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# Sustainability Aesthetics of Hybrid Environments: Creation and Perception by the Emerging Generation of Designers

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**Keywords**

Ecological aesthetics, experimental design, hybrid environments, knowledge dimensions, sustainability aesthetics, qualitative analysis.

**Abstract**

**In the contemporary sustainability discourse, the interplay between the aesthetic sensibilities of youth and sustainability presents a fertile ground for innovative exploration, particularly through the lens of experimental design and qualitative research. This study explores the concept of sustainability aesthetics and its application for the assessment and development of hybrid spatial environments, focusing on how this aesthetics is created, perceived, and evaluated by an emerging generation of designers (second-semester design students from Kaunas University of Technology (Lithuania)). As this generation of emerging designers will be increasingly responsible for making sustainable and aesthetic decisions in both daily life and creative endeavours, understanding their engagement and empathy towards the environment is crucial. This study addresses a significant research gap by investigating trends in the expression of sustainability aesthetics in design and architectural objects and their interactions with contextual environments as well as youth aesthetic sensibilities in this context. Through qualitative assessments and reflective analysis, the study provides insights into the students' evolving appreciation for sustainability and their ability to express this through aesthetically pleasing and environmentally conscious designs. This research includes a literature review on the application of experimental design in sustainability aesthetics research, the elaborated research methodology for analyzing and evaluating students' works and their written reflections and primary research findings from the first stage of research – from the sample of more than 20 student works.**

## Introduction

As cities and countryside evolve, often blending traditional boundaries through urban sprawl, rural development, and new technologies, new challenges related to typology, functionality, and aesthetics of environments and questions of population well-being and lifestyles emerge. According to D. Torreggiani et al. [1], the contact of urban and rural environments results in "patterns with hybrid identities"; they note that such hybridization can be observed at different scales – regional, urban, and settlement scales, and even single buildings in rural and urban settings. The research by D. Torreggiani et al. [1] and similar studies reveal that such multi-scale hybridization is mainly driven by urbanization. Researchers mention functional heterogeneity, multifunctionality and even contradictory functions in hybrid environments [1], [2], which are inevitably interconnected with manifold and sometimes competing identities of such environments. The changing identities, functionality, and aesthetics are coupled with changing lifestyles, quality of life and well-being problems. It is possible to note that the above-mentioned changes cause one of the problems of 21st-century cities – the lack of access to comfortable living space for both older and younger urban dwellers. For example, part of the older generations of residents in cities of Lithuania often lives in quite large Soviet-period flats that are not comfortably designed for their living, rest, and sleep. During the Soviet period, these apartments were given by designation when young specialists, workers, teachers or other staff in the service sector after studies came to work in the cities. Quite often, these residents were couples already married during studies with one or even two children. The area of the flat in square meters then was calculated according to the number of family members. This social segment is sometimes viewed as more privileged in the context of obtaining housing compared to younger generations [3]. However, after a

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few decades, the spaces in these flats became useless as children moved out and the flat owners' lifestyles changed. The old blocks of flats lack good quality public green spaces and recreational facilities, and residents often feel socially excluded. As an alternative to living in the city, the older generations often turn to collective garden houses – the relics of an exceptional phenomenon of the Soviet period [4]. Closer to ex-colleagues, because gardens were designated according to workplace, so they do not feel social isolation; it is easier to go outside there to have a close sense of connection with nature. Then they start to migrate between the city and the collective garden, depending on the season, if their health and circumstances allow. For this group of urban dwellers, the increasingly popular urban gardens would be a preferable option. Some urban residents, after their children have moved out, choose to move to or live for part of the year in their parents' or grandparents' still extant rural homesteads, adapting them to their needs and creating family homesteads [5]. Such moves seem unsurprising and perhaps normal for people whose childhood was spent close to nature, who are not unfamiliar with working in a garden/farm or living with partial amenities. Meanwhile, the younger generations are increasingly turning to hybrid working methods, working remotely [5] or developing their own businesses or crafts, regardless of where they live. With such opportunities and a free lifestyle without being tied to a city residence, the new Generation Z (born 1997–2012) is increasingly attracted to more diverse living spaces that are closer to nature. Some of them choose to "live on wheels" and spend years on the road in motorhomes, while others are keen to set up in the countryside [5]. They buy pieces of land in the wild, abandoned country estates, or inherit them from their grandparents in rural areas. Young settlers are adapting rural homesteads to present-day needs [5]. Such choices raise hopes of regeneration of rural communities and settlements as well as challenges of creating well-being, sustainability, and resilience in constantly changing urban areas.

Thus, observing the interests of Generation Z in the context of the living environment, the question arose: how do young people see the adaptation of existing conditions, environments, nature, landscape and terrain to their own needs, and what are their aesthetic and ethical preferences? Ethical preferences and aesthetic choices are interconnected by the concept of sustainability aesthetics in this research [6], as the concept of sustainability provides multiple opportunities for multidisciplinary integration [7]. Sustainability aesthetics research involving youth is particularly relevant in the context of rapidly changing and hybridizing spatial environments, both urban and rural. The aim of the research is to analyze the concept of sustainability aesthetics and its application for the assessment and development of hybrid spatial environments, focusing on how this aesthetics is created, perceived, connected with different spatial contexts, and evaluated by an emerging generation of designers (second-semester design students from Kaunas University of Technology (Lithuania)). The structure of the research includes 1) literature analysis focusing on the topics of sustainability aesthetics, hybrid environments, and experimental design, 2) formulation and application of the methodology for qualitative exploration of sustainability aesthetics through an experimental design approach including methods for data collection and analysis, and 3) reflection on the implementation of the methodology and preliminary results and conclusions.

## I. Theory: Experimental Design for Better Understanding of Sustainability Aesthetics

***Sustainability aesthetics.*** The literature review indicates that designing for hybrid environments calls for the public and users to embrace new types of design outcomes and aesthetics, which are expected to change and evolve over time [1], [2]. Contemporary researchers in the field of sustainability emphasize the importance of unique aesthetic expressions within the sustainability movement and sustainable environments, with some even identifying a specific need for "sustainability aesthetics" [6], [8]–[10]. S. Kagan suggests that sustainability aesthetics stems from and is closely related to ecological aesthetics, grounding his analysis in G. Bateson's concept of aesthetics, which views aesthetic perception as a response to patterns that connect [8], [9], [11]. S. Kagan further argues that sustainability aesthetics must account for complexity, balancing unity, complementarity, competition, and antagonism while acknowledging the overarching patterns that link the living world [8]. On the other hand, S. Ji and P. S. Lin [10] propose six sustainable design strategies: enjoyment, functionality, narrative, symbolism, interaction, and innovation. As a result, sustainability aesthetics and its perception are complex and layered phenomena, demanding a stage-wise approach to both design and perception [12].

