] or even increases the quality of the environment [29]. The concept of sustainability, that could be considered as the first intentional paradigm shift in human history [13], is constantly revised and expanded. The trends of thought of the last decades [2, 10, 13, 20] reveal the shifts in sustainability paradigm that go beyond the sustaining status quo towards systemic, dynamic, organic, holistic and non-linear approach [20]. The emerging concepts of restorative, regenerative sustainability [29] illustrate the aspiration to restore the lost connection with the natural world and to move towards harmonious co-existence between humans and nature and human-nature co-creation in the living environments of the future.

These changes in the attitudes towards the environment in essence change the architectural expression as well. C. Cucuzzella [8] raises the question: is it possible that "the environmental imperatives are actually imposing a shift in the textual narratives, the visual expression, and the spatial experience of architectural projects?" Actually contemporary design trends move towards so-called "greening" of architecture and urban environments (for example, Barcelona greenery and biodiversity plan) and implementation of environmentally conscious design strategies (for example, biophilic design, biomimicry, regenerative design, cradle-to-cradle approach) that change the aesthetic expression and image of built environments. The emerging trends of peculiar aesthetics of sustainable environments and environmentally conscious building design call for new approaches for understanding and characterizing the sustainability aesthetics [21; 32] of the living environments.

Research aim

The aim of this research was to analyze the existing experience and possibilities of characterizing the sustainability aesthetics of buildings and built environments and to develop and test the methodological frame for this characterization. In order to reach this aim, the literature review of the existing characterization frameworks applied to the environmentally conscious designs was carried out, the existing research gaps were identified and the characterization framework based on the integration of four approaches - biophilic design, sustainability aesthetics, regenerative design and *genius loci* - was developed and tested using as a case study the hybrid built environments in the historic center of Kaunas city.

Research methods

The type of this research is qualitative descriptive study. The methods of research include: literature analysis, concept mapping (mind mapping), comparison and systematization, on-site observation, photographic survey, map analysis, graphical analysis, descriptive analysis. The novelty of this research consists both of development of the framework for characterizing the sustainability aesthetics of buildings and built environments and its testing but also of the employment of mind mapping technique in the research development process and visualization. Mind mapping can be defined as the technique used in brainstorming and allowing deconstructing complex topics by creating a graphical representation of constituent subtopics and related themes [23]; moreover, it allows easier determining and perceiving links between concepts; it is handy for visual representation as well. C. Tattersall et al [33] discussed the possibilities to use mind mapping in scientific qualitative research for such purposes as transcriptions of qualitative interviews and other types of analysis of qualitative data.

Theoretical background and methodology

The relevance of integrative approach in sustainability assessment

In a previous study [18], we analyzed sustainability assessment frameworks and sustainability certification systems for buildings and built environments. Some authors [36] distinguish separate groups of human and ecological criteria in building sustainability assessment systems. Our analysis of the main certification systems (BREAM, LEED, WELL, Living Building Challenge) demonstrated that the majority of criteria applied are two-dimensional, include, for example, an environmental and an economic dimension or an environmental and a social dimension. It is noted that BREAM and LEED focus on the environmental dimension, while the WELL system focuses on social issues. Fully sustainable development can only be envisioned if sustainability is attained in all its dimensions: environmental, economic, social, and cultural [9]. In conclusion, on the way to the restorative and the regenerative sustainability and design, to a co-evolution of humanity and environment [2; 13; 20], approaches are needed that integrate in a synergistic way human (social, cultural, economic) and environmental criteria.

Moreover, the psychological significance of the environment for human well-being has been highlighted in various recent studies. The concepts of psychologically sustainable architecture [3; 25; 28] and „neuro-architecture“ by M. Bond, 2017 [3] consider the psychological impact of the built environment. In this study we consider aesthetics as a sensory experience and in this the visual experience, although probably the most powerful, forms only part of the whole. Therefore, the methods of aesthetic research commonly used in the humanities, such as analysis of composition that are focused on visual evaluation do not meet the goals of this study. M. DeKay's study on the levels of aesthetic perception of sustainable design [14] encouraged us to distinguish other sensory aesthetic features that have also been described in biophilic design patterns, the genius *loci concept*, and sustainability aesthetics. Many of these features are intangible, e.g. time and change, interaction of light and shadow, and often involve psychological aspects such as feelings of safety and protection, risk-peril or curiosity. It is thus possible to surpass the limits of the simplest visual understanding towards further sensory levels of perception and aesthetics – phenomenological, process, ecological or evolutionary [14].

As a result, the four approaches - biophilic design, sustainability aesthetics, regenerative design and genius loci - were identified as having the potential for both the development of three- and four-dimensional criteria for sustainability assessment and the further development of a particular aesthetic expression of sustainability (Fig. 1), which, is still underdeveloped and lags behind the technological, performance-oriented advances in sustainability [38]. The following is a description of the four approaches mentioned above.

Biophilic design

The biophilia hypothesis, which is the basis of increasingly popular biophilic design approach, was developed in 1984 by biologist and philosopher E. O. Wilson. Biophilia hypothesis can be briefly expressed as "innate emotional affiliation of human beings to other living organisms" [37]. According to J. Krčmářová [24], the biophilia hypothesis was both the outcome of thorough human-environment

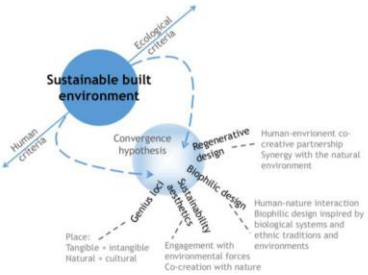

Fig. 1. Concept map of potential synergistic approaches in development and assessment of sustainable built environment [2, 7, 17, 18, 20, 21, 34, 35]

interaction study, but at the same time had an ethical motivation: E. O. Wilson [37] was striving towards "greening" of science and restoring broken human-natural environment connection. Biophilia currently serves as guideline for architectural and urban design [22] but at the same time it is presented as one of biological landscape aesthetics theories [26], stating that our innate affiliation with nature determines aesthetic preferences towards the environments and emphasizes the importance of natural diversity of species and of landscape types. This approach tends to integrate human well-being and healthy physical and psychological development, aesthetic preferences and nature conservation. Several sets of biophilic design guidelines and sets of patterns exist [4, 22]. For example, S. Kellert et al. [22] distinguish six elements of biophilic design - environmental features, natural shapes and forms, natural patterns and processes, light and space, place-based relationships, evolved human-nature relationships - with an array of corresponding attributes. W. Browning et al. 2014 distinguish 14 patterns of biophilic design [4] that are subdivided into three major categories: nature in the space, natural analogues, and nature of the space. Both sets of guidelines correlate highly, although the elements and attributes by S. Kellert et al. [22] are more detailed and the patterns presented by W. Browning et al. [4] are more abstract.

The biophilic design approach distinguishes and discusses aesthetic features encompassing not only visual but also sensory-behavioral (interest, approachability, exportability), cognitive (complexity, organization, modernity, naturalness and beauty) and emotional features, as described in the 2020 study of aesthetic experience by Coburn, et al [6]. The results of their study indicate that „the most salient psychological experiences in the built environment are likely generated by the integration of cognitive, emotional, and sensory information" [6]. Applying the biophilic design approach to the design of sustainable buildings entails these three major components of aesthetic experience that are not typically considered by sustainability assessment systems. The complex system of biophilic patterns by W. Browning et al. [4] was too extensive and abstract to briefly and accurately describe aesthetic features. Therefore, the six elements distinguished by S. Kellert et al. [22] were selected as the basis for a concept map describing aesthetic features to characterize sustainable buildings and environments.

Sustainability aesthetics

Even if current implementation of sustainability paradigm is more technologically oriented, the research on the visual culture in the context of sustainability [8] is taking its ground as well. Such authors and researchers are S. J. Zafarmand et al. [39], S. Kagan [21], C. Cucuzzella [8], I. Di Carlo [11]. According to C. Cucuzzella [8], the more complex understanding of the connection between materials and form choices in the sustainable design is needed; moreover, design aesthetics can have re-directive impact towards more environmentally conscious behavior [8, 32]. S. J. Zafarmand et al. [39] distinguish seven attributes relevant to the aesthetics of sustainability: aesthetic durability; aesthetic upgrade-ability and modularity; simplicity and minimalism; logicality and functionality; natural forms and materials; local aesthetic and cultural identity; individuality and diversity. S. Kagan [21] presents the definition of sustainability aesthetics applicable in various contexts: such aesthetics is focused on relations and processes and is based on a "sensibility to patterns that connect at multiple levels and at the same time is attentive to complexity and highlighting the beauty of the complementarity of antagonisms". He distinguishes such features of sustainability aesthetic as: relation-centered; process-centered; attentive to complexity; combining and contrasting unity; complementarity of antagonisms; open to uncertainties, generativity of chaos, and agitations of disorders.

Regenerative design

Regenerative design is design concept stemming out of regenerative sustainability movement. The field of its application ranges from buildings [2] to landscape management and agricultural practices [17]. According to Ch. du Plessis [13], the regenerative paradigm seeks to "engage with a living world through its emphasis on a co-creative partnership with nature based on strategies of adaptation, resilience and regeneration." This paradigm bears similarities with sustainability aesthetics approach through its co-creative partnership with nature. Different authors distinguish what regenerative design intervention should be like: according to B. Duarte Dias [12], it should be "highly efficient and low impact" and "integrated with the unique local ecosystems and community, co-creating and developing place to its full potential"; according to A. D. Istiadji et al. [20], such interventions should create "healthier and more resilient living quality and equity of community";

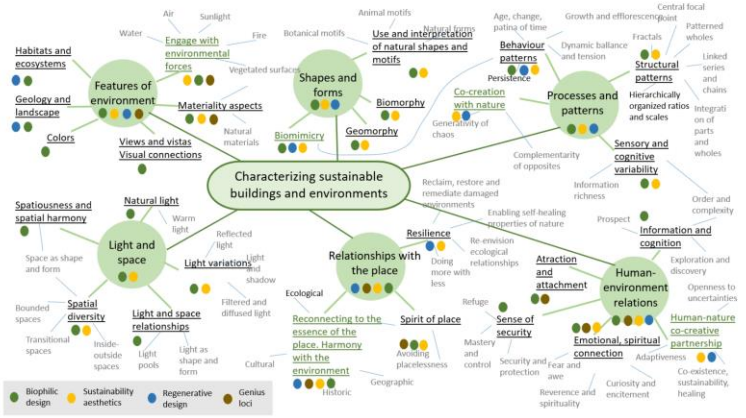

Fig. 2. Concept map demonstrating the interrelations between the above presented approaches and the selected criteria for characterizing sustainable buildings and environments [2, 4, 13, 20, 21, 22, 34, 39]

according to U. Berardi [2], such intervention can become a "live system with dynamic flows with nature". Even if presented definitions sound like mainly technological challenge, numerous authors [17, 20] argue that the change of the world view is of equal or even greater importance. According to A. D. Istiadji et al. [20] the main challenge in achieving the regenerative paradigm is cultural and human psychological one. This once again reveals the relevance of aesthetic expression in solving what appears a technological challenge from the first glance.

Genius loci

According to V. Stauskas [30], one of the design challenges of the 21st century is to transfer or embody the spirit of place (*genius loci*) in all contemporary architecture. *Genius loci* is usually defined as "as the unity of the tangible and intangible components of the <...> environment, forming the uniqueness of the place" [31] and in the recent years with the advent of the historic urban landscape concept is seen not only as heritage preservation issue bus as a resource for urban development [31] and sustainability [34]. Genius loci, being the intangible quality of a tangible place, perceived both physically and spiritually [19, 31, 34] links spatial and intangible, natural and cultural aspects of the place and its sustainable development. Empathetic involvement with the place both of designers and users can lead to the phenomenon called topophilia – the love of place [26] - the powerful motivator for the environmentally conscious behavior.

The concept map demonstrating the interrelations between the above presented approaches and the selected criteria for characterizing sustainable buildings and environments is presented in the Fig. 2. The criteria characteristic to these approaches were distinguished in the course of analysis of literature sources: the main sources for biophilic design criteria were S. Kellert et al. [22] and W. Browning et al. [4]; the main sources for sustainability aesthetics were S. Kagan [21] and S. J. Zafarmand et al. [39]; the main sources for regenerative design were Ch. du Plessis [13], U. Berardi [2], A. D. Istiadji et al. [20]; the main source for *genius loci* in the context of sustainability was M. Vecco [34]. Aesthetic features described in sustainability aesthetics, regenerative design and genius loci concepts correlated highly with features provided in biophilic patterns, however, there were valuable insights that supplemented the set of criteria. It has also allowed us to distinguish the most important aesthetic features introduced by the four theories and to group them in to the complex system.

All the involved criteria can be subdivided in three groups according to their relation with aesthetic expression and perceptions of the object under consideration: 1-characteristics that define visual expression (for example, colors), 2-characteristics that influence visual expression (for example, behavior patterns), 3-criteria that define aesthetic response (for example, emotional, spiritual connection) (Fig. 4). The *human-environment relation* group includes all the criteria defining aesthetics response. The group *light and space* contains solely the characteristics that directly define visual expression. The group *relationships with the place* contains solely the characteristics that indirectly influence visual expression. The group *features of environment, shapes and forms, processes and patterns* contain both the characteristics that define visual expression and the characteristics that influence visual expression. As the

TABLE 1

Questions for the assessment of aesthetic expression of sustainable buildings and environments [2, 4, 13, 20, 21, 22, 34, 39]

Features of environment	- Are there visual connections between the object and its environment present? - Does the object involve variety of colors characteristic to the environment of locality? - Does the object adapt to local terrain and landscape conditions? - Do the object's design and / or functioning involve landscape restoration? - Does the object express the engagement with environmental forces (water, air, sunlight...) in meaningful and visible way? - Does the object integrate local natural materials? - Does the object integrate ecosystems and habitats in meaningful and visible way?
Shapes and forms	- Does the object's design integrate / interpret natural (botanical, animal...) forms and motifs? - Is the object's design based on biomorphic shapes? - Is the object's design based on geomorphic shapes? - Does the object's design mimic nature's forms in functional way?
Light and space	- Does the object integrate / provide natural light? - Are light qualities variations, such as diffused, filtered light, light and shadow, reflections present in the object? - Is the interplay between light and space integrated in the object's design in meaningful way? - Is the spatial diversity / variability integrated in the object? - Are the meaningful connections between spaces present in the object? - Does the object create the feeling (image) of spatiousness and harmony?
Relationships with the place	- Does the object maintain / contribute to the spirit of place? - Does the object involve restoration of the damaged environment in meaningful and visible way? - Does the object contribute to ecological relationships of the locality in meaningful and visible way? - Does the object employ / demonstrate self-healing qualities of nature? - Does the object connect to the essence of the place in ecological, cultural, historic, geographic dimensions? - Is the object harmoniously integrated in landscape / cityscape?
Processes and patterns	- Does the object create sensitive and cognitive variability and / or richness? - Does the object express the process of co-creation with nature? - Does the object express the structural patterns related with fractality, centrality, part-whole integration? - Does the object express in meaningful and visible way the behavior patterns characteristic to natural systems and organisms?
Human environment relations	- Does the object stimulate exploration and cognition? - Does the object stimulate the sense of security in users and viewers perception? - Does the object stimulate the sense of attraction / and attachment in users and viewers perception? - Does the object stimulate emotional, spiritual connection with it and its place in users and viewers perception? - Does the object evoke the feeling of continuous human-nature co-creative partnership?

aesthetic perception of ecological environments goes beyond what is immediately visible [14], these criteria, that involve both the appearance, its causes and the aspects of perception can be valuable in constructing the tools for design and better understanding of sustainable environments. Table 2 presents a series of questions formulated in this research aimed at guiding the interpretation of sustainable building or built environment.

Application: case of courtyards as hybrid environments

Definition of courtyards and their relevance.

According to the definition of the courtyard in Cambridge Dictionary [5], the word describes a flat ground area outside, which is partly or entirely surrounded by the walls of a building, with a hard or grass surface depending on the culture and the region. Most of the time, courtyards can be associated with warm climates due to the need for an

Fig. 3. The scheme demonstrating the solid and void space analysis of the segment of the New town of Kaunas and two courtyard spaces selected for further analysis [from authors private archive]

outdoor seating area with shade and water elements. However, courtyards can have other usages as well. According to Edwards et al. [15], courtyards were used as primary meeting places with various functions such as gardening, cooking, working, resting. Therefore, they can provide semi-private spaces for the inhabitants with the specified borders in the cities' urban fabric. However, when the courtyards are in between the block of apartments rather than part of an architectural element of private houses, the management of these spaces can become problematic. Nowadays, most of the courtyards do not contain a lot of function rather than being a parking lot. However, as it is stated by Almhafdy et al., 2013 [1], courtyards can be commonly applied as an element in architectural design in the environment due to their social, environmental, and therapeutic potentials. In that regard, it is possible to evaluate them as hybrid environments that can administrate various functions that support sustainable development. Furthermore, these spaces provide the possibility to their inhabitants regarding the coexistence of different functions and different people, which makes them open to diversity.

