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Positive effects of wood in Vorarlberg's (Austria) timber kindergartens

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Abstract: The application of sustainable materials and their integration into newly constructed, valuable, and cultural architecture is a topic currently often mentioned in connection with the new initiative called the New European Bauhaus. The aim of this paper is to highlight the impact of wood material in the interiors of preschool institutions, its positive influence on the development of children and its inclusivity in education. The use of wooden furniture and wooden structural elements in kindergarten interiors opens a new area of research and interest in the context of promoting diversity and access for every child, regardless of their abilities or limitations. The article analyses the architecture of kindergartens in Vorarlberg, which serves as an excellent reference example for the development of new school projects. The authors raise questions as to how such architectural and design thinking can support the promotion of inclusive education of children and whether it can positively influence their cognitive abilities, ultimately affecting their overall quality of life. The findings presented in the article can inspire new ideas and solutions for the creation of preschool architecture that aims to provide an inclusive environment for children where they can expand their knowledge and gain new experiences, while applying innovative design thinking. The selected analyses and comparisons focused on whether the presence of wood material can positively impact the well-being of children in the physical environment of kindergartens. The paper aims to prove that interiors with exposed wood can improve the quality of teaching and support social interaction and playful learning of children. The results of this study can serve as a strong argument for the New European Bauhaus initiative advocating for the implementation of renewable materials such as wood in accordance with the principles of biophilic, restorative environmental, and salutogenic design in practice.

Keywords: well-being, wood impact, kindergarten, New European Bauhaus, Vorarlberg, Austria

INTRODUCTION

A physical, built environment has a significant impact on the development, health, and well-being of children in their early years in general (Evans, Kliewer, Martin, 1991; Chu, Thorne, Guite, 2004). The selection of appropriately used materials when creating environments is one of the key parameters through which architects can ensure a higher quality, healthier, more pleasant to the senses and more humane space. One suitable material positively affecting children's health is solid wood. Current research demonstrates that the application of natural materials and principles of biophilic design (Gillis, Gatersleben, 2015), restorative environmental design (Nousiainen, Lindroos, Heino, 2016), and salutogenic design (Tsekleves, Cooper, 2017) can improve health and enhance psychological well-being, resulting in better work performance and lower absenteeism in schools (MacNaughton, Eitland, Kloog, Schwartz, Allen, 2017), and improving educational achievements not only in adults but also in children.

The visual, tactile, and olfactory contact with elements made of solid wood in the environment of preschool institutions undoubtedly affects children's emotional and physiological well-being. The presence of such elements opens up a new area of research and interest in the context of promoting inclusivity for every child, regardless of their abilities or limitations. The use of solid wood material in preschool environments can improve educational processes, contribute to inclusive education of children, influence their cognitive abilities, reduce their stress, and ultimately positively impact their overall quality of life. This article aims to highlight the effects of solid wood material (structural elements, furniture, toys, and play elements) on development of children and inclusivity in education.

The use of solid wood can create aesthetic and psychological effects in the interiors and exteriors of kindergartens, providing children with direct contact with nature, which has become increasingly less frequent due to the modern urban lifestyle. The presented research characterizes wood material as visually appealing, solid interior mass. Its implementation is authentic, with little or no surface treatment that could degrade its visual-tactile-olfactory qualities. The research focused on existing wooden kindergarten buildings in Austria, one of the Alpine countries where wooden kindergartens are relatively widespread. The paper interprets the results of practical research

conducted in eight selected kindergartens in the Vorarlberg region.

The study analyses the presence of solid wood in structures, architectural and furniture elements. The presented article is a partial output of doctoral research focused on studying the positive impact of wood on children's psyche and educational processes in general. One of the research objectives is to identify and summarize the opinions of teachers and educators, present information about the educational potential of these institutions, assess their atmosphere as perceived by users, and evaluate to what extent wood as a material has the potential to positively influence the educational process. The obtained results aspire to serve as inspiration for creating new recommendations, guidelines, and solutions for the design of preschool architecture that would create an inclusive environment for children, offering space where they could expand their knowledge and gain experiences, thus applying design thinking in practice.