***Knowledge dimensions.*** The attempts to define sustainability aesthetics highlight its complexity and multi-layered nature, especially when dealing with hybrid environments, making it challenging to fully comprehend through descriptive analysis or discussions alone. This research posits that sustainability aesthetics, particularly in hybrid environments, encompasses a significant dimension of tacit knowledge. As originally defined by M. Polanyi [13], tacit knowledge is derived from individuals' personal experiences and serves as the foundation for explicit knowledge [14]. M. Polanyi argues that the knowledge we can express explicitly represents only a small fraction of the total body of knowledge, famously stating that "we know more than we can tell" [13]. It is suggested that tacit knowledge refers to what individuals

inherently know, whereas explicit knowledge can be formalized and documented. Tacit knowledge is ingrained in the human mind and cannot be easily separated from its possessor, making it more difficult and costly to share or transfer than explicit knowledge (Table I) [14].

**TABLE I**

**Features of Tacit and Explicit Knowledge Adapted from Jasimuddin et al. [14] to the Case of Sustainability Aesthetics in Design**

| Features | Tacit knowledge | Explicit knowledge |
|---|---|---|
| *Content* | *Non-codified*<br>In sustainability aesthetics, tacit knowledge involves a non-codified, intuitive understanding of natural harmony, cultural heritage, and environmental integration, often grounded in experience. | *Codified*<br>Codified knowledge about sustainability guidelines, material science, energy efficiency, and environmental impact assessments, usually documented in reports, standards, or design manuals. |
| *Articulation* | *Difficult*<br>Difficult to articulate aesthetic values related to sustainability, such as the emotional or sensory responses to natural materials or local craftsmanship. | *Easy*<br>Easily articulated principles such as the technical aspects of energy use, carbon footprint calculations, or modular design principles that are documented and shared. |
| *Location* | *Human brains*<br>Resides within the minds of experienced designers, architects, and community members who have an inherent understanding of sustainable design principles rooted in the local context. | *Computers, artefacts*<br>Stored in design software, sustainability reports, databases of best practices, or technical guidelines for eco-friendly materials. |
| *Communication* | *Difficult*<br>Difficult to communicate verbally; transmitted through design processes, mentorship, or on-site collaboration that allows for observation and hands-on learning. | *Easy*<br>Easily communicated through presentations, written reports, architectural blueprints, and sustainability certifications like LEED. |
| *Media* | *Face-to-face contact, storytelling*<br>Transferred through face-to-face interactions, site visits, design workshops, and collaborative processes where experiential knowledge of sustainable design is shared. | *Information technology and other archives*<br>Shared through design software, online databases, academic journals, and technical manuals related to sustainable design. |
| *Storage* | *Difficult*<br>Embedded in individuals and teams, often difficult to capture and store; resides in the practice and lived experiences of those who understand sustainability intuitively. | *Easy*<br>Easily stored in online repositories, design libraries, databases of sustainable practices, material guidelines, and case studies. |
| *Strategy* | *Personalization*<br>Focus on personalization; sustainable design strategies may be customized based on local conditions, environmental needs, and personal intuition about what works best in certain climates or cultures. | *Impersonalization*<br>Focus on impersonal, standardized solutions to sustainability challenges, such as applying universal green building codes or adhering to sustainability certifications. |
| *Ownership* | *Organization and its members*<br>Owned by designers, architects, artisans, and local communities with a deep-seated understanding of sustainable living and aesthetic values. | *Organization*<br>Belongs to the organization and can be accessed and utilized by anyone within or outside the organization through publications, documented processes, and shared technical guidelines. |

Consequently, the challenge of preserving and transmitting knowledge lies in the tacit nature of part of it, which is often highly, if not entirely, inexpressible [15]. Some scholars argue that tacit and explicit knowledge should not be treated as two distinct types; rather, all knowledge contains both tacit and explicit elements, existing along a continuum between these two extremes [14].

***Relevance of the tacit knowledge in sustainable design.*** As is visible from Table 1, tacit knowledge in sustainability aesthetics may involve personal intuition, hands-on experience, and cultural understanding, while explicit knowledge includes measurable and codifiable elements like energy efficiency standards, documented environmental impact, and green certifications. Tacit knowledge plays a crucial role in expressing sustainability ideas in the aesthetics of design because it encompasses the intuitive, experiential understanding that guides a designer's creative process. Artists and designers often possess ideas or hypotheses which may result from a rich understanding and knowledge but cannot be explained by explicit reasoning [15]. This form of knowledge is deeply embedded in the designer's skills, perceptions, and experiences, often influencing design decisions in subtle but significant ways. In the context of sustainability aesthetics, which is complex and multilevel [6], [8] and hardly definable in its own way, tacit knowledge enables designers to intuitively integrate sustainability principles into their work without always needing to rely on explicit rules or guidelines. For example, a designer might have an inherent sense of how to use natural materials effectively, balance form and function in an eco-friendly way, or create designs that harmonize with natural environments. This knowledge often manifests in the aesthetic qualities of the design, such as its form, texture, colour, and materiality – where sustainability principles are expressed not just in explicitly legible ways but also through the nuanced, context-sensitive details that give a design its unique identity and contextuality. Moreover, tacit knowledge allows designers to respond flexibly and creatively to complex, real-world challenges in sustainability, where standard solutions may not always apply and where constructive ambiguities may be needed. Thus, tacit knowledge enriches the expression of sustainability in design, contributing to outcomes that are not only functional but also resonate on a deeper, more intuitive level with users and the environment revealing both complexities and connecting patterns [8].