As it is presented by the United Nations Sustainable development goals, goal 11 recognizes universal access to green and public spaces for the people [16]. Furthermore, due to the recent developments in the world, that were caused by the Covid-19 pandemic, the requirement for open spaces, where people can spend time, increased. Therefore, it is essential for people to have access to these courtyards as well as green spaces where they can linger. However, the motivation for spending time in these areas can be various and different from individual to individual. Examining the characteristics and the reasons for visiting courtyard spaces can help to understand their usage potential, and furthermore, it can help to offer relevant functions for supporting sustainability and distinctive aesthetics of these environments. In that regard, a case study area was selected in the New town of Kaunas, Lithuania, which accommodates variously sized and shaped courtyards.

Research process

The research process can be subdivided into several steps. In the first step, the borders of the case study area were decided by the analysis on the map of Kaunas. The segment which was selected for the research is around Nepriklausomybė Square with St. Michael the Archangel's Church, which is located on the main axis of the New town area. In the second step, the courtyards in the selected area were analyzed by the solid and void space analysis to understand the size and shape of them in the two-dimensional plane (Fig. 3.). After this step, the selected area was investigated by visiting the sites to evaluate the spatial configuration of these courtyards; therefore, the analysis at the site involved taking photographs and making sketches of the space. In the investigation process, the courtyards were visited in two different seasons. The first visit was in autumn (October 2020), and the second visit was in summer (June 2021). After all these three steps, two different courtyards were selected as the case study subjects of this research (Fig. 3). The further analysis of two selected courtyards in order to identify their sustainability aesthetics characteristics included: additional on-site observations and photographic survey, graphical analysis and visualization, and descriptive qualitative analysis attempting to answer the questions presented in the table 1. For the graphical analysis and visualization of sustainability aesthetics characteristics the set of icons was developed and applied (Fig. 4).

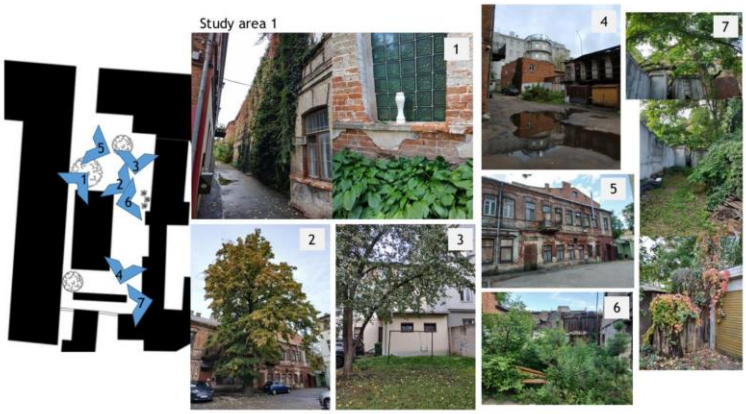

Fig. 5. Photographic survey and analysis for the first study area. The particular aesthetic expression of criteria for characterizing sustainable buildings and environments: 1 - sense of place, growth and efflorescence, characteristic brick color, prospect; 2 - sense of security, growth and efflorescence; 3 - sense of security, attraction and attachment, growth and efflorescence; 4 - prospect, openness to uncertainties; 5 - patina of time; 6 - habitats and ecosystems, engagement with environmental forces, openness to uncertainties; 7 - habitats and ecosystems, exploration and discovery, engagement with environmental forces, openness to uncertainties, light variations, inside-outside space

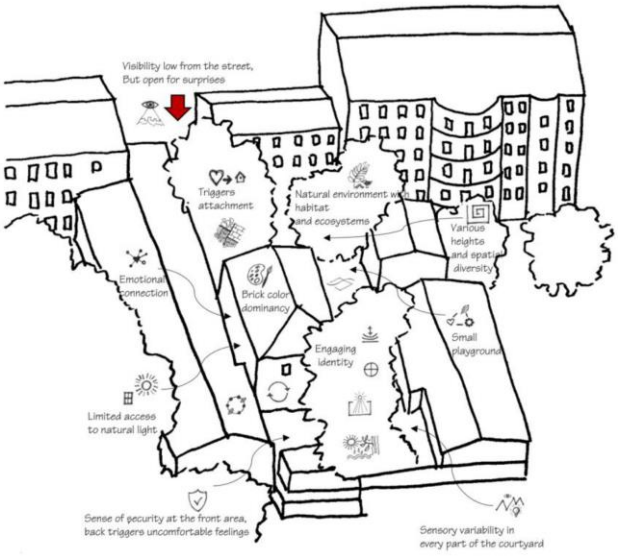

Fig. 6. Graphical representation of sustainability aesthetics features in the first study area

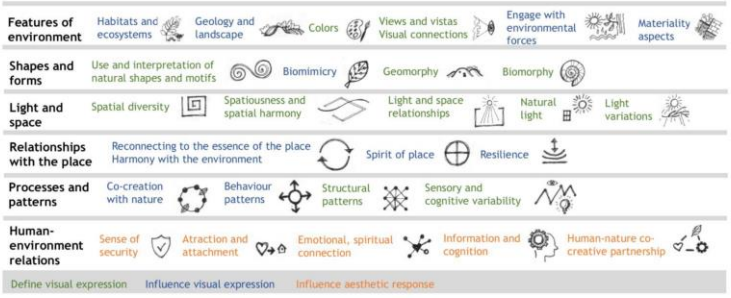

Fig. 4. Icons representing criteria for characterizing sustainable buildings and environments developed in the course of the research and applied in the graphical analysis of the courtyards [from authors private archive]

Research results

The first courtyard (Fig. 5) is at the south-eastern part of the Nepriklausomybė Square, which has a small entrance from the main street. Therefore, the visibility of the courtyard is low and open for surprises for the people who enter it. The courtyard has only one entrance, which makes it a lot more semi-private when it is compared with the other courtyard. In the middle of the courtyard, there is a brick building located that contains geometrical decorations on its façade. When the courtyard is analyzed as a whole, the brick building can be regarded as the centre of the space. The other buildings which are surrounding the courtyard are mostly brick as well, and only one of them contains plaster. Therefore, there is the red brick color dominancy in the courtyard.

The building which occupies the central place in the space is closer to one of the edges, which establishes a smaller pathway to the back part of the courtyard and creates a transitional space. Due to the high walls and the spatial composition of this area, there is limited access to the natural light in this area which makes a shaded space both in autumn and summer. Therefore, the light around this place is filtered. The ivy which is covering one of the façades in this pathway gives a vivid colour and a contrast to space. Furthermore, there are small marble art objects located on the windowsills. In that regard, it might be possible to state that this specific part of the courtyard establishes a sense of place, and it is open for emotional connection for the people who are experiencing it. The usage of the courtyard is mainly as a parking lot, however, a small area as a playground is separated at the corner of the space, which gives the impression that this part of the courtyard is more of a living space when it is compared with the other parts. Therefore, the front part of the courtyard evokes the impression which suggests that it is more commonly used by the inhabitants, while the back of the courtyard seems more discarded. However, the same characteristic of the courtyard also stimulates curiosity and exploration for the people who spend time there.

The storage units which are located at the back part of the courtyard are abandoned and contain considerable decay. The minor part, which is between the border of the courtyard and the storage units, contains trees and weeds, which creates an impression that this part of the courtyard is not actively used and not well maintained by the users. However, due to the massive branches of the trees and the limited area for the movement, this part of the courtyard has an engaging identity. The courtyard as a whole is a hybrid environment which is the result of the human and nature co-creation.

The second courtyard (Fig. 7) is on the opposite side of the first courtyard, and it also has an access point from the main street. However, since it is part of an empty plot rather than being an identified space as a gateway for the courtyard, it does not establish the feeling of an entrance. The courtyard has another opening by an archway from the Nepriklausomybė Square at the side, which contains more of a characteristic of an entrance. Furthermore, the east side of this courtyard also contains the parking lot of the next building, which does not help to have strict borders and establishes an impact that space is not fully identified. As it was detected on the first courtyard as well, this courtyard consists of a building in the middle of it, however, the building divides the courtyard into two different parts rather than being at the centre. The front façade of the central structure has columns which give it an impression of a monumental building. However, when the back façade of the same building is analyzed, it is possible to detect that this part of the structure is quite abandoned, and there is a large amount of decay. Therefore, the sensation which it

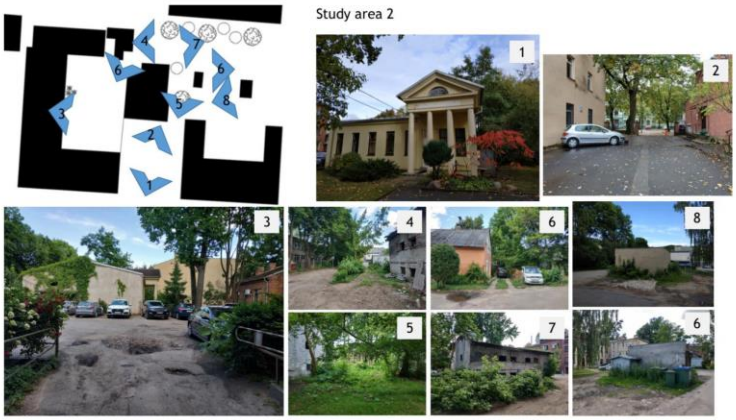

Fig. 7. Photographic survey and analysis for the second study area. The particular aesthetic expression of criteria for characterizing sustainable buildings and environments: 1 - colors, sense of security, sense of place; 2 - prospect, transitional space; 3 - prospect, sense of security; 4 - exploration and discovery, engagement with environmental forces, openness to uncertainties, cognitive variability; 5 - habitats and ecosystems, growth and efflorescence; 6 - resilience, habitats and ecosystems, sense of security, information richness, adaptiveness; 7 - exploration and discovery, engagement with environmental forces, openness to uncertainties; 8 - transitional spaces, habitats and ecosystems, prospect; 9 - transitional spaces, habitats and ecosystems, prospect

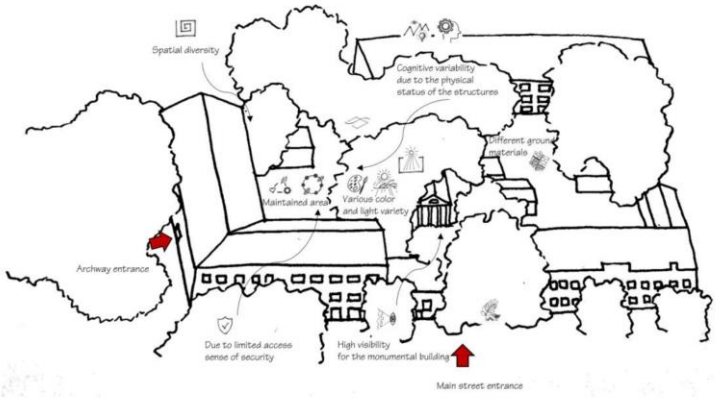

Fig. 8. Graphical representation of sustainability aesthetics features in the second study area

establishes on the observers of the space is different from the other parts of the courtyard. The entrance with the archway has more limited access, and due to the fences at the edges of it, it is more of a private territory when it is compared with the other parts of the space. The fences in this area create a division with the other parts of the courtyard and draw its borders more clearly. The usage of this part of the courtyard is mainly as a parking lot for the buildings which establish the edges of the space. The façades which are facing this part of the courtyard have various materials and patterns with different spatial compositions.

The second half of the courtyard has a less private identity which establishes the impression that it is more of a public space rather than owned by the buildings nearby. However, the area next to the monumental structure is used by the inhabitants of the building, and it is better maintained. The existence of the fruit trees and the small shed near

the building creates more of a countryside environment rather than an urban fabric. Furthermore, due to the close location of the fruit trees to the structure, they filter the natural light and establish a space that mostly contains shade.

When the courtyard is analyzed as a whole, it is possible to state that it catalyzes different emotions and impressions in each section of it since it has various characteristics. However, it also establishes the sensation that even though it is a hybrid environment, the different parts of the space are not well integrated to each other and they contain different stories both physically and emotionally.

Discussion and Conclusions

The intentional paradigm shift towards sustainability in the last decades of the 20th century and continuous development and application in various fields of sustainability concept change the predominant attitudes towards environment and the design expression and aesthetic perception as well. Besides the increasing ecological performance of buildings and related technological advancements the notion of particular aesthetic expression of sustainability ideas in our living environments is unfolding as well and it is sometimes referred as sustainability aesthetics. However, the qualitative aesthetic side of sustainability paradigm is much less explored compared to quantitative performance side and it is possible to conclude that sustainability aesthetics of the built environments still lacks its own vocabulary.

As it was mentioned above, the concept of sustainability is evolving towards restorative and regenerative and towards the goal of co-evolution of humanity and environment. Such development will require the integrative approaches towards the living environment that integrate environmental, economic, social, and cultural sustainability dimensions in a synergistic way. Biophilic design, sustainability aesthetics, regenerative design and *genius loci* were distinguished as such integrative approaches and applied in the elaboration of methodological frame for characterizing sustainability aesthetics. The concept map approach was selected for developing and visualizing the methodological frame, which was organized around six elements - features of environment, shapes and forms, light and space, processes and patterns, relationships with the place, and human-environment relations - adapted from S. Kellert et al. [22]. The distinguished criteria grouped around these elements can be subdivided into: defining visual expression (for example, colors), influencing visual expression (for example, behavior patterns), defining aesthetic response (for example, emotional, spiritual connection). These criteria that involve the appearance of the building or environment, its causes and the perceptional aspects were further developed into a series of questions to evaluate the particular space or design.

For testing the developed methodological frame, the courtyards in the historic environment of New Town of Kaunas reflecting long-lasting sustainable co-existence between humans and their environment and representing characteristics of both architectural and urban space were selected. The analysis process involved map analysis, on-site observations and photographic survey, graphical analysis and visualization, and descriptive qualitative analysis attempting to answer the sustainability aesthetics related questions developed in the methodological section.

The analysis of the courtyards has demonstrated that these spaces of quite simple layout create the impression of complex, dynamic, emotionally involving environments from the human eye level. The majority of distinguished characteristics, except ones requiring intentional sustainability oriented design (such as biomimicry), were identified in the analyzed courtyards. It was determined that some sustainability aesthetics characteristics have evolved organically, for example, ecosystems are present in courtyard spaces in unintentional way. Even the supposedly negative environmental features, for example, decaying buildings, can trigger sustainability aesthetics responses. The research has confirmed the importance of new vocabulary for sustainability aesthetics: new language applied for description helps to see the environment differently and to develop empathetic relation with the place. Such sustainability aesthetics analysis could become a part of elaborating maintenance and development guidelines in order not to lose valuable qualities that may lie in such from the first glance undesirable features as re-naturalization and decay in the urban fabric. Moreover, such analysis would allow employing heritage environments that are often partially organically developed, as a source of inspiration for architects and planners.

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Kopsavilkums. Pieaugošā vides apziņa un jaunās dizaina un darbības prasības, kas saistītas ar ilgtspējības mērķu īstenošanu, neizbēgami ietekmē būvniecību, arhitektūru, pilsētbūvniecību un mūsu apbūvētās vides attīstību kopumā. Šī ietekme izpaužas gan arvien efektīvākā būvēto konstrukciju ekoloģiskajā izpildījumā un pieaugošajā saistīto tehnoloģiju klāstā, gan šo videi draudzīgo dizainu estētiskajā izteiksmē. Ilgtspējības koncepcijas un vērtību estētiskā izpausme dažkārt tiek saukta par ilgtspējības estētiku. Pētījuma mērķis ir izstrādāt un pārbaudīt metodisko ietvaru, lai raksturotu apbūvētās vides ilgtspējības estētiku.

buildings

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Article

Classification of Biophilic Buildings as Sustainable Environments

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Abstract: Biophilic design approach aims at creating favorable conditions for humans in various types of anthropogenic environments, while at the same time restoring broken human–nature connection. The biophilic design guidelines and principles are general and flexible and allow wide array of architectural expressions. In order to better understand the architectural expression possibilities provided by biophilic design approach, the existing classifications of biophilic architecture and biophilic design examples were analyzed with the aim to develop the classification that would reflect the links between a building's architectural expression and biophilic qualities. Three categories of biophilic architecture were distinguished in the developed classification: mimetic, applied, and organic. The distinguished categories were illustrated with the characteristic building examples and the evaluation of biophilic qualities and human-nature collaboration potential of these example buildings was carried out using comprehensive system of criteria. The analysis has demonstrated that all three distinguished categories—mimetic, applied, organic—allow for the creation of biophilic environments and hold the potential for human–nature collaboration, although organic biophilic design would be currently considered as the least developed, although most promising category.