METHODS

The empirical research included questionnaire-based surveys, originally written in German:

1. Characteristics of the respondent

2. Do you know that the kindergarten you work at or your child attends is a wooden building?

3. Do you believe that wood, if used in kindergarten facilities, can influence the psychological well-being of children?

4. Do you believe that children feel more comfortable or safer in this modern wooden kindergarten building compared to your previous workplace (a traditional elementary school or kindergarten where you worked before)?

5. If you feel safer, better and more comfortable in this modern wooden kindergarten building compared to your previous workplace (an elementary school or kindergarten made from traditional building materials where you worked before), please explain why.

7. Based on your previous experience working with children, do you believe that natural wood environments contribute to the well-being of children and enhance their concentration? Or do you see another advantage?

8. Do you believe that the smell of wood can have a positive effect on a child's psyche?

9. Do you believe that the colour of wood, its softness, or its natural character have a more positive effect on children and teachers compared to ordinary white walls?

10. Are there any issues related to the wooden structures in the kindergarten? (technical, health-related, physical or psychological)

11. In which areas of the kindergarten do you encounter wooden materials? (besides furniture)

12. If there was something you could architecturally change or add to the interior or exterior of your kindergarten, what would it be?

The questionnaire comprised questions in a multiple-choice format, where respondents could mark their answers as yes, no, or do not know. In all the questions posed, the respondents were asked to provide a rationale and expand their answers using keywords. The case study presents the conducted research in eight selected kindergartens, which are listed below (Tab. 1).

Tab. 1. The subject-matter of research was the presence of solid wood in selected kindergartens in Vorarlberg, Austria. (Source: Authors, 2023)

Kindergarten	Address	Architect
Kindergarten Am Schlatt	Birkenweg 6, 6890 Lustenau	Bernardo Bader Architekten, Bregenz
Kindergarten Am Engelbach	Hasenfeldstraße 35, 6890 Lustenau	Innauer-Matt Architekten, Bezau
Kindergarten Hatlerstraße	Hatlerstr. 36, 6850 Dornbirn	Nagele Waibel ZT GmbH, Dornbirn
Kindergarten Wallenmahd	Bachmähdle 11, 6850 Dornbirn	Johannes Kaufmann Architektur, Dornbirn
Kindergarten Muntlix	Fidelisgasse 1, 6835 Muntlix	HEIN architekten zt - Zwischenwasser, Bregenz
Kindergarten Altenstadt	Im Grisseler 25, 6800 Feldkirch	Rainer + Amann ZT GmbH, Feldkirch
Kindergarten Susi Weigel	Rungelinerstraße 14, 6700 Bludenz	Bernardo Bader Architekten, Bregenz
Kindergarten Mellau	Platz 551, 6881 Mellau	Dorner / Matt Architekten, Bregenz

All selected timber kindergarten buildings were analysed on-site. The management of Altenstadt kindergarten in Feldkirch refused to grant us access to the interior of their premises, however, they still decided to participate in the research. A total of 51 teachers and educators took part in the study. The focus of research in the selected case studies was the subjective perception of a wooden kindergarten environment, including its visual and aesthetic quality, and the proportion of visible wood surfaces in the kindergarten interiors. The participants were confronted with questions such as whether wood as a material influenced the level of concentration, mood, or emotional well-being of the child users. Additionally, they were asked whether they believed that wooden walls were a better choice than white walls and they were also asked to explain and describe their observations and subjective feelings resulting from their work with children in timber educational structures where they work.

JOURNEY OF ARCHITECTURE FROM RURAL AREAS TO INTERNATIONALLY RECOGNIZED ARCHITECTURAL SCENE

Vorarlberg is the smallest state of Austria, situated in the western part of the country, bordering Germany, Switzerland, and Liechtenstein. It is also the least populated federal state, with its capital city being Bregenz, located on the shores of Lake Constance. The improvement of the construction culture began in the late 1950s when a group of young graduates - architects from the Academy of Fine Arts in Vienna decided to return to the rural region of Vorarlberg. In this region, the construction culture developed alongside a movement known as "Vorarlberger Bauschule"(Fiel, 2014) - translated as "Vorarlberg Building School". It brought together several personalities who realized their pragmatic vision based on the knowledge and mastery of local building craftsmanship, with wood as a fundamental material.