Experimental design. In the context of analysis and understanding of sustainability aesthetics and Generation Z aesthetic sensibilities, research by design or experimental design refers to a methodological approach where the design process itself serves as a primary mode of inquiry. This research makes a presumption that experimental design as a method can help to better understand the dimension of tacit knowledge in sustainability aesthetics. L. Groat and D. Wang refer to experimental design as one of the areas of research in the built environment. They state that the objective of such research is to test new building technologies, constructions, and means of architectural expression, including aesthetics [16]. This type of design, which tests and attempts to realize innovative ideas in the shaping of the environment, is referred to as an experiment and, at the same time, is considered a research method, as it tests the possibility of realizing innovative ideas, i.e., it is a method of research through design, or design as research, where design activities are used as a method of investigation [17], [18], [19] and testing of innovation. S. Lenzholzer et al. [17] identify four types of experimental design as research: (post)positivist, constructivist, participatory and pragmatic. Experimental design in the (post)positivist worldview is concerned with the physical realm and addresses technical, functional as well as environmental, psychological or behavioral issues. Participatory experimental design focuses on social transformation and the actions needed to bring about the intended change. In this type of research, the community itself is involved in the construction of meaning, for example, in the identification of the problem and the collection of data. The pragmatic trend of experimental design seeks to address problems in a specific context [17], [19]. The constructivist trend in experimental design is suitable for addressing socio-cultural problems; it is most often context-specific. Moreover, this trend of experimental design research is mainly concerned with discovering problems and generating new insights or constructs rather than testing them. This latter aspect of exploring and generating the new and the unknown has been one of the reasons why constructivist research methods have been widely adopted in the field of arts. The knowledge produced in this kind of research by design is most often qualitative, dealing with the interpretation of concepts, new meanings, new forms of architecture, landscape, or other design objects [17], [19].

***Experimental design*** for uncovering tacit knowledge in sustainability aesthetics. Thus constructivist experimental design, coupled with the analysis of design outcomes and reflections, provides the possibility for uncovering both tacit and explicit knowledge related to sustainability aesthetics. Tacit knowledge, which is often intuitive and difficult to articulate [15], emerges through the design process as research participants, in this case – design students, engage in hands-on activities with materials, forms, and contexts. I. Nonaka and H. Takeuchi [20] proposed four mechanisms through which knowledge can be shared and created, noting that as knowledge is exchanged, it can shift between tacit and explicit forms or remain in either state. Figure 1 presents the SECI wheel, where SECI stands for Socialization, Externalization, Combination, and Internalization [20], [21], adapted to the process of sustainable design. The SECI approach can be seen as the basis of the experimental design process.

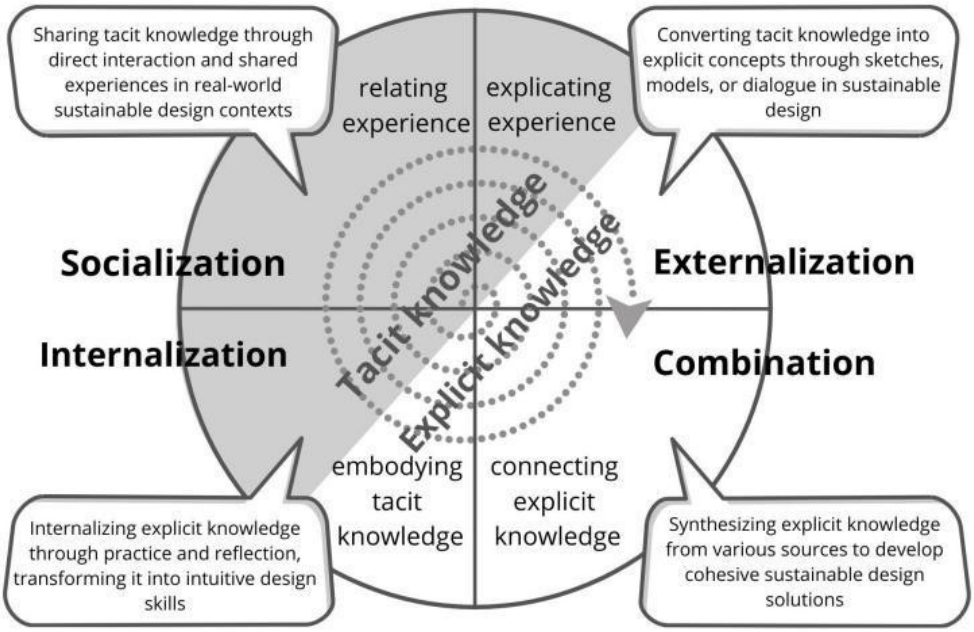


Fig. 1. SECI wheel of knowledge creation and sharing adapted from I. Nonaka and H. Takeuchi [20] and J. Mahadevan [21] demonstrating shifts from tacit to explicit knowledge and vice versa in sustainable design [created by authors]..

By physically creating and iterating on sustainable designs, students internalize the principles of sustainability in a way that may not be easily verbalized but is evident in their creative decisions, material choices, and design solutions. The process of making, experimenting, and reflecting allows this implicit, tacit understanding to surface, becoming more visible and explicit through the analysis of the design outcomes. Explicit knowledge, on the other hand, is more easily articulated and can be captured in the students' written reflections and discussions. These reflections provide insights into the conscious decisions and reasoning behind their design choices, revealing how students understand and apply theoretical concepts of sustainability. The analysis of these reflections, alongside the physical designs, helps to clarify how students interpret sustainability aesthetics, bridging the gap between theory and practice. By combining these elements, experimental design allows for a comprehensive exploration of sustainability aesthetics, uncovering the nuanced, often unspoken knowledge that informs design practices, as well as the more straightforward, codified understanding of sustainability principles.

## II. Methodology: Qualitative Analysis of Sustainability Aesthetics Through Research by Design Approach

***Data collection.*** The first stage of the design experiment was started in April 2024 and lasted till the 1st of June 2024. The students of the second-semester full-time bachelor's study program Industrial Design Engineering of the Kaunas University of Technology were selected for the study and performed experimental design tasks during the lectures of the spring semester module Fundamentals of Design. The first part of the semester was dedicated to the history of design, composition fundamentals, and coloristics; the second part was dedicated to practical work with material and freehand 3D modelling – the design experiment. The experiment is planned to be repeated annually, in the spring semester, between April and June and continue until June 2026. As around 20 first-year second-semester Industrial Design Engineering students take the Design Fundamentals module each year, it is planned to create around 20 design outcomes each year by repeating the experiment session. Once the study is completed, it is expected to compare and analyze projects and written reflections completed by around 60 students over the 3 years. The experimental design process aimed to create a contextual modular system that would express sustainability aesthetics is distinguished into four stages – 1) empathizing with the environment and problem identification, 2) idea generation, creative process and prototyping, 3) testing, and 4) completion of the project and presentation.