Keywords: biophilia; biophilic architecture; biophilic building; classifications of biophilic design; human–nature collaboration

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1. Introduction

The term biophilia was coined as early as in 1964 by E. Fromm; however, it was developed and popularized in certain circles by biologist and naturalist and writer E. O. Wilson, who had developed and published in 1984, and later refined in his further works, what he has referred to as the biophilia hypothesis. According to this hypothesis, humans, as well as other species on Earth, had developed throughout their evolution and history surrounded by biodiversity and thus the interconnections with natural environment have persisted until this day [1–3]. The biophilia hypothesis states that human beings have an innate biological need to affiliate with nature; consequently, the biological diversity, the diversity of relations to nature, and diversity of landscape types are important for healthy human physical and psychological development [4]. Despite the benefits of connections with nature proven by environmental psychologists, medical researchers etc. [1,4], the human–nature connections and the biophilic qualities of our everyday environments continue to decline. Some researchers even identify our contemporary living environments as anti-biophilic [5]. According to A. Samalavičius [2], with the entrenchment of technologies and technological processes in human civilization, the human environment has strongly changed as well. Human habitats became closed and relatively sterile, even movement between locations happens in the closed environment of automobile. The mega-cities became inhospitable to nature and humans became distanced from their natural contexts, which has been their habitat for millennia. In order to restore broken human–nature connections and provide all the potential benefits of biophilic environments—the improvement of individual physical, psychological, and cognitive health and well-being as well as some social benefits like enhanced workers' productivity, improved public health, phytoremediation of industrial ruins [1,6]—the disciplines of biophilic design, biophilic urbanism, and diverse systems

of criteria and patterns (for example, Kellert et al. [7]; Browning et al. [1], Salingaros [5]) that facilitate biophilic projects implementation have emerged. E. L. M. Wolfs [6] distinguished several characteristics of biophilic approach to design that differentiate it from other environmentally-oriented design concepts: positive focus on enhancing instead of minimizing and the potential for mutually beneficial human–nature collaboration. E. L. M. Wolfs [6] biophilic design focuses on the actualization and enhancement of nature's ability to improve the quality of human experience and well-being instead of focusing on minimizing negative human impacts, and strives to develop the link between artificial and natural processes based on symbiotic interdependence.

However, some challenges could be identified related with the increasingly growing trend of biophilic design. One of these challenges is identified by A. Samalavičius [2] as the paradigm of thinking entrenched by the architectural ideology of the last century. The other challenge is design superficiality, mentioned by E. L. M. Wolfs [6], when the biophilic commitment of the creators is limited to "videos of cats, the rounded edges of a mobile phone or the digital representation of natural material". The relevance of biophilic design and distinguished challenges encourage directing the attention of designers and researchers towards the peculiarities of biophilic architectural form, understanding better how architectural form can engender biophilic qualities or/and how biophilic features can be integrated into architectural form.

The aim of the research is to analyze the existing classifications of biophilic architecture and biophilic building design examples and to develop a classification that would reflect the links between building's architectural expression and biophilic qualities. The categories of biophilic architecture distinguished in the developed classification are illustrated with characteristic building examples and the evaluation of biophilic qualities of buildings is carried out using a comprehensive set of criteria. The methodology of the research includes an analysis of the literature and architectural design examples, a comparison and systematization, and an assessment of architectural designs according to predefined criteria. The relevance and novelty of the research are determined by the contemporary challenges of entrenched modernist architecture ideology and design superficiality and the proposed and elaborated classification of biophilic architecture, as well as the evaluation of buildings not only from the point of view of biophilic qualities, but also from the perspective of human–nature collaboration as possible responses to these challenges. The problems and difficulties in the context of this research were the need to grasp the diversity of expression of biophilic design into a limited number of categories as well as finding the categories that would reveal the synergistic relation between the expression of the building and its biophilic qualities.

2. Review of Present Classifications of Biophilic Design

In order to understand better the extent of biophilic design, it is important to delve into the ways that biophilic design applications could be classified and categorized. The review of existing classifications of biophilic design included a search of the literature on the subject of biophilic design in the scientific literature databases Web of Science, Scopus, and Google Scholar. The publications on the biophilic design of buildings [6–10], biophilic design principles [1,5,7–10], and biophilic urbanism [8] were reviewed and examined for existing classifications or distinguished specific categories of biophilic architecture. The analysis of the literature has revealed that first of all, with the growing understanding of the benefits provided by biophilic environments, efforts have been made to distinguish between biophilic and non-biophilic or "business as usual" designs or even anti-biophilic environments [5]. For this purpose, different systems of criteria [5] and patterns [1] were formulated. For example, the company Terrapin Bright Green has elaborated 14 patterns of biophilic design subdivided into three categories: nature in the space; natural analogues; nature of the space [1]. The analysis of the literature clearly reveals that biophilic design applications can be categorized according to scale (for example, biophilic building, biophilic block, biophilic street, biophilic neighborhood, biophilic community, and biophilic

region [8]) or object (for example, biophilic interior design [9]). This research primarily focuses on the architectural expression of biophilic buildings. After reviewing the literature, several existing classifications applicable to architectural expression of buildings were distinguished in the biophilic design discourse: those inspired by nature and traditional design trends, historic and contemporary biophilic architecture, natural and artificial biophilic environments, and explicit and implicit biophilic design (Figure 1).

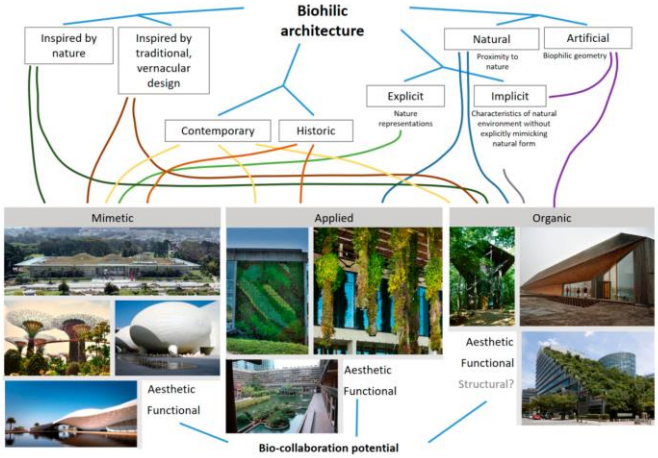

Figure 1. Existing classifications of biophilic architecture distinguished after a literature analysis and their links with proposed biophilic architecture categories: mimetic, applied, and organic. Each of three categories is illustrated by characteristic examples. Mimetic biophilic design: California Academy of Sciences (USA), Supertree Grove (Singapore), Weill Cornell Medical College (Qatar), BEEAH Headquarters (UAE). Applied biophilic design: green wall at Simon Fraser University (Canada), Perez Museum (Miami, Florida, USA), Khoo Teck Puat Hospital (Singapore), Barbican Estate (London, UK). Organic biophilic design: Thorncrown Chapel (USA), Wadden Sea Centre (Denmark), Acros building (Japan). All the images used in the illustration are from Wikimedia commons.

2.1. Inspired by Nature and Traditional Design

Two trends or dimensions towards which architects could orient the expression of biophilic buildings—inspired by nature, biological systems and natural shapes and inspired by traditional, vernacular, ethnic architectural forms, construction cultures and material applications—can be identified in the literature [7,10]. Both of these trends are generally characteristic for green design approaches since their inception and are identified in the book, Green Architecture by J. Wines [11]. For example, Snail House, designed by the Jersey Devil company in Forked River, New Jersey (USA) in 1972, is an example of architectural design inspired by nature [11]. S. Keller et al. identify Sydney Opera House designed by Jorn Utzon as inspired by natural shapes and forms [7]. An example of a building inspired by traditional design is the clay and straw Studio in the West Country, designed by David Lea (England) [11]. These broad trends allow conceptualizing biophilic shapes not only for natural and countryside landscapes, but also for urban and peri-urban areas.

2.2. Historic and Contemporary Design

Researchers analyzing biophilic design have noticed that both professional and vernacular architecture of the past eras was biophilic in its qualities even if the term itself

was not known [1,5,6]. According to E. L. M. Wolfs [6], architects and designers have been inspired by nature since antiquity. W Browning et al. [1] notice that animal themes could be found even in prehistoric-built structures and nature was used as a source of symbolic and decorative ornamentation and directly brought into exterior and interior spaces in the form of plants, animals, natural materials, etc. S. Keller et al., note that many organic features are often encountered in Gothic architecture and mention the Gothic Revival Harkness Tower at Yale University, designed by James Gamble Rogers as example of biophilic architecture [7]. According to A. Salingaros [5], this human–nature relationship remains important from traditional cultures until today, but has increasingly been abandoned with the rise of industrialization.

2.3. Natural and Artificial

According to N. Salingaros [5], the positive effects of biophilic environments are induced either by proximity and visual contact with nature (plants, animals, scenic views, natural materials, or even other people) or by artificial environments that "follow geometrical rules for the structure of organisms". For example, proximity with nature is visible in the designs using vegetated surfaces, as in the case of botanists Patrick Blanc's green walls [8]. An example of an artificial biophilic environment is the interior design by Adolfsson & Partners in the King office complex in Stockholm providing artificial forest experience for its employees [12]. In other words—it is possible to design artificial shapes and spaces that stimulate the same responses as natural environments and biological forms. In the first case the positive effect of biophilic design can be defined as the "healing influence of nature" and the second case is identified as "biophilic geometry" by N. Salingaros [5]. Similar approach is visible in nature in the space and nature of the space categories in the 14 patterns of biophilic design [1]. The better results would be obtained if both the healing influence of nature and biophilic geometry were be integrated into the project.

2.4. Explicit and Implicit Representation of Nature

N. Salingaros [5] distinguishes explicit and implicit representations of nature. Explicit representations of nature include direct visual representations of natural forms in design. The foliated sculpture by Kent Bloomer in the Ronald Reagan National Washington Airport terminal is an example [7]. Implicit representations of nature would be "organized complexity—purposeful complication that is also accompanied by a high degree of organization". This abstract characteristic of natural world can be achieved in artificial environments in numerous ways, creating hierarchies similar to natural ones and providing an information-rich expedience as an intriguing balance between boring and overwhelming [1]. An example of a multilevel organized light and space complexity is Genzyme Center interior space designed by Behnisch Architekten in Cambridge, Massachusetts [13]. Similar categorizing could be inferred from the 14 patterns of biophilic design, where "biomorphic forms and patterns" and "complexity and order" are distinguished as "natural analogues" [1].

3. Proposed Classification of Biophilic Architecture

The above-presented analysis of existing classifications applicable to biophilic architecture has revealed the lack of universal classification that would be suitable both to innovative and traditional buildings or to buildings based on the biophilic geometry and the healing influence of nature, or which integrate both of those aspects. Moreover, it would be desirable that the classification would reflect the interconnections between the architectural form of building and its biophilic properties. In order to develop such a classification, the analysis of existing biophilic design classifications presented in Section 2 was complemented with an additional review of the literature on the classification of architectural objects and features in the above-mentioned scientific literature databases as well as available Internet search engines and encyclopedias, the general overview of biophilic design principles [1,5,7,9], and existing examples of biophilic buildings. The search and

general overview of biophilic architecture examples was carried out using available Internet search engines and keyword combinations such as "biophilic architecture", "biophilic building", "biophilic design", etc. The criteria for selecting examples for analysis were that the buildings were referenced in prominent architectural online editions and corresponded to the criteria of biophilic design. Bearing in mind that buildings having biophilic qualities are not always explicitly identified as biophilic, an additional overview was carried out in architectural websites and databases, such as ArchDaily, Divisare, Dezeen, etc. The iconographic material (photographs, drawings, visualizations) and the descriptions of projects were overviewed in light of biophilic design criteria, presented by A. Salingaros [5], W. Browning et al. [1], and S. Kellert et al. [7]. The analysis revealed the diversity of scales, functions, and expressions of biophilic buildings. The examples demonstrate that biophilic qualities can be achieved using the internal and external layers of vegetation and natural materials to mimic forms of natural landscape or biological organisms by creating a complex organization of volumes and spaces characteristic to natural environments. The results of this general overview allowed parallels to be made between the interconnection between ornament and architecture and biophilic qualities and architecture. Bearing in mind this semblance, the literature on ornament in architecture was reviewed and the classification of architectural objects by A. Tikkanen [14], based on the character and integration of ornament, was viewed as having potential for adaptation to classifying biophilic buildings. A. Tikkanen [14] has distinguished three types of architecture: mimetic or imitative (symbolic ornaments imitating natural features, structural elements of preceding wooden structures etc.), applied (ornament, often without precise symbolic meaning, applied as a surface element for pure decorative purposes), and organic (ornamental effect of the inherent qualities of building materials). Such principle of classification—mimetic, applied, and organic—was modified and adapted to biophilic buildings (Figure 1).

3.1. Mimetic Biophilic Buildings

In the case of biophilic architecture, mimetic biophilic buildings are those that achieve biophilic qualities by using forms which "have certain definite meanings or symbolic significance" [14]. This can be either through botanical motifs, imitation or interpretation of traditional architectural forms, or interpretation of landscape features in the design of the building. For example, the New California Academy of Science Museum designed by Renzo Piano integrates the interpretation of the surrounding hills in its roof structure [6]. Some mimetic biophilic design features can also be identified in the structures designed by Arata Isozaki and Zaha Hadid Architects (Figure 1).

3.2. Applied Biophilic Buildings

In the case of biophilic architecture, applied biophilic buildings are such designs, where biophilic qualities are added as a layer that appears extrinsic to the structure itself. These can be buildings with vertical internal and external greenery, interior parks, or roof gardens that, in addition to these biophilic features, maintain a modernist, high-tech, or sleek architectural outlook. The example of such approach is Khoo Teck Puat hospital in Singapore, which integrates modernist design and lush greenery and viable ecosystems and numerous other biophilic qualities [6], similar to Perez Art Museum, Miami, by Herzog & de Meuron (Figure 1). The applied approach is typical and successful in situations when biophilic refurbishment of the existing structure is necessary, as in the cases of Barbican estate in London.

3.3. Organic Biophilic Buildings

In the case of biophilic architecture, organic biophilic buildings are such designs where the synergistic relation between the biophilic qualities and the structure is achieved. In this case the biophilic qualities are inherent in a building's shape and arrangement of spaces, materials, and functions. The creative works of Barry Wark [15], like the Glasgow School of Art Extension, can be mentioned as the attempts to create a biophilic architectural

form which would be capable of generating human health and well-being benefits without directly emulating elements of natural world and at the same time providing a habitat for other species, thus fostering a human–nature connection.

According to E. L. M. Wolfs [6], biophilic architecture holds unprecedented potential for bio-collaboration, where the integration of natural elements goes beyond aesthetics or symbolism. Organic biophilic design could potentially create environments of distinctive architectural expression that positively affect human health and well-being and provide a habitat for a variety of natural systems, which in turn can "provide wide-ranging services that are integral to solving today's major ecological concerns" [6]. According to E. L. M. Wolfs [6] bio-collaboration in design could occur on aesthetic, functional, and structural levels. While functional and aesthetic bio-collaboration is widespread in biophilic architecture, the structural bio-collaboration, where "the design is primarily made by a living organism" [6] is still in the experimental stage and is referred to as bio-integrated design [16].

4. Evaluation of Selected Building Examples

4.1. Case Study Buildings Selection

In order to analyze in greater detail, the means of expression and design strategies of different categories of biophilic buildings, a sample of case study buildings were analyzed. It was decided that the examples to analyze would be located in the territory of Lithuania, as biophilic design is oftentimes associated with climate zones allowing lush exterior greenery. The Lithuanian climate, with clearly expressed seasons, requires different approaches for creating biophilic qualities, thus we decided to concentrate on the variety of design means and approaches available in such a climatic context. Moreover, biophilic design ideas are just taking the first steps in Lithuania and distinguishing these examples and analyzing them serves an important factor for the entrenchment of biophilic design culture in the Baltic Sea region. In order to select the examples for analysis, prominent Lithuanian architecture journals (both printed and online) aimed at both the professional community and the general public were reviewed, and the buildings were selected based on their correspondence to biophilic design criteria as presented by A. Salingaros [5], W. Browning et al. [1], S. Kellert et al. [7]. Additionally, the possibility to attribute the objects clearly to one of the three distinguished design categories: mimetic, applied, and organic was considered. Each of three categories was represented by one case study example.

The following examples were selected for analysis:

1. Example A—Kindergarten "Peledziukas" [17] (Figure 2); Type of biophilic design: mimetic; Design: "DO Architects" (G. T. Gylyte, D. Baltrunas, K. Ciplyte, V. Babij, S. Daugeliene, A. Baldisiute, A. Neniskis, M. Vysniauskas); Location: Pagiriai, Vilnius; Year of completion: 2021. This object was selected due to its architectural expression (volume and materials) both modern and recalling traditional architectural design in the urban context. Moreover, this is a reconstructed building located in the urban context, where renovation and re-use as well as biophilic quality of the environment are of high importance.
2. Example B—Vilnius University Kairenai Botanical Garden's Green Building-Plant [18] (Figure 3); Type of biophilic design: applied; Design: Paleko "ARCH studija" (R. Palekas, B. Puzonas, D. Zakaite, A. Palekiene, V. Linge); Location: Kairenų st. 43, Vilnius; Year of completion: 2016. This object was selected due to its direct correspondence to the trend of applied biophilic design as this is reconstructed building, the biophilic character of which is created with vegetated columns—an unusual and experimental solution in Lithuanian climate conditions.
3. Example C—Recreation and Water Center in Zarasai (Figure 4) [19]; Type of biophilic design: organic; Design: Archartele ir partneriai (H. Staude and A. Minkauskas); Location: The island of the great Zarasas, Zarasai; Year of completion: 2015. This object was selected due to the synergetic effect between building's shape, materials, and environment creating a biophilic experience.