The construction culture in Vorarlberg owes much to the craftsmanship skills passed down from generation to generation and the large number of small and medium-sized timber con-

struction companies. Historically, architects and craftsmen of the region have inspired and supported each other in the creative process. Local building projects, social contacts and easy communication have enabled them to learn from one another and achieve new levels of creativity. Craftsmen from the Bregenzerwald region formed the Werkraum Bregenzerwald (Werkraum Bregenzwald, 2023) association, whose building in the village of Andelsbuch, showcasing the craftsmanship culture, was designed by architect Peter Zumthor. Every three years, the Handwerk+Form competition takes place, where local craftsmen present their works in cooperation with designers and architects.

Architects in Vorarlberg have gradually been gaining recognition not only in Austria but also beyond its borders, as inspiring shining examples for the realization of ideas of the New European Bauhaus (European Union, 2023) movement in the global context. The BUS:STOP (Bregenzerwald, 2023) initiative brought together international architects with local partners and resulted in unique bus stops in Krumbach. These projects highlight Vorarlberg's reputation for a high level of expertise and interest in the craftsmanship of demanding construction details.

THEORETICAL FRAMEWORK

Biophilic, restorative environmental and salutogenic design

Materials used in the environment where children are present have a significant impact on their well-being, as they provide them with a concrete and real world. However, in many kindergartens there are spaces where practical and efficient but often cheap and inappropriate materials are preferred, which do not evoke any emotions or, what is more, elicit undesirable emotions. Plastic feels artificial, stone is hard, concrete is cold and white-painted walls evoke minimal emotions. In contrast, wood always creates a warm and pleasant impression. Moreover, wood is the only sustainable and renewable natural material among those mentioned. Recently, we have witnessed an increased use of wood imitations, such as various laminates or ceramic tiles with wood prints, which offer only a positive visual experience. Although this artificially created product may look good, it lacks the tactile properties, a pleasant smell, and, most importantly, it is a material that deceives. Compared to authentic solid wood, it is always artificial and false and can have a negative impact on children's material experiences.

Biophilic environment in kindergartens created with wooden structural elements and wooden furniture can provide a harmonious, nature-evoking, and inspirational learning environment. This concept is suitable for inclusion as it brings many benefits for children's physiological and psychological well-being. A lack of time spent in nature leads to various disorders and health problems related to stress (Jimenez, DeVille, Elliott, Schiff, Wilt, Hart, James, 2021). Stress induced by an unpleasant environment can cause feelings of anxiety, sadness, or helplessness, increase blood pressure and heart rate, cause muscle tension, and suppress the immune system. On the other hand, the presence of natural elements like solid wood in the physical environment of kindergartens contributes to reducing anxiety and stress, improves mood and overall well-being. For children with special needs, the presence of solid wood can create a stable and predictable environment, which helps optimize their emotional balance. Additionally, wood support fosters sensory development in children, stimulates their sensory perception, and creates an environment that enhances mood, reduces stress, and provides a pleasant and natural space where children can feel comfortable and safe.

In today's world of interior design, health and well-being are becoming increasingly important. However, it is essential to recognize that salutogenic design and biophilic design are not identical. Biophilic design focuses on exploring our relationship with nature and natural elements, including not only the presence of plants, trees, and natural wood but also concepts like natural lighting, improved air quality, and water elements. On the other hand, salutogenesis concerns promoting active health, productivity, and efficiency. It is measurable and motivates us to achieve maximum performance, whether it is mental or physical. Salutogenic design is a key component of WELL building certification. In addition to biophilia, salutogenic design also addresses comfort, nutrition, physical fitness, and mental state in the environment. For example, salutogenic design focuses on designing stairs that encourage people to use them instead of elevators and creating active courtyards, terraces, and atriums that promote personal interactions. Its goal is to ensure that the environment contributes to improving people's health and enables them to achieve mental, social, and physical well-being (Mazuch, 2017).

Explanatory notes

Restorative environmental design is a paradigm of architectural design that combines sustainable construction practices with building methods that are beneficial to the health of the occupants (Nousiainen, Lindroos, Heino, 2016).

Biophilic design represents a holistic approach to the design of interiors and exteriors, where the focal point is the human being and its impact on their psychological and physical well-being and health. In combination with an approach that considers the long-term impact on the natural environment, we refer to it as restorative environmental design, which promotes individual health (Gillis, Gatersleben, 2015).