***Empathizing with the environment and problem identification.*** For the first meeting, students gathered in a regular classroom at KTU student campus, where the task of photography and reflection was given: to step out of their comfort zone – regular university classroom, whatever the weather conditions, to walk around the surrounding area within a radius of up to 5 km, and to make a photographic

reportage that captures landscape, terrain, or shrubbery, natural or man-made, and abandoned formations, that commonly are repaired or bulldozed to fit the "common landscape standards" and often classified as "ungrateful and unfit for human needs". It was expected that students would notice that these places could be used, without being fundamentally altered, to perform a function, a purpose, only by adding the additional object, element, or structure, that would help to make the environment more adaptable, fit for some purpose, more useful, and give it function. The time allowed for the task was up to 3 hours. The KTU student campus is located next to Oak Grove, with the Gričiupis River running nearby with its valley stretching alongside the dormitories, and the redoubt of Kaunas fortress is nearby. Taking into account these geographical and landscape features, it was not difficult for the students to collect a vast photo gallery (one student needed to collect up to 10 photos to fulfil the requirements of the assignment), which had to be presented together with a reflection paper of up to 250 words in Lithuanian.

***Idea generation, creative process and prototyping.*** After discussion, presentation of photographs, and reflection presentation, all students, based on their experience and reflections, moved on to the elaboration of ideas, creating sketches, mind maps or mood boards. The creative expression tool was optional. The task was to express how and for what purposes, in which way the problematic environments that surround us could be exploited and adapted without fundamentally changing the landscape. Step one was to identify the problems in the environment that hinder the actualization, use, and adaptation of the environment to the needs of society. Before the creative process started, land art, landscape design examples, sculptures, and modular projects by various artists and designers, for example, totems by Ettore Sottsass and garden solutions by Roberto Burle Marx, were represented for inspiration. Creative brainstorming took place in a classroom; thus, discussion, sharing ideas and teamwork was encouraged. The work progress was followed by sketching, design drawings, and mind-mapping projects (Fig. 2).

Once the initial sketches had been made, the work moved on to prototyping. For prototyping the most sustainable media available in the field was chosen – natural clay: students were working with red or white clay optionally. Natural clay could be melted and kneaded again and again in case of unsuccessful trials of modelling. Only the mixing of these two colors of the clays was not allowed in the process. Using only hands, participants of the experiment started to work with soft clay. If needed, only one additional tool – a stick – could be used for making holes or relief. During the session with clay, 2 to 5 different prototypes of modules were built by each student. The students had to solve the problem of how to join modules to each other and later connect creatively to the whole modular system (Fig. 3). All the process and results had to be recorded in photographs and saved for the record into a portfolio folder.

Fig. 2. Sketches by the students from the idea generation stage of the experimental design process [from the archive of authors].

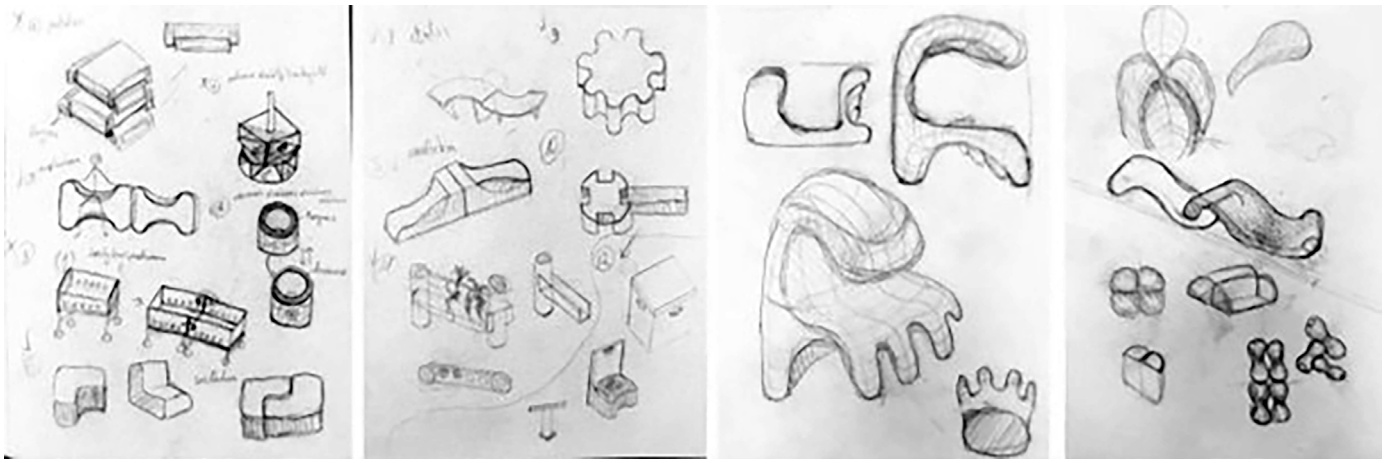

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Fig. 3. The process and outcomes of the prototyping stage using sustainable material – red and white clay [from the archive of authors].

***Testing.*** To start the testing phase, the best module created by each student had to be chosen and replicated several times to have enough of them for the testing and for the final presentation. The modules had to be moved outdoors and placed in natural environments, public spaces, woods, parks or other chosen locations, where the testing experiment will be held. Students were asked to observe how these modules interact with the natural environment, fauna, flora, human activity and atmospheric phenomena (Fig. 4). The recommended duration of testing was specified as 5 days. During this period, surveys had to be done repeatedly. Impressions in text and photos on how modules were affected by nature, had to be taken every day at a chosen hour. The investigation should reflect the changes in the modules and modular system, how it was affected, or if it could have been. There was no limit to the number of photographs that students could take each day. However, for the monitoring-testing presentation, 2–3 good-quality photos per day had to be chosen to represent the testing result. It was noticed that some of the objects were affected by humidity and some – by rainstorms. There even were cases when modules from the modular system were stolen by crows, but most widespread harm was done by lawnmowers.