Figure 2. Kindergarten "Peledziukas" located in Vilnius, made with materials and roof configuration recalling traditional wood architecture was selected as an example of mimetic biophilic design. Photographs by A. Daugelaite.

Figure 3. Vilnius University Kairenai Botanical Garden's Green Building-Plant with external layer of vegetation was selected as an example of applied biophilic design. Photographs by A. Daugelaite.

Figure 4. Recreation and Water Center in Zarasai with landscape-inspired volumes and nature-like spatial characteristics was selected as an example of organic biophilic design. Photographs by A. Daugelaite.

4.2. Assessment of Case Study Buildings

The overall biophilic design aim, to restore broken human–nature connections, encourages an analysis of biophilic buildings not only from the point of their aesthetic expression and human well-being benefits, but also from the points of view of human–nature integration and human–nature collaboration. As it was mentioned in the previous section, aesthetic and functional bio-collaboration distinguished by E. L. M. Wolfs [6] is widespread in biophilic architecture. In this research we apply the more general term human–nature collaboration, used in the fields of sustainability aesthetics [20] and regenerative sustainability [21–23]. The term human–nature collaboration encompasses bio-collaboration in its turn but is not limited to it and includes such factors as designs' engagement with environmental forces.

In order to evaluate the mimetic, applied, and organic biophilic designs from the points of view of biophilic qualities, aesthetic expression, and human–nature collaboration a series of questions was formulated. It was first based on the biophilic design criteria [1,5,7] and other sources (Table 1) and then applied for on-site evaluation of three selected design examples, representing the above-distinguished trends.

Table 1. Questions used for the assessment of selected buildings as a means for design evaluation from sustainability aesthetics, biophilic design, and human–nature collaboration points of view [1,5,7,20–26]. Buildings correspondence to the criterion is evaluated in the scale from 0 to 2: None = 0 (gray color in the table); Some = 1 (yellow color in table); Clearly expressed = 2 (green color in the table).

Criteria of Architectural Expression		Architectural Means/Explanation/Hint	Examples		
			A	B	C
Features of environment	Does the object adapt to local terrain and landscape conditions?	Prioritize real nature over simulated nature; Adaptation to local terrain forms; Preservation of vegetation; Response to landscape character	2	2	2
	Does the object express the engagement with environmental forces (water, air, sunlight...) in meaningful and visible way?	Sun, shade, reflections; Integration of waterbodies; Rainwater management; Integration of vegetation; Possibilities to feel airflow, etc.	2	2	2
	Does the object integrate ecosystems and habitats in a meaningful and visible way?	Flora: ecological systems, visual continuity, trees, shrubs, vegetated ground covers, habitats, rare plant species, nectar rich vegetation, flowering wild local herbs etc. Fauna: birds, insects, land animals and reptiles, fish, endangered species, etc.; Bird box, bat box, biotope for specified insects	1	1	1
	Does the object provide opportunities for seeing, hearing or touching of water?	Naturally occurring: river, stream, ocean, pond, wetland; Visual access to rainfall and flows; Seasonal flows Simulated or constructed: water wall, constructed waterfall, aquarium, fountain, constructed stream; Reflections of water (real or simulated) on another surface; Imagery with water in the composition	0	2	2
Materials	Does the object integrate natural (and local) materials?	Real materials are preferred over synthetic; Materials and elements from nature that, through minimal processing, reflect the local ecology or geology to create a distinct sense of place, sometimes stimulating to the touch	2	2	2
Visual interest	Are there visual connections between the object and its environment present?	A view to elements of nature, living systems and natural processes; Prospect—an unimpeded view over a distance; Quality views from the outside and inside	2	2	2
	Does the object contribute to scenic quality or landscape character?	Architectural object interacts with landscape (identical, similar, contrasting) and forms qualitative wholeness	2	2	2
	Does the object provide views to elements of nature, living systems, and other living things at all?	Naturally occurring: natural flow of a body of water; Vegetation, including food bearing plants, animals, insects, fossils, terrain, soil, earth Simulated or constructed: mechanical flow of a body of water; Koi pond, aquarium; Green wall; Artwork depicting nature scenes; Video depicting nature scenes; Highly transformed, designed landscapes	2	2	2
	Does the object correspond to other unique physical features?	Unique site elements are integrated into the design	2	2	2
	Is the object harmoniously integrated in landscape/cityscape and looks visually balanced?	Part/whole relationships that may include balance, coherence, concinnity, consonance, orchestration, proportion, symmetry, symphony, unity	2	2	2

Table 1. *Cont.*

	Criteria of Architectural Expression	Architectural Means/Explanation/Hint	Examples		
			A	B	C
Shapes and forms	Does the object's design integrate / interpret natural forms and motifs?	Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature; Presence of natural (botanical, animal) motifs in the design	1	1	2
	Does the object's design mimic nature's forms (e.g., biomorphic shapes) in a functional way?	Functional biomimicry	0	0	2
	Is the object's design based on geomorphic shapes?	Relation to the form or surface features of the earth or landscape	0	0	2
	Does the object include spatial hierarchy similar to those encountered in nature?	Complexity that simultaneously stimulates senses of intrigue and order, and reduces stress	0	1	2
Light and space	Does the object integrate/provide natural light?	Architectural object provides users with natural lighting options	2	2	2
	Are light quality variations, such as diffused, filtered light, light and shadow, reflections present in the object?	Varying intensities of light and shadow that change over time to create conditions that occur in nature Naturally occurring: daylight from multiple angles, direct sunlight, diurnal and seasonal light, firelight, moonlight and star light, bioluminescence Simulated or constructed: multiple low glare electric light sources, illuminance, light distribution, ambient diffuse lighting on walls and ceiling, day light preserving window treatments, task and personal lighting; accent lighting Personal user dimming controls; Circadian color reference	1	2	1
	Is the spatial diversity, variability and interest integrated in the object?	Curving edges; Dramatic shade and shadows; Winding paths; Partially revealed spaces; Translucent materials; Obscuring of the boundaries and a portion of the focal subject	2	1	2
Processes/Patterns *	Does the object create sensitive and cognitive variability and/or richness?	Information-richness, balance between boring and overwhelming	2	2	2
	Does the object express the process of co-creation with nature?	Construction using mycelium, technologies with algae for energy production and air quality improvement, "bio-concrete" made of moss and beef mushrooms in rainwater and allowing plants to be grown on the facades, salt slabs made of salt, sunflower and algae, bioplastics made of algae, etc.	1	2	1
	Does the object express the structural patterns related with fractality, centrality, part-whole integration?	Self-similarity across different scales. Integration or interpretation of naturally occurring fractals: branches of trees, animal circulatory systems, snowflakes, lightning and electricity, plants and leaves, geographic terrain and river systems, clouds, crystals; Nested fractal designs Action of a central element in its periphery Part-whole integration—relation of object's parts to the whole object itself; Application of the Fibonacci series, the Golden Mean	1	1	1
	Does the object express in a meaningful and visible way the behavior patterns characteristic to natural systems and organisms?	Change over time; Decaying—changing properties (rusting metal, wood changing color over time), natural patina of materials (leather, stone, copper, bronze, wood); Growing plants, moss	2	2	2
	Does the object express the stochastic and ephemeral connections with nature?	Integration, emphasis of naturally occurring phenomena: cloud movement, breezes, plant life rustling, water babbling, insect and animal movement, birds chirping, fragrant flowers, trees and herbs. Simulated or constructed: billowy fabric or screen, materials that move or glisten with light or breezes, reflections of water on a surface, shadows or dappled light that change with movement or time, nature sounds broadcasted at unpredictable intervals, mechanically released plant oils	1	2	1
	Does the object provide thermal and airflow variability?	Naturally occurring: solar heat gain, shadow and shade, radiant surface materials, space/place orientation, vegetation with seasonal densification Simulated or constructed: HVAC delivery strategy, systems controls, window glazing and window treatment, window operability and cross ventilation	2	2	2

Table 1. *Cont.*

	Criteria of Architectural Expression	Architectural Means/Explanation/Hint	Examples		
			A	B	C
Human–environment relations	Does the object maintain/contribute to the spirit of place?	The design maintains/contributes to tangible (buildings, sites, landscapes, routes, objects) and the intangible elements (memories, narratives, written documents, rituals, festivals, traditional knowledge, values, textures, colors, odors, etc.) of the spirit of place. The object connects to the essence of the place in ecological, cultural, historic, geographic dimensions	2	2	2
	Does the object involve restoration of the damaged environment in meaningful and visible way?	Improved ecological situation: surfaces are permeable to water, variety of vegetation, rainwater management (bioswales, raingardens, etc.), a section of the courtyard is left for natural succession (that is, to naturally grow and regenerate), composting biodegradable waste; Design prioritizes biodiversity over acreage, area or quantity	0	2	0
	Does the object employ/demonstrate self-healing qualities of nature?	Little maintenance is required, the site is self-operating like in natural places, like meadow or forest	0	0	0
	Does the object stimulate exploration and cognition?	The object creates the conditions that differentiate between surprise (i.e., fear) and pleasure, creates a sense of mystery, risk/peril, arouse interest of exploring Mystery created by the promise of more information achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment. e.g. Peek-a-boo windows that partially reveal, curving edges, winding paths. Risk/Peril is created as an identifiable threat coupled with a reliable safeguard: double-height atrium with balcony or catwalk, architectural cantilevers, infinity edges, façade with floor-to-ceiling transparency, experiences or objects that are perceived to be defying or testing gravity, transparent railing or floor plane, passing under, over or through water, proximity to an active honeybee apiary or predatory animals, life-sized photography of spiders or snakes	2	1	2
	Does the object stimulate sense of security in users and viewers perception?	Creating physical and mental safety, refuge—a place for withdrawal, from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead	2	2	2
	Does the object stimulate sense of attraction and emotional, spiritual connection with it and its place in users and viewers perception?	People are taking photographs, collect litter, spend their free time in and around the object	2	2	2
	Does the object stimulate experience of nature through senses?	Design stimulates auditory, haptic, olfactory, or gustatory stimuli referring to nature, living systems or natural processes. Naturally occurring: fragrant herbs and flowers, songbirds, flowing water, weather (rain, wind, hail), natural ventilation (operable windows, breezeways), textured materials (stone, wood), crackling fire/fireplace, sun patches, warm/cool surfaces Simulated or constructed: digital simulations of nature sounds, mechanically released natural plant oils, highly textured fabrics/textiles that mimic natural material textures, audible and/or physically accessible water feature, music with fractal qualities, horticulture/gardening, including edible plants, domesticated animals/pets, honeybee apiary	1	1	1
	Does the object stimulate connection with natural systems?	Naturally occurring: climate and weather patterns (rain, hail, snow, wind, clouds, fog, thunder, lightning), hydrology (precipitation, surface water flows and resources, flooding, drought, seasonal flows), geology (visible fault lines and fossils, erosion, shifting dunes), animal behaviors (predation, feeding, foraging, mating, habitation, migration), pollination, growth, aging and decomposition (insects, flowering, plants), diurnal patterns (light color and intensity, shadow casting, plant receptivity, animal behavior, tidal changes), night sky (stars, constellations, the Milky Way) and cycles (moon stages, eclipses, planetary alignments, astronomical events), seasonal patterns (freeze-thaw, light intensity and color, plant cycles, animal migration, ambient scents) Simulated or constructed: simulated daylighting systems that transition with diurnal cycles, constructed wildlife habitats (e.g., birdhouse, honeybee apiary, hedges, flowering vegetation), exposure of water infrastructure	1	2	2
		Total:	42	49	52

* Pattern—a form or model proposed for imitation.

31 questions subdivided into 7 categories—features of environment, materials, visual interest, shapes and forms, light and space, processes/patterns, and human–environment relations—were answered evaluating the answer in the scale from 0 to 2, evaluation 0 meaning that qualities are not present and 2 meaning qualities are clearly expressed. The highest

possible evaluation of the building using this approach is 62. Quantitative assessment of case study buildings has revealed that all of them can be considered as biophilic buildings, having features of sustainability aesthetics and human–nature collaboration as the evaluation score in all three cases has exceeded 30. Object A—Kindergarten "Peledziukas" was evaluated with the score 42, the lowest of all three case study objects with weakest evaluation in the categories of human–environment relations and shapes and forms. Object B—Vilnius University Kairenai Botanical Garden's Green Building-Plant was evaluated with the score 49 with weakest evaluations in shapes and forms category. The lower evaluation of shapes and forms of both buildings is determined by the fact that both objects are reconstructed Soviet era buildings. The facts of reconstruction and adaptive re-use give positive consideration from sustainability point of view. Object C—Recreation and Water Center in Zarasai received 52 scores from 62 and demonstrates the highest presence of biophilic qualities from all the evaluated case study objects. The weakest evaluation of this object is in the category of human–environment relations as well as in the first case study building. It is possible to conclude that the potential possibilities provided by restorative and regenerative approaches to design were not employed in these projects.

4.3. Descriptive Analysis and Discussion of Case Study Buildings

Descriptive qualitative analysis of case study objects provides the example of analyzing and discussing the buildings and their surroundings from biophilic design, sustainability aesthetics, and human–nature collaboration points of view offering a different angle for looking at projects and their implementation. The descriptive analysis of each object was elaborated based on the questions presented in the Table 1, demonstrating the suitability of this approach for both quantitative and qualitative analysis of buildings.

Kindergarten "Peledziukas". The object's terrain is flat, and the object is placed there without extreme changes in the terrain. The object is strongly engaged with the sun—it provides many opportunities of feeling the sun in different angles and places and provides shaded areas under the trees or tracery walls. The vertical timber panels cast changing shadows. The object provides a lot of open spaces, such as the inner garden, a rooftop terrace, playgrounds, etc. with a possibility to feel the air. However, there are no water features.

The project deserves the highest evaluation of the efforts to preserve the trees (the initial idea of the project was changed in order to save the old spruce tree, which even has a tale of origin). However, the area is poor with other parts of ecosystem, such as fauna habitats or wild herbaceous flowering plants. There is not any water element. The object is constructed of timber, which dominates in the interior and exterior and furniture design.

The object provides very strong visual connections among its spaces (for example, children can see the work at the canteen or cleaner's room) and to the outside with views to the pine grove from the roof terrace, which obviously add value to the project. The object definitely contributes to scenic quality of the area.

The object looks visually balanced and well placed. Strict lines and forms dominate in the building, which is rarely found in nature. Biomorphic forms are not directly visible in the design; aside from the color and shape of the roofing which recalls traditional wooden architecture as well as the stylized owl's ears that can be associated with the owl-themed name of the institution (Pelėdžiukas translates to owlet in English). The site's surface is flat, thus it is not applicable to the evaluation of geomorphic forms. Spatial hierarchy is expressed in the building's volume, but the object lacks fractality.

The object provides sunlight from different angles and in different daytimes, however lighting variations (interplay of light and shadow, diffused light, etc.) are rare. The object is rich with diverse and partially revealed spaces and their dynamics and creates cognitive variability. A co-creation with nature is expressed through the naturally aging wood cladding.

The object has strong relation between the whole and its parts. The centrality of the object is created through the central garden which forms the core of the whole project. Ephemeral connections with nature may be felt by seeing naturally occurring phenomena

through the windows (like cloud movement, birds, etc.). There is a lack of other senses, like smells of plants, blooming flowers, water features or animals, insects, etc. life. The curtains in the corridor may rustle with light breeze. The windows are openable and the rooms can be ventilated, and air movement can be felt.

The object contributes to the spirit of place by enriching it with innovative architecture and improving the urban landscape of the area. Although the existing trees are involved beautifully in the design, other features of improving the local ecology, such as permeable surfaces, variety of vegetation, biodiversity, etc. are missing.

The object definitely stimulates exploration and cognition by involving "mystery" elements in partially revealed spaces, roof terrace, and walls with floor-to-ceiling transparency. The sense of safety and attraction is strong. The experience of nature and connection to the living systems could be stimulated through the senses even stronger. It is possible to feel warm/cool surface in sun-shaded areas, natural ventilation in the building, or feel the breeze while being in the courtyard, as well as see weather conditions through the large windows or touch the natural wood on the facade. However, auditory, olfactory, or gustatory stimuli are not reflected and the project could be enriched with flora and fauna.

Vilnius University Kairenai Botanical Garden's Green Building-Plant. The object's terrain is flat. The object is placed there without extreme changes in the terrain. The building engages with environmental forces by the vegetated façade that provides light and shadow interplay, the sound of wind through the plants, a little fountain is integrated near the entrance of the building, and large pond is located on the site. The object integration with local ecosystems and habitats is not visible despite the fact that it is located in the botanical garden. The project contains few habitats for the fauna in the backyard, there are shrubs growing on the premises to the building, however, in terms of habitat it is probably insufficient. Flowering plants for bees or butterflies are found further from the building premises. Concrete paving is hardly permeable surface, however, it only takes up a small area. The object provides views to the pond and fountain and it is possible to hear and touch the water on the building's site.