Salutogenic design is a concept and approach to environmental design that aims to support and enhance the health and well-being of individuals. Its focus is different from the traditional approach, which concentrates on disease prevention and addressing negative environmental impacts. Salutogenic design instead emphasizes strengthening factors that contribute to health and creating conditions for prosperity and a better quality of life for individuals (Gattupalli, 2022).

Maslow's hierarchy of needs

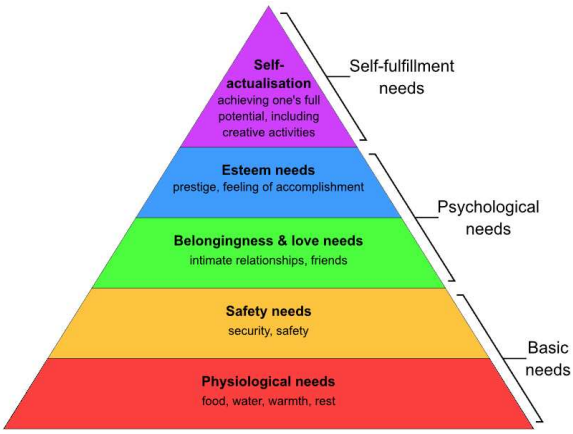


Fig. 1. Maslow's hierarchy of needs. (Source: Androidmarsexpress, 2020; CC BY-SA 4.0)

When considering the conceptual pyramid of Maslow's hierarchy of human needs (Fig. 1), we find various classifications in general. As regards the basic needs, there are physiological

needs, needs for safety and security. As to the psychological needs, we find the need to belong and the need for love, the need for recognition and self-esteem. In the expanded section, we can find cognitive needs, aesthetic needs, and the need for self-actualization (Maslow, 1943). All these mentioned needs are very important for physical, emotional, and mental well-being and can be influenced by spatial and material factors.

The basic physiological needs of humans include breathing and the need for fresh air. Humans require clean and sufficient air and oxygen supply for proper body functioning. The presence of solid wood in interiors can contribute to the air quality in the room as it is naturally hygroscopic), meaning it can regulate air humidity. This creates a more pleasant and healthier atmosphere, but this phenomenon can only be achieved with efficient natural or controlled ventilation. Another physiological need is the need for regulating body temperature. Besides the mentioned benefits, wood also has natural thermal insulation properties, and physical contact with this non-conductive material is pleasant. Wooden structures and furniture can, therefore, contribute to maintaining thermal comfort in the room.

Wooden walls, ceilings, and floors can create a sense of safety as they are associated with durability and resilience. Wood is known for its strength and ability to withstand certain external influences, contributing to a sense of security in the environment. When using wood in physical spaces, it is essential to ensure that the wood is properly treated and safe for users. Smooth wood surfaces and appropriate treatments reduce the risk of injury or splintering. In this regard, proper wood maintenance and adherence to safety measures are important.

Wood, with its natural textures and colours, evokes a connection with nature and creates a friendly environment that can encourage mutual relationships and interactions among people. Wood has natural beauty and unique patterns that can evoke feelings of recognition and admiration. The presence of wood in physical spaces can enhance a sense of self-worth and self-esteem, as it evokes a connection with natural and authentic elements. Wooden surfaces and furnishings can create an environment that promotes communication, cooperation, and mutual support. Wood can serve as a common element that brings people together and provides a space for sharing, discussion, and creative exchange. Wooden constructions and furniture can contribute to creating pleasant and intimate spaces. Wood has the ability to create a warm and cozy environment, ideal for forming relationships and engaging in intimate communication. The presence of wood can offer space for privacy and closeness.

The presence of wood in physical spaces can support cognitive stimulation and learning. Wooden surfaces, textures, and patterns can provide visual and tactile stimulation, which supports the development of sensory skills and cognitive functions. In addition to these needs, the ability to concentrate is linked to the ability to perceive word intelligibility in school buildings. Acoustic conditions represent one of the greatest challenges and have an impact on the level of achieved knowledge. Well-designed acoustic environment affects our well-being and ability to concentrate. Wood has the ability to absorb and dampen sounds, which can contribute to better acoustic comfort inside the room. Wooden surfaces, such as wooden walls or floors, can help reduce reverberation and noise, which is important for concentration, communication, and relaxation.