*Effects of humidity*

Fig. 4. The testing phase of the experimental design process, where elements of the modular systems were displayed and observed in the outdoor settings [from the archive of authors].

*Effects of rain*

*Effects of wildlife (crows)*

Fig. 4. The testing phase of the experimental design process, where elements of the modular systems were displayed and observed in the outdoor settings [from the archive of authors].

***Completion of the project and presentation.*** Finalizing the task and making as many replicas of the modules as necessary for the modular system took around 14 days. During this time, there were meetings in groups, discussions and individual consultations with students. Everyone created as many modules according to their needs for installation, abilities to organize their personal time and patience. There were from 5–8 pieces to 25 or more identical 3D clay modules of a single modular system, ranging in size from 30 × 30 × 30 mm to 12 × 10 × 15 mm. The modules had to be connectable in a coherent way into the modular system to form a structure that could be integrated into the landscape and could potentially be functional (recreational, landscaping-structural, constructional, etc.). The working process had to be recorded in photographs from the very beginning till the end. Photographs had to represent not only the technical part of the working process but also be aesthetic and of good quality (with a good focus, composition rules, suitable, contrasting light that highlights the aesthetic advantages of the project, etc.). For the final presentation photoshoot, students had to transpose the finished modular system to the natural environment that could represent a real problematic landscape in scale to observe its relationship and aesthetic interaction with the surrounding natural structures (Fig. 5). Photographs had to reflect the concept, the modules, and the versatility of the modular system. It was recommended to choose such an angle and the location of the camera that the installation would be rendered at a scale that makes it appear as if it were a life-size building. Each student had to describe his/her creative experience and outcome in a text reflection. For the final exam, students presented the simulated "micro-world" and the modular installation they had created within it (Fig. 7).

Fig. 5. Modular systems expressing sustainability aesthetics created and recorded in photographs by students [from the archive of authors]. .

***Data analysis.*** A structured yet flexible methodology was developed for the analysis of the design outcomes and written reflections produced by students. The qualitative analysis approach was selected. It is agreed that qualitative research is an umbrella term for a wide variety of methods and approaches dedicated to a meaningful approach to everyday contexts [22]. In this case, the process of analysis is based on two theoretical approaches – the dimensions of knowledge (tacit and explicit and transition between them) [14], [20], [21] and the step-wise perception of ecological aesthetics approach developed by M. Dekay [12]. The proposed process of analysis consists of four stages – general overview and organization of data, thematic analysis, cross-analysis, and interpretation of the results; and the ways in which qualitative analysis results can be presented are also discussed (Fig. 6). This approach is intended for an in-depth understanding of how sustainability aesthetics is both conceptualized and materialized through the design process using a smaller number of cases [22].

The initial step of the analysis of accumulated material is a general overview and organization of data. Given the multi-modal nature of the data (both photographs of the students' design objects and their written reflections), it is essential to approach each data type differently, especially in the initial stages of the analysis, while maintaining a holistic perspective at the same time. The photographs of the design objects should be systematically categorized based on relevant themes (forms, underlying sustainability concepts, contextual features, etc.). The process of categorization is relevant in this study both for its rigour and for successful movement from data to theory [23]. This categorization allows for the identification of recurring design elements and thematic variations across projects. Meanwhile, the written reflections must be carefully organized and linked to the corresponding design objects, enabling a cross-referencing of visual and textual data. In this stage repeated readings of the reflections, a sense of recurring themes, individual insights, and nuanced expressions of sustainability aesthetics might emerge. This process also provides an opportunity to uncover tacit knowledge, which is often expressed subtly through design solutions or in reflective writing.