The object's façade is constructed of planted columns which encourages interest and desire to touch. The columns are constructed of local turf. The building is a reconstructed Soviet era apartment building. The views to the living systems and natural processes are obvious. The building provides an unimpeded view over a distance, views from the building are exceptional. The building definitely supplements the landscape. A unique site characteristic is the botanical motif which is transferred to the building. The building looks visually balanced itself and on the site.

Strict lines and forms dominate in the building, which is rarely found in nature. However, the planted columns soften the impression. The site's surface is flat, thus it is not applicable for the evaluation of geomorphic forms. Spatial hierarchy is not expressed and the main façade elements are of one size. The exception is the front garden which is a labyrinth that provides the full scale of fractals.

The spatial diversity, variability, and interest is high. The interplay of light and shadow is variable, however, these features could be expressed even stronger by more expressive loops of the paths and partially revealed spaces in the interior, etc. The process of co-creation with nature is strongly expressed. The object forms a strong relation of its parts to the whole object itself and event to its site which includes reference to fractal systems (planted surfaces), and provides the possibility to feel the airflow and hear nature sounds through open windows, feel the natural smells while being on the site, see water reflections, cloud movement, fountain water babbling, etc.

The object connects to the essence of the place by adding value to its character. Landscape restoration is not included and the surrounding lawn is poor in biodiversity terms. The project definitely improved the existing ecological situation. However, there is little information of how the rainwater is treated and if, for example, a section near the pond is left for natural succession (that is, to naturally grow and regenerate). These means could

help to improve the richness of biodiversity. The site requires constant maintenance and self-healing qualities are not visible.

The object raises interest; however the stimulation of exploration and cognition may be expressed stronger by risk/peril and mystery means. A sense of security is strong. A conscious attempt to include auditory, haptic, olfactory, or gustatory stimuli into the design is not visible, however, some of these emerge from the special site itself. A connection to natural systems is stimulated through feeling (on the site) and observing (through windows) of naturally occurring processes like climate and weather, seasonal and diurnal patterns, and the feeling of the presence of vegetation and water. However, life of fauna is little expressed due to lack of wildlife habitats (e.g., birdhouse, honeybee apiary; hedges, flowering vegetation).

Recreation and Water Center in Zarasai. The object nicely integrates man-made structure and natural landscape. The architectural structure connects land and water. The question may arise about whether it is a building, a bridge, or a path. Structural variety offers possibilities to touch the water or to feel the wind breeze, shade, and sun. Although ecological systems such as habitats, rare plant species, nectar rich local vegetation, and others are not integrated in the project on purpose, it offers visual continuity of a man–nature made landscape, and opportunities to find fauna life in the trees or the lake.

Timber cladding reflects the local materials. Visual connections between the object and its environment are strong from both the inside and outside. The object definitely contributes to the scenic quality. The object provides views to elements of nature and living systems including the lake. The object provides the paths over water and roof terraces. The object takes advantage of the unique lake shores and existing tree line. The object looks harmoniously integrated in the landscape.

The object's design is based on an organic, naturally flowing form that looks like it is grown out of its site. Biomorphic shapes are repeated through the object's design—rooms or roof terraces are evolving out of the paths, etc. The object creates geomorphic forms and the image of the hills rising up or down. This feature expressed the spatial hierarchy as well. The object provides light from different angles and offers some dramatic shadows, however, light variations are not very rich. Curving edges and winding paths partially revealed spaces to offer spatial variability.

The object is information-rich and involves the process of co-creation with nature through decaying natural wood and strong connections with landscape. Fractality is not expressed. The object creates a central focal point of interest in the landscape and part-whole integration is nicely expressed. The object has a wonderful location; however, it expresses the stochastic and ephemeral connections with nature only partially. It could integrate more strongly the life of birds, insects, wild plants, and others, however, its impermeable asphalt surfaces, shortly cut lawn, and lack of surrounding biodiversity show the lack of landscape restoration means in a meaningful and visible way. It could be done additionally without changing the properties of the object itself. Thermal and airflow variability is rich and is provided by the possibilities of the variety of spaces. The object contributes to the spirit of place by enriching the landscape and providing strong attraction, as well as a meeting and recreational point in a small town. The site requires maintenance, although it would require less if the meadows would be left to bloom.

The object stimulates exploration and cognition by creating a sense of mystery, risk/peril and arouses the interest of exploring. Winding paths, terraces, and paths over water invite a visitor for a stroll. The sense of safety is strong as well as attachment to the area. As the object may be visited at night, it offers experiences of stargazing, watching the moon, etc. However, auditory, olfactory, or gustatory stimuli are not reflected and the project could be enriched with flora and fauna, especially those natural to its wild location.

It is possible to conclude that all three analyzed projects are strong at integrating environmental features, however struggling with the inclusion of fauna life, such as insects, and flora, like blooming local flowers. Biodiversity on the sites is not rich enough and surfaces are rarely permeable. Therefore, it leads to difficulties for implementing the

design criteria of engagement to living things and other sensorial stimuli like smells. This confirms the results of quantitative evaluation, demonstrating the lack of human–nature collaboration and restorative and regenerative approaches in case study objects. Although projects are strong in creating good pieces of architecture, they could have more features to provide senses of mystery, risk/peril, and naturalness, as well as spaces requiring low maintenance and offering a variety of natural processes that enrich people's lives. However, all three case study objects confirm that it is possible to create biophilic buildings and biophilic interior and exterior experiences in the Lithuanian climate not only in natural, but in urban environments as well. Moreover, biophilic qualities were successfully created even in the cases of Soviet era buildings reconstruction and adaptive re-use.

5. Conclusions

The significance of the biophilia hypothesis and biophilic design in providing favorable conditions for human well-being and healthy development in anthropogenic environments, restoring human–nature connections, and potentially bringing the development of built environments and human habitats to human–nature collaboration level significant for regenerative sustainability encourages the analysis of possibilities of architectural expression of biophilic buildings.

Existing classifications of biophilic design distinguish such trends as inspired by nature and traditional biophilic design, historic and contemporary biophilic design, natural and artificial biophilic design solutions, and explicit and implicit representation of nature in biophilic design. Analysis of the literature has revealed the lack of a universal biophilic design trends classification that would be suitable both to innovative and traditional buildings or buildings based on the biophilic geometry and on the healing influence of nature or integrating both of those aspects.

The classification reflecting the interconnections between the architectural form of a building and its biophilic properties was developed in the course of this research. Biophilic buildings are categorized into mimetic, applied, and organic: mimetic biophilic design achieves biophilic qualities by using symbolic, mimetic forms related to nature or traditional architecture; in the case of applied biophilic designs biophilic qualities are added as a layer, which appears extrinsic to the structure itself; in case of organic biophilic design a synergistic relation between the biophilic qualities and the structure is achieved. The analysis of bio-collaboration and the human–nature collaboration potential of these trends has revealed that all three trends hold the potential in these fields with particular attention to organic design and its structural bio-collaboration possibilities. Evaluation of three selected building examples located in Lithuania corresponding to mimetic, applied, and organic trends according to a comprehensive set of biophilic design criteria confirmed the highest potential for the organic trend to create biophilic environments and the suitability of the applied trend for successful biophilic reconstruction of existing buildings. However, it is possible to conclude that application of each of these trends allows for the creation of biophilic buildings and biophilic experiences in different climatic conditions including in the temperate climate zone.

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Psychological Acceptance of Sustainable Architecture in Lithuania: A Qualitative Study

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Abstract

The concept of sustainable development has been applied to the field of architecture since the end of the 20th century and has become an official paradigm for planning, design, and construction policies. However, a lot of researchers notice the lack of attention to cultural, place-based, and aesthetic aspects in the field of sustainable architecture. Moreover, the efforts to implement sustainability ideas sometimes lead to very unusual designs that can even be provocative experiments, and may sometimes lead to conflicting assessments in the general public. This study investigates the architectural language of sustainable design and how the aesthetics of sustainable architecture are distinguished and psychologically accepted by people. An online sociological survey was prepared and conducted, the results of which were analysed by general statistical calculations. The study analysed respondents' preferences towards sustainability in architecture, opinion towards sustainable architecture trends, and their features. The results of the study are illustrated by comparing opinion between professionals in the field of architecture and general public.

Keywords: Sustainable Architecture, Aesthetics, Architectural Trends, Architecture Quality, Psychological Sustainability.

Introduction

The incorporation of the psychology of sustainability and sustainable development into Sustainability Science has fostered a transdisciplinary approach towards the complex and interconnected realm of sustainable architecture. By studying the psychological aspects of human environments, these disciplines are playing a critical role in advancing the seventeen UN Sustainable Development Goals (United Nations, 2018). This inter-disciplinary approach helps to promote the development of sustainable urban environments that benefit both the present and future generations (Sustainability, 2013). Furthermore, these studies are essential in promoting sustainable living practices, which can improve the overall health and wellbeing of individuals and communities, while also reducing the negative impact of human activities on the environment. As such, the incorporation of psychology of sustainability and sustainable development into Sustainability Science is a necessary step in achieving a sustainable future for all.

Therefore, the need to explore the psychological aspects of sustainable architecture is becoming an increasingly important topic. Fox (2000) working in the field of environmental ethics, emphasises that sustainable development is primarily a value category. Considering sustainable development as a value category, its grounding idea 'Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs' illustrates the focus on traditional three-dimensional model aspects (ecological, economic and social) but omitts the cultural aspect. Moldovanova (2014) approves that this model does not fully reflect complex modern societies, so it is necessary to supplement it with the di-

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mension of cultural sustainability (Culture, 2010; Moldavanova, 2014; Meireis and Rippl, 2019). The cultural dimension of sustainability emphasizes the significance of aesthetics, which is a crucial aspect of sustainable architecture in the broader context of holistic development.

The constructed environment has a strong impact on psychologival states and well-being (Coburn, 2019). The biophilic theory highlights extensive research on the advantages of incorporating natural elements into constructed environments, where both aesthetic and sensory factors are significant (Browning, 2014). Emerging ideas on 'psychological sustainability' in architecture adds to the growing understanding of the importance of aesthetics in architecture (Kok, 2018). Aesthetics is officially one of the architectural quality criteria in Lithuanian law (LR Seimas, 2017), which illustrates its growing practical significance.

However, formal compliance with the principles of sustainability does not ensure the aesthetic quality of architectural works, and their aesthetic expression does not necessarily reflect the ideas of sustainability and environmental friendliness (Heymann, 2020). It is an extremely difficult task to define sustainability aesthetics. It is even more difficult to measure it. Additionally, there is a lack of studies investigating contemporary expression in architecture or trends of sustainable architecture expression. This study aims to explore how sustainable architecture trends are psychologically perceived by professionals and general public, and their association with architectural quality as defined by Lithuanian law.

The psychology of sustainability and sustainable development may be categorized as Guruprasath (n.d.) suggests: Spatial relationship (Relationship between spaces), Interpersonal relationship (Relationship between persons), and Person-space relationship (Relation between persons and spaces). Consequently, this study analyses the relation between person and space. This study systemized and distinguished the directions of sustainable architecture and the features that describe it. These results were used for designing a questionnaire that tested respondents' opinion in order to distinguish the main features of sustainable architecture that ensures psychological comfort and the basic needs of its users.

The present study contributes to the field of sustainable architecture by providing a systematic analysis of the relationship between person and space, and by identifying the main features of sustainable architecture that ensure psychological comfort and meet the basic needs of users. The study also considers psychological acceptance of sustainable architecture, which is described as design ensuring comfort, security, and avoidance of uniformity and inexpressiveness as by Pulyaevskaya (2019). The novelty of this study lies in its specific interest in exploring the aesthetics of sustainable architecture and its relation to attitudes in Lithuania, potentially reflecting Northern European trends.

Methods

For the implementation of the study, an online sociological survey was prepared and conducted by the author. The survey was conducted through an online survey website (https://apklausa.lt/f/darnios-architekturos-tendenciju-patrauklumo-visuomenei-tyrimas-9wl7ybq/answers/new.fullpage) during April – May 2022. The target group was adult residents of Lithuania (age 18 and older). The survey focused on collecting random samples and was shared with the target public groups on social media for architecture professionals and communities. It was shared by email to Lithuanian architectural companies. The questionnaire was completed by 240 respondents (of whom 86 professionals and 157 non- professionals). The survey consisted of 27 open and closed questions that were divided into four groups:

1. Social-demographic questions: age, gender, education, professional experience in architecture, place of residence;

2. Questions illustrating general attitudes towards sustainable architecture and assessment of 10 trends of sustainable architecture (respondents were asked to indicate if the trend is acceptable to them, if the trend seems environmentally friendly, and to leave a short comment about the trend);
3. Questions determining respondents' attitudes towards the distinctive aesthetic features of sustainable buildings;
4. The final question was dedicated to the respondents to describe the features of sustainable architecture by themselves.

Results

Characteristics of the Respondents

The dominant group of respondents may be described as highly educated, early middle-aged urban residents who try to choose environmentally friendly solutions in their everyday life and of whom 1/3rd were related to the field of architecture. The majority (70.0%) of the respondents were 25 – 45 years old. The other largest group (19.8%) of respondents were 45 – 65 years old. Others were 18-24 years of age (8.6%) and 65 years old or older (1.6%). Most of them (67.1%) were women. Most of the respondents had higher education: 80.2% of the respondents had higher (university) education, 4.9% had unfinished higher (university) education and 7.4% higher (college) education. The ratio of specialists (35.4%) in the field architecture with non-specialist (64.6%) was similar to 1/3. The majority of the respondents lived in the residential areas (40.3%) of the city or its central part (34.2%), which together is 74.5% of city residents. The other smaller group lived in the suburbs of the city (13.6%) and the rural area in settlement (9.9%). The residents of the rural home was just 2.1%. The greatest number of respondents choose environmentally friendly solutions in their daily life, 58.0% choose *yes* and 18.5% choose *definitely yes* to this statement.

Most of the residents agreed that the expression of modern architecture should reflect ecological ideas – 48.1% chose yes and 26.3% definitely yes to this statement as well as 46.9% chose yes and 49.0% definitely yes to the statement 'Environmentally friendly solutions should be applied in the field of architecture'. This opinion illustrates that this group of Lithuanian residents highly supports sustainability in the field of architecture. To find out whether it was not just a declarative opinion, three questions were presented with the intention of eliciting personal responses. The majority of the respondents stated that they would choose more expensive but environmentally friendly solutions based on latest technologies (46.9% chose yes and 14.4% - definitely yes to this statement, 30.0% did not have an opinion). It can be assumed that the price of how much more expensive it would be would help them decide.

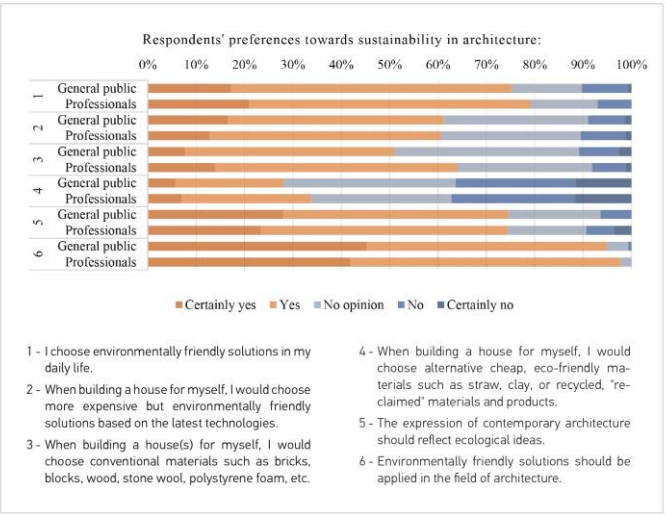
Almost all respondents (95.9%) including professionals and general public consider that expression of contemporary architecture should include environmentally friendly solutions should be applied in the field of architecture.

Both the professionals and non-professionals preferred environmentally friendly solutions based on the newest technologies and supported the idea that contemporary architecture should reflect ecological ideas and apply environmentally friendly solutions. Professionals slightly more often chose environmentally friendly solutions in their daily life. Non-professionals were more interested in trying non-conventional building materials (**Fig. 1**).

Assessment of Sustainable Architecture Trends

The respondents evaluated 10 building groups that represent the most outstanding sustainable architecture. Pictures were given as digital illustrative collages representing each trend (**Fig.2**).

Fig. 1
Respondents' preferences towards sustainability in architecture



1. Low-tech re-used buildings represent the trend promoting the use of recycled or re-used materials to create a modern architectural expression;
2. Dictated by re-used aesthetics, the trend, where aesthetics of buildings is dictated by what materials have been obtained for re-use;
3. Trashy anti-consumerist architecture - the trend in which a building can be created from anything that is discarded using secondary raw materials. In this way, the opposition to modern consumerism is demonstrated;
4. Low-tech expressive organic forms - the tendency to create a particularly mannerly architectural expression using natural, recycled, or reused materials;
5. Low-tech ecological buildings, the trend dominated by local, natural materials (straw-clay mixture, hemp concrete, etc.), although a modern expression is being developed;
6. Eco-technological buildings - the trend dominated by glass and metal, integrating the latest eco-technological advances, often using innovative materials;
7. Vegetated buildings - the trend dominated by greenery (planted facades, roofs, or otherwise integrated plants);
8. Building-landscape integration - the trend in which the building blends in with the landscape;
9. Expressive iconic organic forms, the trend in which the aesthetics of a building is expressed in distinctive organic, plastic forms;
10. Biophilic architecture, the tendency to deliberately reproduce certain features of natural environments in buildings.