Wood is also a material that can be processed and shaped, enabling interactive learning and exploration. It is known for its natural beauty and aesthetically appealing appearance. The presence of wood in physical spaces can evoke aesthetic satisfaction and pleasure. Wooden structures, furniture and toys can contribute to the aesthetic perception of the environment and support creativity and appreciation of beauty. The presence of wood in physical spaces can evoke a sense of authenticity, which is important for personal growth and self-realization. It can create a space for self-expression and provide an environment where one can express their own creativity and individuality. Wood is a material often associated with creativity and inspiration. It can enhance a creative and inspirational environment that supports cognitive processes related to creation, ingenuity, and innovation. Wooden surfaces of structural elements and furniture can serve as a source of inspiration and support the development of creative thinking.

CASE STUDY

Kindergarten Am Schlatt in Lustenau by Bernardo Bader Architekten, Bregenz

Fig. 2. A view of a ventilated facade that has naturally changed to a grey shade due to weather exposure. (Photo: Jakub Hanták, 2023)

Fig. 3. The interior of the playroom is predominantly equipped with structural elements made of solid wood, including the floor, furniture, and window frames. (Photo: Jakub Hanták, 2023)

The extension of a new wing (Fig. 2) to the kindergarten in Lustenau was completed as a single-story wooden structure in 2019, based on the competition-winning design of architect Bernardo Bader. The extension project incorporates some architectural elements, such as window shapes (Fig. 3) and wooden structural elements (Fig. 4), found in the original building to which the new extension is connected. Threshold-less and low-placed windows create a connection between the exterior and interior for the children, allowing sufficient natural light to enter and providing a pleasant spatial experience. The extension houses three educational units, and at the heart of each unit is an outdoor play "room" - a terrace which is well integrated into the interior layout and can be covered with a horizontal sun-

shade in case of unfavourable weather conditions. The ratio of walls with significant clear height in the playrooms and the terrace offers a high standard of spatial quality. The kindergarten's construction includes solid wood panels, making it a structurally simple building (Bernardo Bader Architekten, 2019). The structures are made from local wood, and the main benefit of using prefabricated elements was the short construction time.

In the questionnaire (2 participants), very similar responses were recorded as in our previously conducted case study of wooden kindergartens in Slovenia (Hanták, Končeková, 2022). Teachers and educators largely agreed that the presence of solid wood in the interiors of their kindergarten creates a warm, pleasant, and inviting atmosphere. They stated that it is an aesthetically valuable material that encourages contemplation and has a calming and relaxing effect on children, enlivens the interiors, and brings in the scent of nature and a feeling of safety. There was also a comparative question regarding concrete structures, which, according to respondents, feel cold, distant, and lack warmth.

Fig. 4. The interior of the connecting hall is also extensively furnished with structural elements made of solid wood. It also features built-in furniture made of the same solid wood material. (Photo: Jakub Hanták, 2023)

Regarding the negative aspects of wood usage, some respondents expressed concerns about the risk of children getting injured on wooden walls. Therefore, it is crucial for wooden walls to be sufficiently smooth and treated to minimize the risk of injury. Proper maintenance and suitable surface finishes can ensure safety while preserving the aesthetic values of wood. Some respondents mentioned that wooden floors cannot be cleaned with water, and their maintenance is demanding and complicated. They would prefer a more easily maintainable floor. Also, a comment was made about the wooden floor of the outdoor terrace being very slippery, and it certainly needs a different solution in terms of safety and functionality. Child safety should be a priority, and it would be appropriate to consider a solution that eliminates the risk of a child slipping, falling, or even injuring themselves. One option is to apply a different surface finish or create grooves or a non-slip cover for the terrace that can withstand adverse weather conditions.

Kindergarten Am Engelbach in Lustenau by Innauer-Matt Architekten, Bezau

Fig. 5. The entrance area of the kindergarten building in Lustenau; the wooden cladding is complemented by perforations that evoke folk patterns. (Photo: Jakub Hanták, 2023)

The next kindergarten is also located in the town of Lustenau. It was designed by the duo Innauer-Matt Architekten (Markus Innauer and Sven Matt). As the architects say: *"A place with a homely atmosphere characterized by an aura of great relaxation. A kindergarten that combines the potential of the location with the demands of modern pedagogy"* (Pintos, 2022). The new kindergarten building in Lustenau is designed as a two-story compact structure (Fig. 5), built with solid wood panel and concrete construction in 2020. The upper floor houses playrooms (Fig. 6), all located on the southeast side, with optimal daylight exposure during morning sessions. All terraces of the playrooms are protected from the weather.