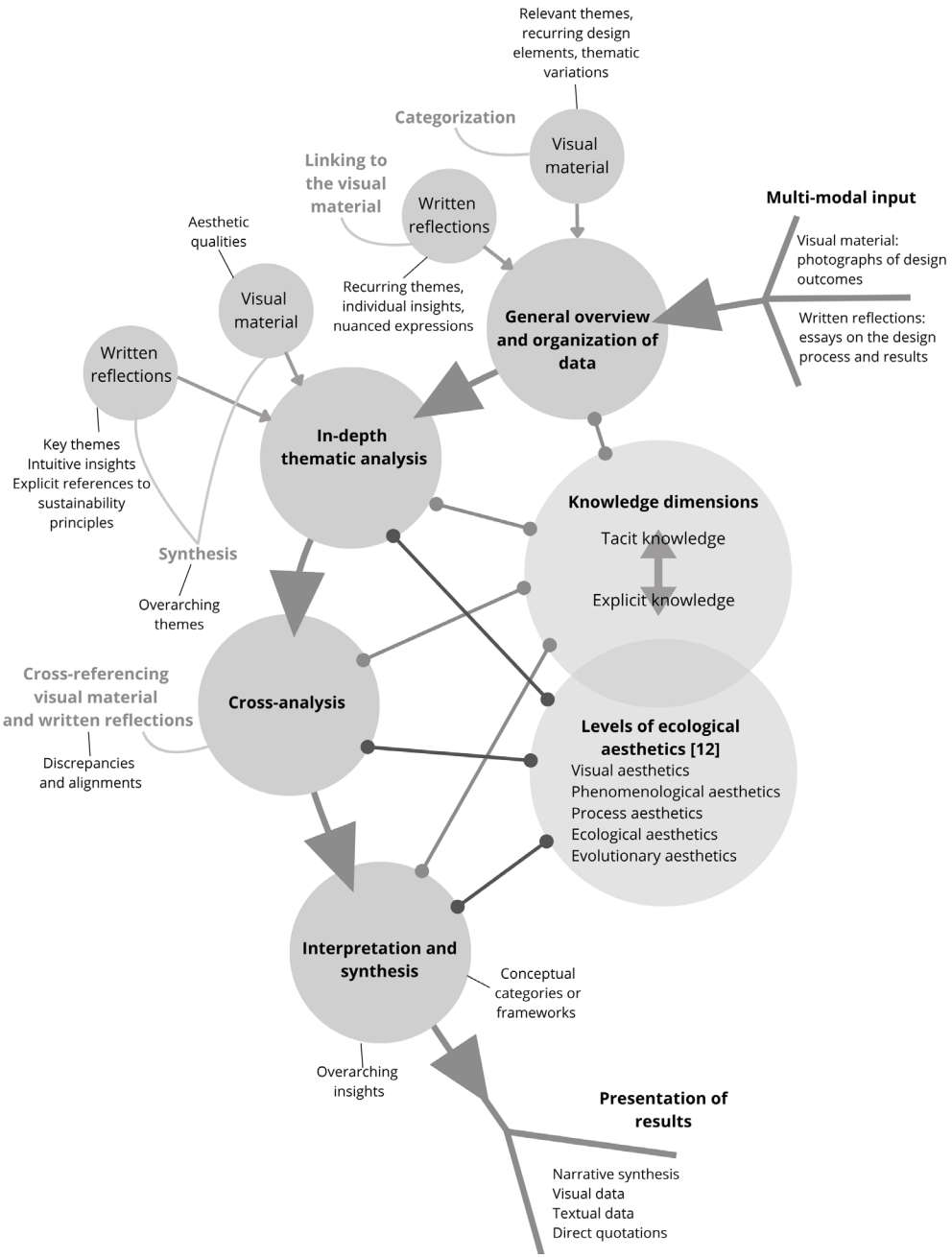


Fig. 6. Methodology for qualitative data analysis integrating the dimensions of knowledge (tacit and explicit) [14], [20], [21] and levels of ecological aesthetics approach developed by M. Dekay [12] [created by authors].

The next step is thematic analysis, which also involves analyzing design outcomes and reflections separately and then synthesizing the insights. The thematic analysis of the students' written reflections involved a two-step process. First, an open coding approach should be applied to the reflections, identifying key themes related to sustainability aesthetics, design processes, challenges, and successes. This step can capture both explicit references to sustainability principles, such as energy efficiency and material use, as well as implicit, intuitive insights – often a result of tacit knowledge – that might manifest as emotional or intuitive responses to the design challenges. Simultaneously, a visual content analysis of the photographs should be conducted. This involves examining the aesthetic qualities of the designs, focusing on elements such as form, texture, how the designs integrate with their intended context, etc. After organizing the photographs and written reflections, the ecological aesthetics categories (visual aesthetics, phenomenological aesthetics, process aesthetics, etc. [12]) can be used as thematic codes for both the visual and written materials. The aim of this analysis is to understand how sustainability aesthetics is visually expressed and whether these visual outcomes are aligned with the themes identified in the written reflections. The insights from both the written reflections and the visual analysis are synthesized in this stage in order to identify overarching themes that connect the students' conceptual understanding with their design outcomes. These themes can help to reveal the interplay between explicit scientific knowledge and the tacit, often unspoken, understanding that guides students' aesthetic choices.

Cross-analysis stage involves cross-referencing the students' written reflections with photographs of their designs. This comparative approach allows for a deeper understanding of how students' conceptualizations of sustainability, as expressed through their reflections, were translated into tangible design outcomes. By identifying both discrepancies and alignments between the intended and realized designs, insight can be gained into the students' evolving grasp of sustainability aesthetics. The ecological aesthetics categories [12] can be used to compare whether the students' written understanding of sustainability aesthetics aligns with what is visually present in their designs (Table 2). Such comparison may reveal if students' tacit knowledge (evident in their design choices) complements or diverges from their explicit understanding (expressed in their reflections). In cases where discrepancies emerge – for example, such as when students realize in their design a particular sustainability feature, which they do not mention in their reflections – these gaps can be indicative of an incomplete articulation of their tacit knowledge. Conversely, strong alignments between the reflections and designs pointed to the successful integration of both explicit sustainability principles and the students' intuitive, tacit understanding of the aesthetic choices.

**TABLE II**

**Possible Application of Levels of Ecological Aesthetics Approach Developed by M. Dekay [12] by Identifying Manifestations of Different Ecological Aesthetics Categories in Students' Design Outcomes and Written Reflections in the Process of Qualitative Analysis**

| | Visual material (photographs) | Written material (reflections) | Synthesis |
|---|---|---|---|
| **Visual aesthetics (aesthetic form)** | Look at the formal aesthetic qualities of the design, such as shapes, materials, textures, and visual harmony. Does the design visually communicate sustainability (e.g., through the use of natural, organic forms, minimalism, eco-friendly materials, etc.)? | Identify explicit references in students' reflections to how they aimed to achieve a certain visual expression of sustainability. For instance, did they intentionally use organic forms, earthy colour palettes, or materials that evoke ecological themes? | Compare the visual qualities of the designs with the students' written intentions. Look for alignment or discrepancies between how students articulate the aesthetics of sustainability and how they visually represent it in their work. |
| **Phenomenological aesthetics (aesthetic experience)** | Evaluate whether the design evokes a sensory or emotional response that connects users to nature or sustainability. This could include elements like spatial flow, the tactile qualities of materials that invite interaction, etc. | Look for instances in the reflections where students discuss the sensory experience of their design, such as how the space feels, how it engages with the senses, or how it might foster a connection to nature. | Assess how well the physical aspects of the design convey the sensory experience described in the reflections. Does the design embody the emotional or sensory goals that the students intended? |

| | Visual material (photographs) | Written material (reflections) | Synthesis |
|---|---|---|---|
| **Process aesthetics (aesthetic that reveals the process)** | Analyze whether the design makes visible the sustainable processes behind its creation. For example, does the design reveal construction methods, use of natural materials, or processes like recycling or energy efficiency? | Identify any discussion of process in the reflections, such as how sustainability principles informed their design decisions or the challenges faced in choosing eco-friendly solutions. | Compare how the design reveals the sustainability processes with how the students describe these processes. Does the final design make these processes evident or are they more hidden? |
| **Ecological aesthetics (aesthetics of patterns that create ecological health)** | Examine how the design reflects patterns of ecological health, such as biodiversity, balance, or the integration of the design within the natural environment. Does the design encourage ecological balance or mimic natural systems? | Look for references to ecological patterns in the reflections, such as discussions on biodiversity, harmony with the environment, or the role the design plays in supporting ecological health. | Synthesize how the design, both visually and conceptually, aligns with the students' understanding of ecological health. Are they able to effectively integrate ecological patterns into their design? |
| **Evolutionary aesthetics (aesthetics that reveal evolution over time towards greater integration, order and complexity)** | Investigate whether the design reflects an evolutionary process, where the design might evolve over time to become more integrated with its context. This could involve adaptive reuse, modularity, or designs that grow and change with the environment. | Identify if students discuss the potential for their design to evolve over time – whether it be through the use of renewable materials, adaptability to changing environments, or design features that foster long-term sustainability. | Assess whether the designs visually demonstrate potential for evolution and adaptability and how well these align with the written reflections on long-term sustainability and adaptability. |