1. Low-tech re-used (Source: 1 & 3 – Weburbanist.com, 2 - Archdaily.com)

2. Dictated by re-used (Source: 1 - Modlar.com; 2 & 3 - Weburbanist.com)

3. Trashy anti-consumerist (Source: Inhabitat.com)

4. Low-tech expressive organic forms (Source: 1 & 3 - Dailymail.co.uk; 2 - Vice.com)

5. Low-tech (Source: 1 - Archdaily.com; 2- Dezeen.com; 3 - Dezeen.com)

6. Eco-technological buildings (Source: Archdaily.com)

7. Vegetated buildings (Source: 1 & 3 - Arquitecturaviva.com; 2 - Archdaily.com)

8. Building-landscape (Source: 1 - Archdaily.com; 2 - dortemandrup.dk; 3 – Ignant.com)

9. Expressive iconic organic forms (Source: 1 - Cgarchitect.com; 2 – Archdaily.com; 3 – Aureus-studio.com)

10. Biophilic architecture (Source: 1 - Lrt.lt; 2 - Designwanted.com; 3 - Archdaily.com)

Fig. 2
Trends of sustainable architecture (sources numbered left to right and provided in the list of pictures at the end of the article)

Respondents were asked to indicate whether the trend was acceptable to them (**Fig. 3**) and if the trend seemed to be environmentally friendly (**Fig. 4**). All trends of sustainable architecture were accepted generally well. It was interesting to test tolerance towards architectural experiments and its scope. To find out respondents' opinion, examples of recycling projects were divided into three groups which showed different levels of recycling intensity (group 1-3).

The first group was the most reasonable recycling trend which aimed to use recycled or re-used materials for a contemporary architectural expression; architecture of the second group was more focused on expression, which was dictated by received materials and showed more intense level of recycling. The last group were extreme examples as a declarative form against consumerism, a form of protest rather than a real building.

The first group of recycling projects (Low-tech reused) was highly positively accepted by most respondents, with 78.6% finding it acceptable and 60.9% considering it environmentally friendly. The acceptance of the second group (Dictated by reused) was more evenly divided by possitive and negative answers, with 46.1% finding it acceptable and 46.9% considering it environmentally friendly. The third group (trashy anti-consumerist) was hardly acceptable, with 27.2% finding it acceptable and 44.8% considering it environmentally friendly.

Fig. 3
Respondents' opinion about acceptability of architectural trends

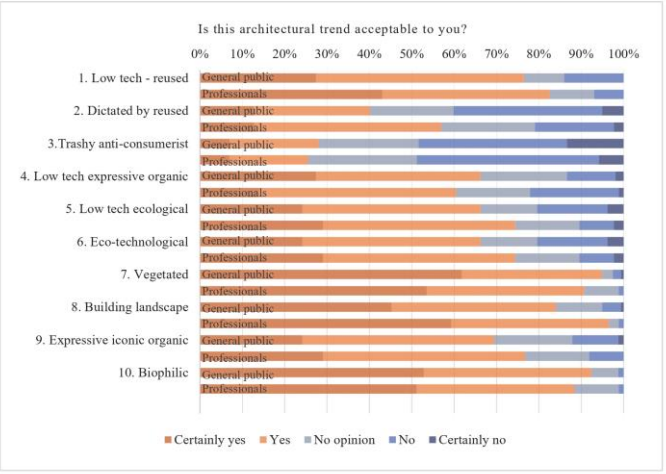
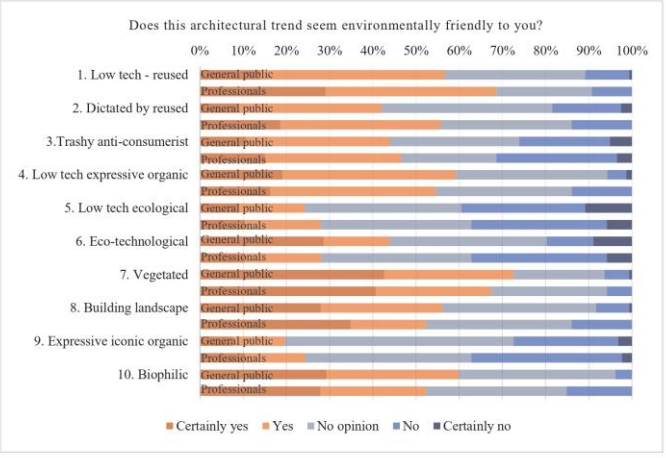


Fig. 4
Association of architectural trends with environmental friendliness



To summarise, the initiative of using recycled materials was generally welcomed by the respondents, however supported more often by professionals.

The best accepted trends in sustainable architecture were Vegetated (93.4% positive responses), Low-tech ecological (92.5% positive responses), and Biophilic (91.0% positive responses). Vegetated architecture, characterized by greenery integrated into buildings was the most accepted

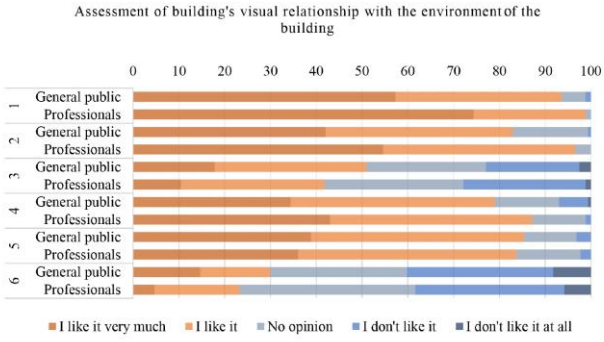
trend, with 93.4% of respondents giving positive answers. Low-tech ecological buildings that employ contemporary architecture with low-tech solutions were also accepted very well, with 92.5% of respondents giving positive answers. Biophilic architecture, which aims to replicate natural environments in buildings, was the third most accepted trend, with 91.0% of respondents giving positive answers. The most environmentally-friendly looking trends were Vegetated (70.8% positive responses) and Low-tech reused (60.9% positive responses) and Low-tech expressive organic (57.6% positive responses) architectural trends.

Low-tech expressive organic buildings and building-landscape integration were also well-received. Buildings integrated into the landscape were considered as environmentally-friendly by the majority of the respondents. The trend of expressive iconic organic forms (group 9) had a positive acceptance rate, but was perceived as the least environmentally friendly. As later noticed in the comments – due to often extensive use of materials and large consumption in the construction site. The trend of eco-technological buildings was also accepted well, but was the second least perceived as environmentally friendly.

The most significant differences, albeit minor, between professionals and the public were that the reuse and building-landscape projects were more favorably received by the former. On the other hand, the eco-technological trend was perceived as environmentally friendly more frequently by the public.

The Attitudes towards the Distinctive Aesthetic Features of Sustainable Buildings

Building's visual relationship with the environment was assessed (**Fig. 5**). Majority of respondents (95.5%) agreed that an attractive quality of the building is when a building opens views to distant perspectives. Buildings that adapt to their environment through materials and colours were preferred to buildings contrasting by materials and colours. Local and natural materials were appreciated by the majority of respondents (97.7% of positive answers).



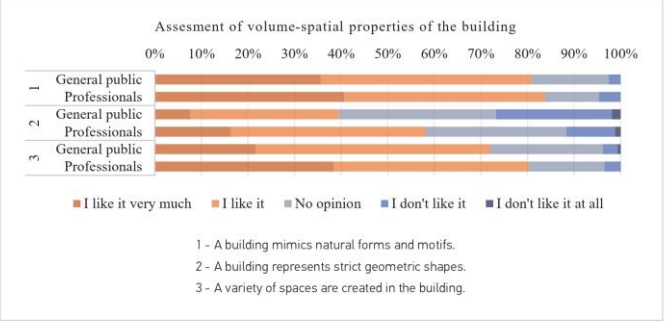
1 - Opens views with distant perspectives.
2 - It is made of local and natural materials.
3 - Contrasts with the environment in colour and materiality.
4 - Adapts the landscape by its form (e.g., earth-shelter buildings, buildings replicating landscape forms, etc.).
5 - It is similar in colour and material to the environment.
6 - It dominates the landscape with its volume.

Fig. 5
Assessment of the visual relationship with the environment of the building

The similarity in colour and material to the environment was preferred by the majority (84.8% of positive answers). On the contrary, buildings contrasting by colour and materiality were evaluated as disliked by 22.6% of respondents and as totally disliked by 52.1% of respondents. Buildings, adapting to the landscape by their form, were also valued (81.8% of positive answers), but the buildings dominating the landscape by their volume were perceived more negatively than positively (27.6% of positive answers versus 39.51% of negative answers). The general public accepted more positively buildings that dominate the landscape and contrast by colour and materiality in the environment compared with professionals.

Furthermore, respondents were asked to evaluate the volume-spatial properties of the buildings (Fig. 6). The buildings which mimic natural forms and motifs were more preferred than buildings consisting of strict geometric shapes. To illustrate this, buildings that mimic natural forms and motifs were almost completely liked, while strictly geometric buildings were disliked by 19.8% and evaluated as totally unacceptable by 1.6% of the respondents. Strict geometric shapes were more appreciated by professionals than by the general public. A variety of spaces created in the building was evaluated as an attractive feature of the building.

Fig. 6
Assessment of the visual relationship with the environment of the building



Furthermore, respondents evaluated materials used in building construction (Fig. 7). Respondents were more likely to choose conventional materials such as bricks, blocks, wood, stone wool, polystyrene foam, etc. that may not always be sustainable (45.7% answered *yes* and 9.9% - *definitely yes*) rather than alternative cheap, eco-friendly materials such as straw, clay or recycled, "reclaimed" materials and products (11.5% answered *yes* and 25.1% - *definitely yes*). However, it is worth to notice that respondents indicated in the comments that they value durability and aesthetics. Based on that, it could be predicted that respondents who doubted (33.3%) could possibly choose unusual eco-friendly materials if they were durable and aesthetic.

The most appreciated materials that were selected as *'really liked'* were plants (49.8%), wood (41.6%) and clay (19.3%), also selected as *'liked'* were brick (60.1%), timber (51.4%) and stucco (44.4%). Meanwhile, the least appreciated were synthetic materials (disliked by 37.0% and totally disliked by 14.0% of respondents) and metal (disliked by 34.2% and totally disliked by 5.8% of respondents). The most liked material of all (sum of responses *'I really like'* and *"like"*) were wood and plants. Metal and concrete were liked more by professionals than by general public.

The natural and local materials were liked by a larger percentage of the professionals than general public, with minor differences between both groups.

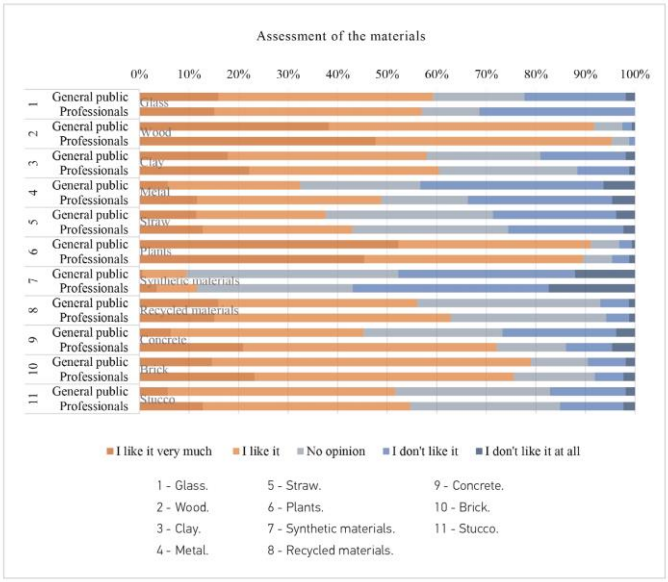


Fig. 7
Assessment of the materials of the building, if the aesthetics is dominated by

Describing the features of sustainable architecture

Further, respondents were asked to evaluate the lighting of constructed environment (Fig. 8).

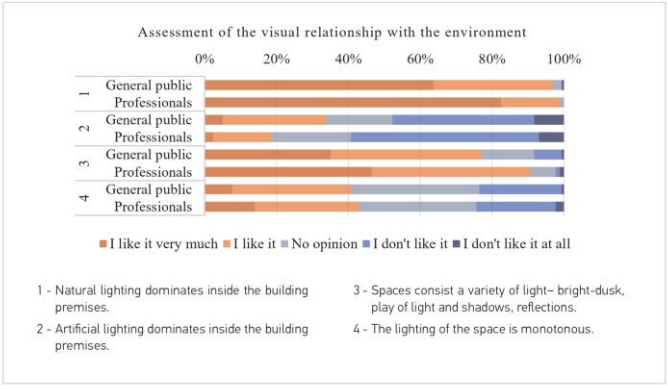
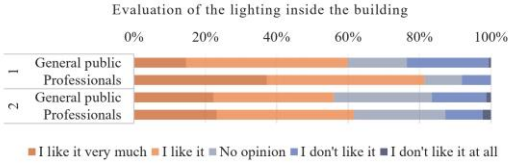


Fig. 8
Assessment of the visual relationship with the environment of the building

The study showed that natural lighting was considered as a very important feature of a building. Almost all the respondents (97.6%) answered *'I really like"* (70.4%) and *"I like"* (27.2%) the natural lighting dominant inside the premises. Meanwhile, the dominating artificial lighting in the building was disliked by 44.0% of the respondents and 7.8% considered it totally unacceptable. More respondents liked spaces consisting a variety of light such as bright-dusk, play of light and shadows, reflections, etc. (*"I really like"* - 39.1% and *"I like"* - 42.8%) rather than monotonous light inside (*"I really like"* - 9.9% and *"I like"* - 31.7%). In addition, the monotonous lighting was disliked more often (22.6%) than the variety of lighting (5.3%). Lighting qualities such as a variety of light and natural light was more preferred by professionals.

Other aesthetic properties such as changes of the building during time and presence of renewable energy production systems were evaluated during the study (**Fig. 9**). The aesthetic changes of the building over time were accepted positively - 22.6% of respondents really liked it and 44.9% liked it. However, it was more preferred by professionals. Visibility of renewable energy production and/or rainwater harvesting systems was not considered as an aesthetic drawback of the building - 22.6% of respondents really liked it and 35.4% liked it.

Fig. 9
Evaluation of lighting inside the building



1 - The aesthetics of the building change significantly over time (e.g., rusted metal, seasonal change of green facades, modernisation of historical buildings, etc.).

2 - Renewable energy production and/or rainwater harvesting systems are visible in the architecture of the building and create the aesthetics of the building.

It was important for the study to evaluate not only visible characteristics of the built environment but also the sensual experience within it (**Fig. 10**). The most important features were creating a sense of security, being aesthetically pleasing, and contributing to the creation of the local spirit in an ecological, cultural, and historical aspect. The least important thing was expressing the co-creation of nature and man. Experiencing the environment through various senses, promoting spiritual attachment and encouraging exploration were considered important more frequently by professionals than by general public.

Describing Sustainable Architecture

The last question of the survey asked to associate features of the building with sustainable architecture (**Fig. 10** and **Fig. 11**). From a total of 196 comments, meaningful responses were selected and assigned to 25 groups as 437 short responses - qualities of the built environment. Subsequently, the number of responses was compared to the architectural quality criteria established by the Lithuanian architecture law and the characteristics of sustainable buildings and environments (LR Seimas, 2017). The results show the attention given by the respondents illustrated by the significance of each response group in comparison between answers of professionals and general public.

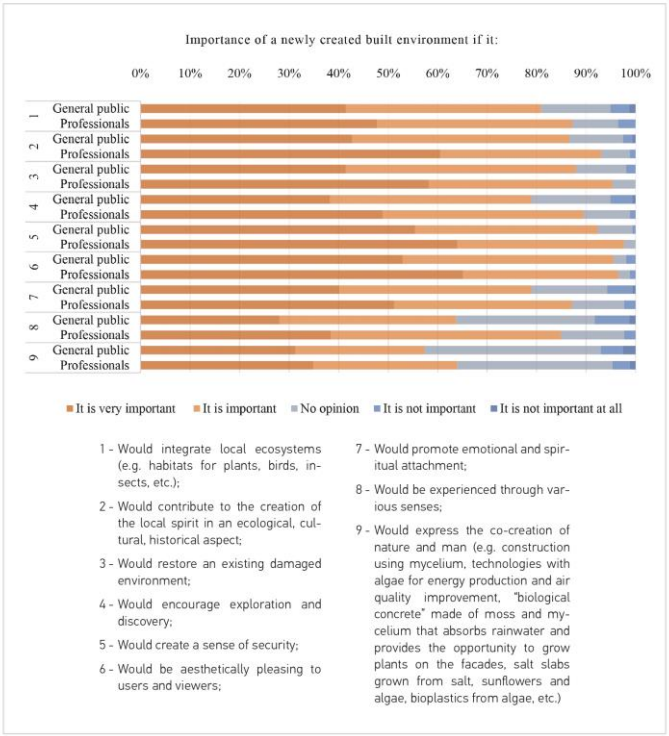


Fig. 10
Evaluation of the important features of a newly created built environment

Respondents defined sustainable architecture in their own words, where the greatest attention was given to the use of natural, ecological, and local materials, integration into the environment, connection with the place, locality and harmony, energy efficiency and use of renewable energy sources. Quality criteria No. 5 – *'Preservation of cultural heritage'* was not associated as a feature of sustainable architecture at all.