The interior and exterior have a unified design dominated by natural local solid wood, combined with other natural materials. During the building's construction, high-quality, ecological, and locally available materials were used. The building is technologically sophisticated, utilizing energy-efficient building technology systems. It also employs renewable energy sources and its operation is adapted to environmental protection, thus positively contributing to sustainability. These features and elements, along with an emphasis on aesthetics and a natural environment, ensure that the new kindergarten building in Lustenau provides a suitable environment for children, educating them, and supporting their thinking towards a sustainable and environmentally friendly lifestyle.

According to the questionnaire (5 participants), users perceive the solid wood material very positively. The surveyed teachers and educators claim that wood creates a homely atmosphere and contributes to a pleasant spatial climate. Wood is a true connection to nature, exuding peace and a positive impact. Users also value the scent of wood, which evokes a feeling of being

in touch with nature. As for negative aspects related to wooden structures or elements, no feedback was provided. Haviarová and the co-authors (Eckelman, Haviarova, Zhu, Gibson, 2001) point out that *"the current concept of school furniture design is mostly traditional, and the furniture found in current kindergartens has basically remained unchanged over the last centuries"* (Haviarova, Eckelman, Erdil, 2001). However, here we can see that the architects opted for more inclusive solutions in the form of height-adjustable chairs (Fig. 7).

Fig. 6. The interior of the playroom is mostly furnished with structural elements and furniture made of solid wood. (Photo: Jakub Hanták, 2023)

Fig. 7. The furniture - chairs in the dining area are height-adjustable, which makes them inclusive and user-friendly. (Photo: Jakub Hanták, 2023)

Kindergarten Hatlerstraße in Dornbirn by Nagele Waibel ZT GmbH, Dornbirn

One of the other kindergartens included in the research was Kindergarten Hatlerstraße (Fig. 8), designed by the Nägele Waibel studio (Elmar Nägele, Ernst Waibel), in the city of Dornbirn. The kindergarten was designed in 2013, and the construction took place in 2014. Located in close proximity to a church in the central part of Dornbirn, the kindergarten is a wooden building with a simple cubic form on a square floor plan. The small plot required the building to be three stories high, which is not a typical solution for the typology of a kindergarten.

Fig. 8. The small plot of land required the building to be three stories high, which is not a typical typology solution for a kindergarten. (Photo: Jakub Hanták, 2023)

On the ground floor, there are common spaces such as an auditorium, an exercise room and administration offices. The central spatial zone for arrivals and social activities is directly connected to the southern garden. On the upper two floors, there are four playrooms (Fig. 9). Each floor has a common area for exercise and dressing rooms, and around it, two main areas and two additional areas are arranged, along with two loggias opposite each other. This intertwined structure provides a clear basic layout that remains clear and adjustable for use. The wooden structures, floors, walls, and ceilings are made of solid wood from local forests. The window elements have small window alcoves adapted to children.

Fig. 9. A playroom, featuring elements of solid wood. (Photo: Jakub Hanták, 2023)

The questionnaire (2 participants) shows that users perceive the solid wood material very positively. According to the surveyed teachers and educators, wood is a living material that creates a warm and pleasant atmosphere in the built environment. Both children and teachers feel safer in the wooden space because they are familiar with this material (note by the au-

thors: in Vorarlberg, many family homes are built using solid wood panels, or frame construction with exposed solid wood). Wooden floors are more pleasant for play and movement. Manuel Reis states: *"Since I am a friend of wood, I feel good in this environment."* As for negative aspects related to wooden structures or elements, no feedback was recorded.