The final phase of the analysis is interpretation and synthesis, it involves synthesizing the key findings that emerged from the cross-analysis. This synthesis highlights how students understood and expressed sustainability aesthetics through both their reflective writing and design work. The analysis should be focused on revealing a dynamic interplay between explicit scientific knowledge – such as the technical aspects of sustainability – and the tacit knowledge that shapes intuitive design decisions, often influenced by personal experience and cultural context. From the themes and patterns identified, it is possible to develop conceptual categories or frameworks that encapsulate the students' understanding of sustainability aesthetics. In synthesizing research findings, it is possible to develop overarching insights based on ecological aesthetics categories [12]. For example, it might appear that students are particularly adept at expressing visual aesthetics but struggle with revealing process aesthetics.

The results of the analysis can be presented in a comprehensive narrative synthesis that integrates both visual and textual data. Direct quotations from the written reflections can be used to illustrate key themes, while examples of the designs can be included to visually represent how sustainability was manifested in their creative outputs. The narrative should not only capture the scientific and technical aspects of the designs but also illuminate the role of tacit knowledge in shaping students' understanding and application of sustainability aesthetics.

## III. Reflections on the Process and Preliminary Results

***Reflections on the process.*** The main challenge in the process of experimental research was to keep a smart distance from the students' creative process and explorations and to maintain a position of mentor and observer. Rather than moving into the role of teacher, educator, or advisor, influencing the direction, style or decisions of the work. Mistakes and pitfalls were impossible to avoid, as expected from the very beginning of the research. The influence of modern media, students' personal character traits or learning habits hindered some abilities to engage with the assignment. It was not easy for some participants to follow the stages that were planned in the cycle of the experiment and to realize and present everything in a coherent way to fulfil their plans on time, as some technical decisions prevented them from returning to the previous stages of the work. For many of the participants in the study, the main challenge was the modular system – how to create an element that will participate in the overall creative design process alongside other elements and how to realize a structure as a contribution to the environment, not only one's creative expression. It was a challenge to empathize with the environment and to detach from personal expectations or habits.

Fig. 7. The final presentation of experimental design outcomes during the exam in a simulated "micro-world" representing landscape [from the archive of authors].

***Preliminary results.*** The final results – the integration of modular systems into the "micro-world" (Fig. 7) – revealed each student's individual approach to nature and sustainability, as well as their temperament and personal relationship with their work, and their attention to presentation and details. The different plasticity and shapes revealed each student's unique approach not only to the task but also to the material itself. Designs ranged from organic soft and sleek solids to billowing, flat, leaf-like planes. The wide variety of different shapes and choices revealed the desire of each student to remain unique in his or her own creative process rather than to copy the style of their colleagues. There were also some solutions where it was difficult to avoid massive monolithic blocks and brick-like segments, which do not give an organic impression. In some of the projects, it was very difficult to give up the figurativeness and to create a new, unique, organic shape to abstract the ideas. Thus, there were the recognizable "mushrooms", "leaves", and "firewood stumps". However, when some of the elements and their structures were transposed to the natural environment, the doubts disappeared, and the modules were harmoniously assimilated into the environment, merged into the whole and did not create the effect of a mismatched element. Students' involvement in the project has not only met expectations but has also exceeded them. Three months after the experiment, one student shared photographs of the ongoing observation experiment that he had carried out during the summer holidays, further tracing independently the interaction of his installation modules with nature, their disintegration, fusion, and return to the natural world in the form of clay.

It is possible to reflect in the first stage of this research that the design process and objects created by students exemplify the interplay of tacit and explicit knowledge regarding sustainability, as well as embody the five categories of ecological aesthetics. Tacit knowledge is reflected in the intuitive, hands-on manipulation of natural

forms and materials, while explicit knowledge is evident in the attention to sustainable principles such as the choice of environmental context and materials for installations. Visually, the designs demonstrate an awareness of visual aesthetics through the organic forms that mimic natural elements, blending with their surroundings to evoke a sense of harmony. At the phenomenological level, the textures and shapes invite interaction, evoking a sensory and emotional response from users, encouraging deeper engagement with nature. In terms of process aesthetics, many of the designs reveal their making through visible textures and construction methods, which suggest sustainable approaches and materials in their creation. Ecological aesthetics is embodied through designs that integrate seamlessly with their environment, promoting a balance between human-made objects and the natural world. Finally, evolutionary aesthetics is evident in the adaptability and organic growth suggested by the designs, as many pieces appear capable of evolving or being reinterpreted in different contexts over time, suggesting a dynamic relationship between sustainability and design.

## CONCLUSIONS

Contemporary hybrid environments and lifestyles pose challenges to functionality, aesthetics, and well-being while also offering opportunities for regeneration and adaptation. With youth increasingly gravitating toward diverse living spaces and adopting flexible lifestyles, this research is aimed at examining their aesthetic and ethical preferences, particularly in relation to sustainability. By focusing on the concept of sustainability aesthetics, this research investigated how design students perceive existing environments and envision their adaptation to their needs and how these preferences align with broader ethical and ecological principles.

The exploration of sustainability aesthetics reveals its complex and evolving nature, especially in hybrid environments where both tacit and explicit knowledge contribute to the design process. Tacit knowledge, rooted in personal intuition and hands-on experience, plays an important role in shaping design decisions that align with sustainability principles but may not always be easily articulated. By integrating theoretical insights with practical experimentation, sustainability aesthetics can be more holistically understood, bridging the gap between abstract ecological concepts and tangible, user-centred design outcomes.

The theoretical analysis has revealed the interconnections between tacit and explicit knowledge in the realm of sustainability aesthetics. While explicit knowledge offers measurable and codifiable guidelines for sustainable design, tacit knowledge enables designers to intuitively apply sustainability principles through creative, context-sensitive solutions. Experimental design, particularly within a constructivist framework, provides a method to uncover this implicit knowledge, enriching both the understanding and application of sustainability aesthetics in design practice and in shaping the environments.