Respondents hardly associated sustainable architecture to the quality criteria No. 6 – *'Accessibility of the environment (universal design)'* and No. 7 – *'Integral architectural idea"*, although ~85% (245 of 439) of the answers were related to the aesthetic characteristics of the architecture.

General public paid more attention to the presence of greenery, environment protection, safety, and durability, innovativeness of the building, functionality, aesthetics and natural lighting. Professionals were more concentrated on connection to the place and integration into the environment, use of renewable energy sources, naturalness, simplicity and minimalism while defining sustainable architecture.

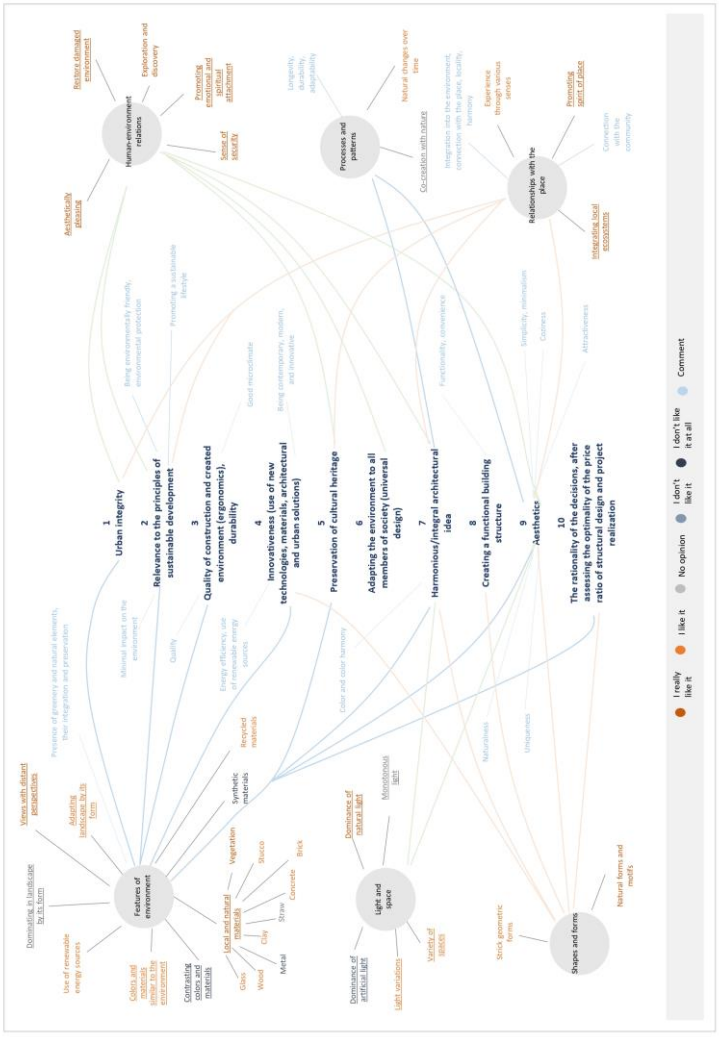


Fig. 11
Preferences of sustainable architecture features and their relation to the 10 architecture quality criteria outlined in Lithuanian Law of Architecture (LR Seimas (2017)

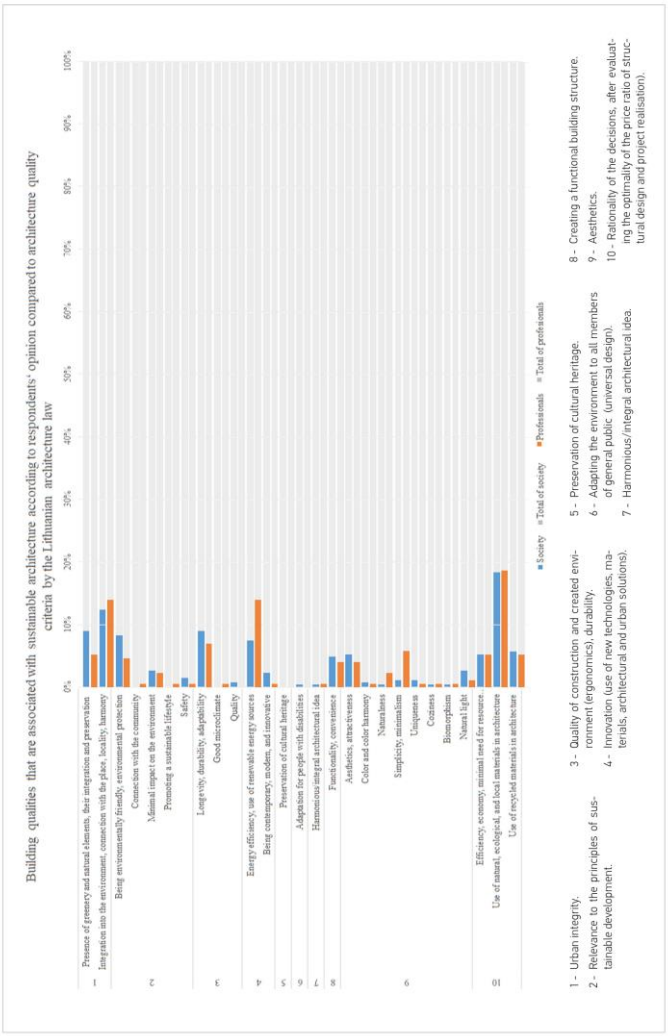


Fig. 12

Visual representation of the building features that survey respondents identified as being associated with sustainable architecture and its comparison to the 10 architecture quality criteria outlined in Lithuanian Law of Architecture (LR Seimas (2017)

Conclusions

The majority of the respondents supported the concepts of sustainability in architecture, demonstrated by their agreement that environmentally friendly solutions should be applied and that modern architecture should reflect ecological ideas. Almost all respondents believed that contemporary architecture should include environmentally friendly solutions, indicating that this issue is of great importance to the general public as well as professionals in the field of architecture. Both professionals and non-professionals showed a preference for environmentally friendly solutions based on the newest technologies. In contrast, even though the respondents highly supported sustainability in architecture, they were more likely to choose conventional materials such as bricks, blocks, wood, stone wool, polystyrene foam, etc., over alternative cheap but eco-friendly options such as straw, clay or re-used materials. The non-professionals displayed greater interest in trying non-conventional building materials. The comments indicated that if the alternative materials were durable and aesthetic, they could become more favorable. The general acceptance of recycling projects was related to aesthetics, material durability, and possible comfort of living. These findings provide valuable insights into urban residents' opinion about sustainability in architecture.

In this study the three most well-received trends in sustainable architecture were vegetated, low-tech ecological, and biophilic designs, with over 90% of respondents giving positive responses. The low-tech ecological trend was considered to be the most environmentally friendly, with almost 85% of respondents finding it acceptable. These trends were appreciated for their use of environmentally friendly solutions such as protecting trees and landscapes, saving resources, reducing carbon footprint, using sustainable engineering solutions, and using patterns.

Relation to the environment plays an important role in creating an aesthetically pleasing building. According to the survey results, almost all respondents agreed that the aesthetic quality of a building is enhanced when it is harmonized with surrounding environment and provides views of distant perspectives. In fact, buildings that adapt to their environment through the use of materials and colors were preferred over contrasting ones. The use of local and natural materials was also highly preferred. This suggests that appearance of building materials can help a building blend into the surrounding environment and improve its overall aesthetic appeal.Wood and plants were the most popular building materials, followed by clay, brick, and stucco. Synthetic materials and metal were the least favored, though professionals had a slightly higher appreciation for metal and concrete. Wood has always been a traditional building material in Lithuania, but it's novel attractiveness may be attributed to image of a renewable eco-friendly material that brings people closer to nature. Trees have always held a significant and even sacred role in the lives of Lithuanians, which may explain why wood remains a preferred building material. The fact that plants were the second most favored material suggests a desire to incorporate nature into building design.

Additionally, buildings that adapt to the landscape by their form were more commonly liked, while buildings dominating the landscape by their volume were more commonly disliked, suggesting that a thoughtful use of proportion impact a building's attractiveness. Creating a variety of spaces within a building was preferred over monotonous spaces. Psychological research (Ramzy, 2015) has shown that people prefer shapes based on the Golden Ratio, which is found in nature and reflects order and sequence. This ratio is also prevalent in growth patterns of many organisms, including nautilus shells, fern fronds, and vine tendrils As a result, buildings that incorporate natural forms and motifs are often favored over those with strict geometric shapes.

The results show that natural lighting was essential to respondents, while artificial lighting dominating the building was disliked. Spaces with a variety of light, such as bright-dusk, play of light and shadows, and reflections, were preferred over monotonous ones. Maximizing daylight not only saves electricity but also contributes to the psychological well-being of building users. Natural light enables people to experience the natural progression of time throughout the day. Additionally, research by Smolders (2013) suggests that increased light exposure is linked to higher

levels of vitality. In January 2023, the sun shone for less than five hours per month in Vilnius (Lrt.lt, 2023), which may help explain why Lithuanians place a high value on natural daylight as a crucial aspect of building design.

This study revealed the importance of aesthetics in architectural design, as the majority of the respondents (85%) who defined sustainable architecture themselves related sustainability with aesthetic features. This supports the notion that aesthetics is a key factor in creating sustainable and psychologically acceptable architecture. Moreover, the study suggests that psychological sustainability of architecture may be related to several factors, including the use of natural and local materials, building's integration into the environment, connection with the place, locality, and harmony. Therefore, architects and designers should consider these factors when creating sustainable buildings to achieve psychological comfort of building's users and preventing inexpressiveness in architecture.

Overall, the study's findings suggest that environmental sustainability and eco-friendly architectural solutions are becoming increasingly important to urban residents, particularly those who are highly educated and early middle-aged. The study suggests that further research on architectural aesthetics and social-psychological acceptability could lead to a more precise definition of aesthetic quality criteria. Additionally, educating the general public about the relationship between sustainability and heritage preservation is crucial, as respondents did not associate these two concepts. The general public did not associate the accessibility to sustainable architecture, emphasizing the need for further education about social challenges in sustainable building. Moreover, the sustainability aesthetics ideas should be integrated into the initial stages of architectural design and considered as features of quality and originality. Additionally, this study can inform the development of national policies and local initiatives aimed at promoting sustainable building practices.

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List of pictures in Fig. 2

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Scientific papers related to the topic of dissertation:

1. Daugėlaitė, A., Gražulevičiūtė-Vileniškė, I. (2022). Retrospective Analysis of Sustainable Architecture: Mind-Mapping Development of Ideas and Expression. Journal of sustainable architecture and civil engineering = Darnioji architektūra ir statyba. Kaunas : Technologija. ISSN 2029-9990. eISSN 2335-2000. Vol. 30, no. 1, p. 78-92. DOI: 10.5755/j01.sace.30.1.29829 [Scopus; Index Copernicus; DOAJ] [CiteScore: 0,80; SNIP: 0,433; SJR: 0,212; Q2 (2021, Scopus Sources)] [M.kr.: H 003] [Contribution: 0,500].
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ANNEXES

Annex 1. Scientific article "Social – psychological responses to trends of sustainable architecture"

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PAPER #2.06

SOCIAL–PSYCHOLOGICAL RESPONSES TO TRENDS OF SUSTAINABLE ARCHITECTURE

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ABSTRACT

Sustainable development became the predominant official paradigm of planning, design, and construction policies. This concept with its environmental, social, economic and cultural dimensions has been applied to the field of architecture since the end of the 20th century. However, numerous researchers still notice one-sided technological and ecological orientation of sustainable architecture and the lack of attention to its cultural, place-based and aesthetics aspects. Nevertheless, sustainability as a design paradigm, undoubtedly encourages a change in the way people consider the notion of aesthetics. The efforts to implement sustainability ideas sometimes lead to very unusual designs – provocative experiments, futuristic solutions or re-using - recycling projects that sometimes may lead to conflicting assessments in the society. This research investigates how aesthetics of sustainable architecture is distinguished and psychologically accepted by people.

KEYWORDS

Sustainable architecture; aesthetics;
architectural trends; sustainability; architecture.

1. INTRODUCTION

Relevance of research. Sustainable architecture can be broadly defined as architectural design and practice based on the paradigm and general principles of sustainability, such as the pursuit of material and intangible well-being, justice for present and future generations, justice within and between societies, protection and promotion of cultural and environmental biodiversity, precautious decision-making, recognition of the interdependence of phenomena (Throsby, 2002), in social, cultural, economic and environmental dimensions. Sustainability must be programmed during the idea generation and development phases and manifest throughout the life cycle of the architectural object. It is maintained that sustainable architecture must not only be durable, flexible, and environmentally friendly, but also contextual, aesthetic and psychologically acceptable (Kamicaityte-Virbasiene and Grazuleviciute-Vileniske, 2011; Berardi, 2013). It is desirable, that the object of sustainable architecture would impact positively, stimulate the sustainable development of environment and society in a broader sense (Kamicaityte-Virbasiene and Grazuleviciute-Vileniske, 2011). For this broader impact to occur, sustainable architecture must be accepted and desired by the society – it must be socially and psychologically acceptable. Social and psychological acceptability of architecture is

closely linked with its aesthetic expression. However, the definitions of sustainable building (Kamicaityte-Virbasiene and Grazuleviciute-Vileniske, 2011; Berardi, 2013) do not identify the particular architectural expression. There have been attempts to categorize sustainable buildings according to their aesthetic expression (Guy and Farmer, 2001; Wines, 2000; Sauerbruch and Hutton, 2011; Di Carlo, 2016); however, the field of sustainable design is constantly evolving and expanding and new trends are emerging. Moreover, the definition of sustainability itself is constantly under debates and new notions of restorative and regenerative sustainability (Istiadji et al., 2018) are taking their grounds more firmly in the recent years. For example, U. Berardi (2013) presents definition of sustainable building related with regenerative sustainability "a building is sustainable if <...> it favors a regenerative resilience of the built environment among all the domains of sustainability". It is possible to presume, that such rapid changes in the design paradigms and constant search for corresponding architectural forms may receive very different reactions in society, which, actually is the end user of buildings and built environments. Consequently, amidst this constant change it is valuable to look at the aesthetic trends of sustainable architecture and to analyze social-psychological reactions to them.

The aim of the research was after the analysis of literature and examples to distinguish currently relevant (both predominant and marginal) aesthetic expression trends of sustainable architecture and to evaluate their social-psychological acceptability.

The methodology of the research encompasses analysis of literature and examples, comparison and systematization of literature analysis results, design and application of online sociological survey, quantitative and qualitative analysis of survey results, formulation of conclusions.

The structure of research is the following: methodological section presents structure and details of research methodology, results section presents distinguished aesthetic expression trends of sustainable architecture with corresponding illustrative material and the quantitative and qualitative analysis of sociological survey results.

2. METHODS

Analysis of literature and examples. Literature analysis was focused on the publications distinguishing trends of sustainable architecture (Guy and Farmer, 2001; Wines, 2000; Sauerbruch and Hutton, 2011; Di Carlo, 2016) and design examples (implemented and projects) available online. The search keywords, such as "sustainable architecture", "sustainable design" were applied in internet search engines. Although the search was not limited to the designs explicitly labeled as sustainable, as numerous high quality nature and advanced technology inspired architectural designs may contain these qualities as well. Additionally, the search in internet resources of architectural content, such as ArchDaily, Divisare, Dezeen etc. was carried out. The collected information included descriptions, photographs, drawings of the objects. After the analysis, comparison, and systematization of collected data 10 contemporary trends of expression of sustainable architecture were distinguished and digital collages were constructed from online available material to illustrate each distinguished trend.

Design of sociological survey. Sociological survey was administered online in the months of April – May 2022. The questionnaire consisted of 27 closed and open questions. The questions were organized in three groups: social-demographical questions, questions aimed at the assessment of 10 trends of sustainable architecture and questions aimed at determining respondents' attitudes towards the distinctive aesthetic features of sustainable buildings. While evaluating each

trend of sustainable architecture, respondents were asked to indicate if the trend is acceptable to him / her, if the trend seems environmentally friendly and to leave a short comment about the trend. 240 respondents, inhabitants of Lithuania, compiled the questionnaire.

Analysis of survey results. In order to analyze emotional responses of survey respondents to the trends of sustainable architecture, qualitative and quantitative approaches were applied. Identifying emotions in written texts requires high level intelligence (Park et al., 2020), thus qualitative approach based on R. Plutchik's (2001) classification of human emotions was applied. According to R. Plutchik (2001), In English language there are few hundred words for defining emotions, thus some kind of categorization and classification is necessary; he provides circumplex model for classification of emotions analogous to a color wheel (Fig. 1), "placing similar emotions close together and opposites 180 degrees apart, like complementary colors". The comments provided by the respondents were analyzed and emotional label was attached to each individual comments using the above-mentioned classification. Quantitative sentiment analysis, judging whether each comment has positive or negative emotion, was carried out further. As a way of recognizing emotions in sentences, the keyword-based sentiment analysis method employs emotional scores of each word (Park et al., 2020). NLTK VADER Sentiment analyzer was applied in this case. The framework of emotional analysis of responses is presented in the Figure 1.