The methodology developed for this research provides a structured yet flexible approach to analyzing student design outcomes and reflections in a qualitative manner, integrating both tacit and explicit knowledge dimensions with ecological aesthetics. By employing a four-stage data collection (empathizing with the environment and problem identification, idea generation, creative process and prototyping, testing, completion of the project and presentation) and analysis (general overview, thematic analysis, cross-analysis, and interpretation) processes, the developed methodology enables a nuanced exploration of how sustainability aesthetics is conceptualized and expressed through design. This qualitative approach allows for the categorization of visual and written data, revealing recurring themes and insights that bridge theoretical concepts with practical design outcomes. The first stage of application of the methodology and obtained preliminary results confirm the suitability of this approach for the qualitative exploration and categorization of sustainability aesthetics.

## REFERENCES

**Torreggiani, D., Dall'Ara, E., Tassinari, P.** The urban nature of agriculture: Bidirectional trends between city and countryside. *Cities,* 2012, vol. 29, no. 6, pp. 412–416. https://doi.org/10.1016/j.cities.2011.12.006

**Hou, J.** Hybrid landscapes: toward an inclusive ecological urbanism on Seattle's Central Waterfront. In *Proceedings of the ACSA 94th Annual Conference Proceedings, Getting Real: Design Ethos Now, Salt Lake City, UT, USA,* 2006, vol. 30., pp. 1–6.

**Indriliūnaitė, R.** Possibilities of self-provision of housing for the middle generation (born in 1970–1984) in Lithuania. *Viešoji politika ir administravimas*, 2020, vol. 19, no. 3, pp. 63–75.

**Šiupšinskas, M.** Vasarnamio sublimatas: kolektyviniai sodai sovietmečiu. *Acta Academiae Artium Vilnensis*, 2018, vol. 88, no. 1, pp. 233–243.

**Daukšienė, J., Jasaitis, J.** Šiuolaikinių šeimos sodybų kūrimas kaimiškose gyvenvietėse. *Kaimo raidos kryptys žinių visuomenėje: mokslo darbai*, 2011, vol. 2, pp. 84–94.

**Daugelaite, A., Grazuleviciute-Vileniske, I.** Aesthetics of sustainability and architecture: An overview. *Architecture and Urban Planning*, 2020, vol. 16, no. 1, pp. 48–55. https://doi.org/10.2478/aup-2020-0008

**Seduikyte, L., Gražulevičiūtė-Vileniškė, I., Povilaitienė, I., Fokaides, P. A., Lingė, D.** Trends and interdisciplinarity integration in the development of the research in the fields of sustainable, healthy and digital buildings and cities. *Buildings*, 2023, vol. 13, no. 7, p. 1764. https://doi.org/10.3390/buildings13071764

**Kagan, S.** Aesthetics of sustainability: a transdisciplinary sensibility for transformative practices. *Transdisciplinary Journal of Engineering & Science*, 2011, vol. 2, pp. 65–73. https://doi.org/10.22545/2011/00014

**Kagan, S**. Cultures of sustainability and the aesthetics of the pattern that connects. *Futures*, 2010, vol. 42, no. 10, pp. 1094–1101. https://doi.org/10.1016/j.futures.2010.08.009

**Ji, S., Lin, P. S.** Aesthetics of sustainability: research on the design strategies for emotionally durable visual communication design. *Sustainability*, 2022, vol. 14, no. 8, p. 4649. https://doi.org/10.3390/su14084649

**Bateson, G.** *Steps to an ecology of mind.* Ballentine, 1972. 542 p.

**Dekay, M.** Five levels of sustainable design aesthetics. Perceiving and appreciating developmental complexity. In: *28th International PLEA Conference on Sustainable Architecture + Urban Design: Opportunities, Limits and Needs-Towards an Environmentally Responsible Architecture proceeding*, 2012, pp. 7–12.

**Polanyi, M.** *The tacit dimension.* Routledge & Kegan Paul Ltd, 1967. 128 p.

**Jasimuddin, S. M., Klein, J. H., Connell, C.** The paradox of using tacit and explicit knowledge: strategies to face dilemmas. *Management Decision*, 2005, vol. 43. no. 1, pp. 102–112. https://doi.org/10.1108/00251740510572515

**Wong, W. L. P., Radcliffe, D. F.** The tacit nature of design knowledge. *Technology Analysis & Strategic Management*, 2000, vol. 12, no. 4, pp. 493–512. https://doi.org/10.1080/713698497

**Groat, L. N., Wang, D.** *Architectural research methods.* John Wiley & Sons, 2013. https://doi.org/10.1007/s00004-004-0006-7

**Lenzholzer, S., Duchhart, I., Koh, J.** 'Research through designing' in landscape architecture. *Landscape and Urban Planning*, 2013, vol. 113, pp. 120–127. https://doi.org/10.1016/j.landurbplan.2013.02.003

**Nijhuis, S., de Vries, J.** Design as research in landscape architecture. *Landscape Journal*, 2019, vol. 38, no. 1-2, pp. 87–103. https://doi.org/10.3368/lj.38.1-2.87

**Kamičaitytė, J., Gražulevičiūtė-Vileniškė, I., Mačikūnaitė, A., Marozaitė, G.** Kultūrinė darnaus vystymosi dimensija kraštovaizdžio architektūros eksperimentiniuose projektuose. *Kraštovaizdžio architektūra*, 2023, vol. 2, pp. 8–28.

**Nonaka, I. Takeuchi, H.** *The knowledge-creating company.* Oxford University Press, 1995. 284 p.

**Mahadevan, J.** Change and learning, tacit knowledge management and virtual team innovativeness under BANI conditions: the role of leadership, organization and technology. In: *Virtual Team Collaboration: A Guide for Individual Team Members*, Springer Fachmedien Wiesbaden, 2024, pp. 255–287. https://doi.org/10.1007/978-3-658-44969-8_10

**Mey, G.** Qualitative methodology. In: *International handbook of psychology learning and teaching*, Springer International Publishing, 2022, pp. 453–478. https://doi.org/10.1007/978-3-030-26248-8_22-2

**Grodal, S., Anteby, M., Holm, A. L.** Achieving rigor in qualitative analysis: The role of active categorization in theory building. *Academy of Management Review*, 2021, vol. 46, no. 3, pp. 591–612. https://doi.org/10.5465/amr.2018.0482

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