3. RESULTS

3.1 Sustainable architecture directions

Analysis of literature and examples has revealed the wide array of sustainable design manifestations. In order to understand the interconnections of sustainable design trends, the mind map was constructed (Fig. 2) demonstrating five interconnected tendencies – high-tech and low-tech ecological aesthetics, nature-inspired aesthetics, genius loci and participation architecture – that were distinguished based on analysis of literature and examples.

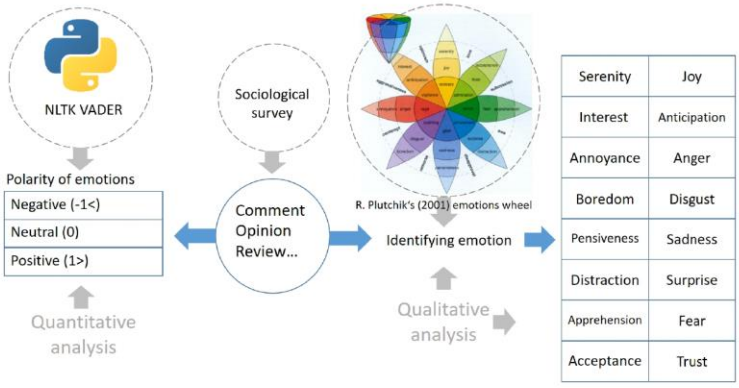

Figure 1. Framework for emotional analysis of survey responses using quantitative (NLTK VADER sentiment analysis tool) and qualitative (R. Plutchik's (2001) classification of emotions) approaches

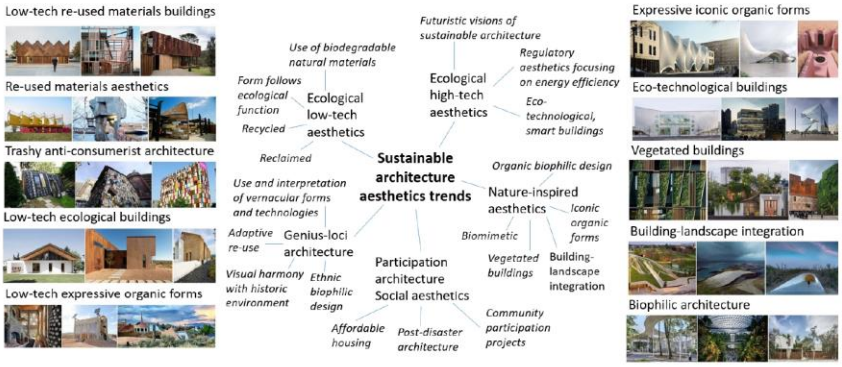

Figure 2. Mind map of contemporary trends of sustainable architecture development and expression and digital collages representing 10 trends selected for the further evaluation of social-psychological acceptability

Researchers still notice one-sided technological and ecological orientation of sustainable architecture (Guy and Farmer, 2001; Wines, 2000), thus distinguishing the expression trends of sustainable architecture for further evaluation, intermediary and marginal trends, that could be beneficial in diversifying the expression of sustainable buildings were given special attention. The following trends were distinguished:

1) *low-tech re-used materials buildings* - the trend towards the use of recycled or re-used materials to create a modern architectural expression;
2) *dictated by re-used materials aesthetics* - the trend, where aesthetics of buildings is dictated by what materials have been obtained for re-use;
3) *trashy anti-consumerist architecture* - the trend where a building can be created from anything that is discarded using secondary raw materials. In this way, the opposition to modern consumerism is demonstrated;
4) *low-tech expressive organic forms* - the tendency to create a particularly mannerly architectural expression using natural, recycled or reused materials;
5) *low-tech ecological buildings* - the trend dominated by local, natural materials (straw-clay mixture, hemp concrete, etc.), although a modern expression is being developed;
6) *eco-technological buildings* - the trend dominated by glass and metal, integrating the latest eco-technological advances, often using innovative materials;
7) *vegetated buildings* - the trend dominated by greenery (planted facades, roofs or otherwise integrated plants);
8) *building-landscape integration* - the trend where the building blends in with the landscape;
9) *expressive iconic organic forms* - the trend in which the aesthetics of a building is expressed in distinctive organic, plastic forms;
10) *biophilic architecture* - the tendency to deliberately reproduce certain features of natural environments in buildings.

Digital illustrative collages were created for each trend. The collages and the clustering of distinguished trends are presented in the figure 2.

3.2. Results of the survey

The study analyzed 1816 comments related with opinion about the sustainable architecture trends and analyzed them using quantitative (NLTK VADER sentiment analysis tool) and qualitative (R. Plutchik's (2001) classification of emotions) – see fig. 3 and fig. 4 for summarized results. Table 1 represents the summary of the most preferred architectural trends, which are Vegetated, Low-tech ecological, Biophilic, Building-landscape, Low-tech re-used.

The first three architectural trends (*low-tech re-used materials buildings, re-used materials aesthetics and trashy anti-consumerist architecture*) were selected for the survey to test the level of acceptance of the unusual and experimental aesthetics arranged from quite unnoticeable to extreme re-using projects as protest against consumerism form (Fig. 2). The results showed the more extreme expression was, the less it was acceptable (Fig. 3). Although those buildings were created from the recycled or re-used materials, it was not considered as environmentally friendly. Respondents raised awareness of the environmental pollution of re-used materials such as plastics which decays into micro-plastics and creates the further pollution. Also, important question was visual aesthetics. The insights of the survey showed that the most acceptable and encouraged solution of re-using materials would be recycling them to new materials to be used in the construction.

The most moderate recycling trend - *low-tech re-used materials buildings* was accepted quite emotionally positively. Majority of the respondents considered this trend as environmentally friendly. Some respondents showed apprehension towards possible threats of the recycled materials such as environmental friendliness of the used materials, like micro-plastic pollution, decomposing materials and their effect on human health, fire safety, structural issues and material compliance with the legal

Statistical answers (certainly acceptable + acceptable)			Polarity (NLKT Vader) -1 to 1			R. Plutchik's wheel of emotions (The least of negative feelings -disapproval, disgust, contempt)		
No.	Trend	Evaluation	No.	Trend	Evaluation	No.	Trend	Evaluation
1	Vegetated	93.4 %	1	Vegetated	0.3512	1	Biophilic	4.1 %
2	Low-tech ecological	92.5 %	2	Building-landscape	0.3252	2	Low-tech ecological	4.9 %
3	Biophilic	91 %	3	Biophilic	0.3236	3	Vegetated	4.9 %
4	Building-landscape	88.5 %	4	Low-tech ecological	0.3209	4	Building-landscape	4.9 %
5	Low-tech re-used	78.6 %	5	Low-tech expressive organic	0.2605	5	Expressive iconic organic	14.4 %
6	Low-tech expressive organic	64.2 %	6	Low-tech re-used	0.2179	6	Low-tech expressive organic	16 %
7	Expressive iconic organic	52 %	7	Expressive iconic organic	0.2073	7	Low-tech re-used	21 %
8	Eco-technological	49.1 %	8	Eco-technological	0.1602	8	Eco-technological	23.5 %
9	Dictated by re-used	46.1 %	9	Dictated by re-used	0.0920	9	Dictated by re-used	29.6 %
10	Trashy anti-consumerist	27.2 %	10	Trashy anti-consumerist	0.0202	10	Trashy anti-consumerist	42.8 %

Table 1. Evaluation of priorities (the most accepted to the least accepted) of sustainable architecture trends using different methodologies. Source: (Author 2022)

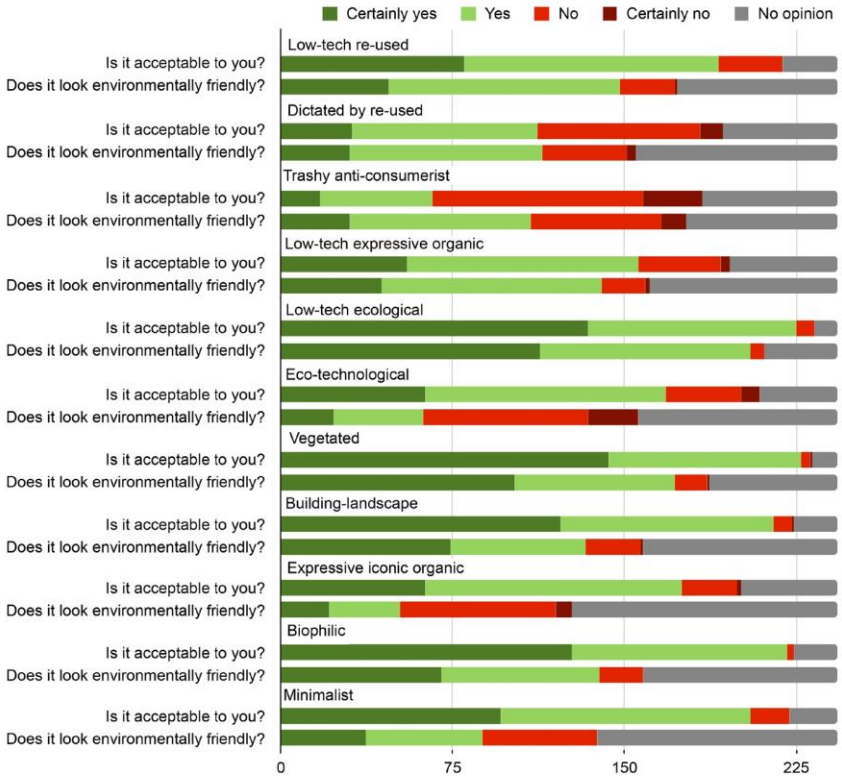

Figure 3. Summarized evaluation of the trends of the acceptance of sustainable architecture. Source: (Author 2022)

requirements for the built environment. The second trend *re-used materials aesthetics* was selected as more intense re-using expression. It was evaluated less positive as the first one, and its acceptance is questionable. Emotional response was hardly positive – disapproval (25.1%) was the dominant answer and was led by the disgust (2.9%) and contempt (1.6%).

The third group in the survey *trashy anti-consumerist architecture* was selected as an extreme re-use example which is actually a form of a protest rather than architectural trend. It was interesting that respondents noticed this difference. The results showed that the greater whole of respondents didn't want to accept this kind of projects. The comments were rich of keywords such as "manifesto", "slum", "trash, "landfill", etc. Two comments greatly illustrates the disagreement towards this trend – „genius" and „shit". Negative emotions, such as dissaproval (32.5%), contempt (9.5%), disgust (0.8%) were obviosly more expressed than possitive feeling such as acceptance (7.0%), interest (2.5%) and surprise (0.8%).

Respondents raised questions towards the quality of aesthethics and architecture itself. Many respondents noticed the colorfulness.

While evaluating *low-tech expressive organic forms* architecture, three groups of answers were noticed: 1 - appreciated as beautiful and sustainable, 2 – disliked because of strongly expressed mannerism, 3 – thought that this style is quite oriental and more appropriate for Eastern part of the world. Integration with the environment was noticed as a frequent remark. This architectural direction was acceptable for the much larger group of respondents and was considered environmentally friendly more often. More positive feelings were noticed such as admiration (15.6%), acceptance (14.8%), interest (9.1%) and surprise (0.4%), rather than negative, such as disapproval (14.8%), contempt (0.8%) and disgust (0.4%). People that expressed pensiveness (9.5%) raised question about the importance of the context, durability, sustainability and appropriateness of this trend to the Lithuanian context.

Low-tech ecological buildings that express contemporary architectural form was accepted really well. Several respondents even expressed the wish to live in this kind of building. The most common keywords in their comments were sustainable, beautiful, ecological, traditional and local. The majority of respondents also noticed that this trends looks environmentally friendly. Some respondents expressed apprehension (0.8%) and pensiveness (5.3%) towards the question if these type of buildings are durable and long-lasting. Acceptance (34.6%), admiration (29.6%) and interest (2.1%) were the dominant positive emotions while negative were only (4.9%) of disapproval.

Evaluation of *eco-technological buildings* was not as good as expected. Although it was evaluated as acceptable, results of emotional analysis showed that positive and negative feelings in the comments balanced quite equally ((acceptance – 26.7% and admiration– 9.5%, while disapproval 20.6%). A lot of respondents noted that the trend is appropriate only for the city center, and only for public and commercial use such as offices. Some comments were that the style looks acceptable, however, it is hardly compatible with the protection of the environment. Expensive and complicated construction, requiring innovative and expensive technology, delivery of the materials extends the supply chain and in this way increases carbon footprint. Apprehension towards the complicated and expensive maintenance of the building such as huge heating and cooling costs, difficult window cleaning, frequent replacement of ventilation filters, and even threats to health such as faster spread of diseases, raising air temperatures in cities. "Lifeless", "deadless" and "disastrous to birds" – was one of the reasons why this type of architecture was disliked. Other features such as non-human scale, aggressive domination, endangering animals and local landscapes, uncozy appearance were the aesthetical reasons of unacceptance. Also, the use of glass in large amounts was one of the unaesthetical features. On the other hand, many respondents agreed that this type of building may be indirectly sustainable, which depends totally on the technology used for saving resources and energy. The larger group of respondents stated that this type of architecture doesn't look sustainable.

Vegetated architecture trend collected the great majority of the positive answers. The results showed its great acceptance to the city environment which lacks nature a lot. Many answers were related to the purified air, beauty and vitality. The apprehension and pensiveness were referred mostly to the maintenance and installation issues as well as concerns regarding to the impact for the building structure. If these questions were solved, this trend would be one of the best accepted.

Building-landscape architecture was also accepted very well but it was related more to natural suburban environments and for places where was important to preserve the view of the landscape. The probable disadvantage of this type of buildings was noted as changes of the natural terrain and possible lack of the sunlight. Respondents noticed that it looks visually

sustainable, however the real sustainability depends on the materials and technological solutions used in the construction.

Although *expressive iconic organic forms* was accepted positively and evaluated as exceptional, interesting and eye-catching, the form itself was not related to environmental sustainability and even in some cases this construction was noted as costly solutions that are complicated to implement and require much more resources. Also, this trend was more acceptable for public buildings rather that individual houses.

Biophilic architecture trend was considered as acceptable and environmentally friendly and was one of the most favorite trends. On one hand, biophilic trend was acceptable through the connection between human and nature, on the other representation of nature and connection to it was criticizes as not sustainable enough without sustainability in construction and materials. (Fig. 4)

Figure 4. Summary of motional evaluation of the trends of the sustainable architecture. Source: (Author 2022)

4. CONCLUSIONS

The concept of sustainability, even though currently acknowledged as the paradigm of development of societies, is not stable and is constantly evolving, currently embracing the notions of restorative, regenerative sustainability and resilience. The expression of sustainable buildings similarly varies between techno-centric, eco-centric solutions and sometimes provocative experiments, futuristic solutions or re-using - recycling projects. For the paradigm of sustainability to succeed social and psychological acceptance is of crucial importance and aesthetic expression of sustainable architecture can play an important role here.

Analysis of literature and examples has revealed the wide array of sustainable design manifestations focusing on high-tech, low-tech solutions, inspired by the characteristics of natural systems and genius loci of the locality, focused on social sustainability. The following trends were distinguished as having potential for diversifying the expression of sustainable buildings: low-tech re-used materials buildings, re-used materials aesthetics, trashy anti-consumerist architecture, low-tech expressive organic forms, low-tech ecological buildings, eco-technological buildings, vegetated buildings, building-landscape integration, expressive iconic organic forms, biophilic architecture.

The study analyzed 1816 comments related with opinion about the sustainable architecture trends and analyzed them using quantitative (NLTK VADER sentiment analysis tool) and qualitative (R. Plutchik's (2001) classification of emotions). The most acceptable and environmentally friendly looking trends were low-tech ecological, vegetated, building-landscape and biophilic buildings. The least acceptable was trashy anti-consumerist, however it was understood as awareness raising project. Many of the respondents welcomed the idea of recycling and reusing, however noticed that the architectural expression is not aesthetically pleasing enough and showed concern to the ecology of the materials used, structural and environmental qualities, impact for the health, material compliance with the legal requirements. Low-tech ecological buildings was one of the most positively evaluated trends, although raised several questions if these type of buildings are durable and long-lasting. Many of the respondents expressed wish to live in this type of house. Although eco-technological trend demonstrates the implementation of environmental friendly technology, it was one of the least related to the environmental protection.

The study showed that sustainability is understood as the wholeness of architectural and engineering solutions, were visual appearance of the building plays and important role. The best appreciated trends were related to naturalness and durability, used environmentally friendly solutions, such as protection of trees and landscape, saving resources, reducing carbon footprint, using sustainable engineering solutions and use patterns.

The study may be concluded by one quote of unknown person of the study:

Style must follow an idea and modern humanity has the ability and means to implement almost any idea in a variety of styles. Style, I think, occurs of what technology is used to extract a particular form of art, and even what material, what function it performs - a pragmatic goal is the essence, it dictates the form as a consequence, not as a goal!

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