Kindergarten Wallenmahd in Dornbirn by Johannes Kaufmann Architektur, Dornbirn

Fig. 10. The photograph shows a recess with entrance. On the facade, one can see how the wood authentically changes when directly or indirectly exposed to weather conditions. (Photo: Jakub Hanták, 2023)

Kindergarten Wallenmahd (Fig. 10) consists of two square parts, creating the letter "L," and this solution allows for the creation of an entrance area set back sufficiently from the roadside. Access to the kindergarten is through the protruding part of the building mass. The central interior space connects the common area with the public space, including corridors that serve as play areas or spaces for exercise, dining, and staff. The playrooms have glass walls facing the garden and covered terraces with skylights providing ample natural light. The wide and bright corridors also serve as play or exercise areas. External stairs provide direct access for groups on the upper floor to the garden, where extensive play areas under the trees are available.

For the construction of this kindergarten, solid spruce and fir wood from the forests of the city of Dornbirn was used, extracted in winter. The walls and ceilings are made of solid wood elements. The ceilings are made of a combination of wood and concrete. The outer walls have a ventilated wooden facade. Vertical spruce slats with generous spacing create a sense of depth on the facades. The parapets in front of the common rooms on the upper floor and the cladding of external staircases were made using horizontal slats with maximum spacing to achieve clarity (Fig. 11). The building is constructed according to low-energy standards with highly efficient insulation on the exterior walls featuring triple-glazed insulating glass. Controlled ventilation ensures optimal indoor conditions.

According to the questionnaire (11 participants), teachers and educators believe that the use of solid wood walls is a better choice than using conventional white walls. They are convinced that wood increases the sense of comfort but cannot state whether the presence of wood also affects children's concentration. Teacher Cornelia Mennel says, *"There are studies showing that wood reduces blood pressure and pulse, so I think wood has a calming effect on children. Thanks to the hygroscopic properties of wood, there is a better spatial climate in the wooden kindergarten, which enhances this feeling. The essential oils in wood have a positive effect on humans, so pine cushions and oils are currently experiencing a BOOM."* Vanessa Staubmann states, *"Light wood and many windows together create a pleasant atmosphere, positively affecting and pleasing people. Wood enhances children's interest and curiosity. Children ask why wood smells, and it contributes to their speech development."* Manon Starcevic would welcome a better and more efficient ventilation system since it is a passive standard building and adds, *"Concrete raw walls are unpleasant, repelling, and sound spreads on them."* Petra Haon mentions, *"Wood is a material from nature, and nature is good for mental health."* Jasmin Ebner speaks very positively about wood: *"Wood is warm, and one feels comfortable in its presence; it is friendly and pleasant to look at. I like its natural, non-chemical smell."* As for negative aspects, teachers and educators generally perceive the functional issue of the corridor designated for exercise; they would welcome a separate gymnasium or a physical education room.

Fig. 11. Claddings of the exterior staircases are made of horizontal slats with maximum spacing to achieve maximum clarity. (Photo: Jakub Hanták, 2023)

Kindergarten Muntlix in Muntlix by HEIN architekten zt - Zwischenwasser, Bregenz

Fig. 12. A view of the ventilated facade, which has naturally changed to a grey shade due to weather exposure. (Photo: Jakub Hanták, 2023)

The kindergarten is located in close proximity to the municipal office, church, and rectory. The kindergarten can accept 50 children, divided into groups arranged around the internal corridor. Each unit has large windows that provide access to the exterior. The front part of the building is equipped with loggias that offer protection from the sun during the summer months. On the ground floor, there is also a multifunctional hall facing the inner courtyard, which serves as a community centre. Playrooms are located in the corridor. In the basement, there are storage spaces, and two single-flight staircases connect the upper floors.

The kindergarten is clad with wooden materials both on the outside and inside (Fig. 12). The facade is unified with narrow, vertical wooden slats, where the side edges of some slats are painted red and others green. The result is a visual effect that

changes with different angles and positions, displaying various colours. The wood used for construction comes from local forests. Natural materials are also used in the interior walls, acoustic ceilings, doors, and built-in furniture (Fig. 13). The floors are covered with a nine-centimetre (Baunetz, 2023b) layer of rammed earth, using material obtained from construction works. The tables at window level, located on the second floor, are an interesting solution. Attention was also given to building materials with the lowest possible content of harmful substances.

The building is heated by a brine-water heat pump utilizing geothermal heat with deep probes. Underfloor heating distributes the warmth throughout the building. The heating demand is 14 kWh/m^2 according to PHPP (Baunetz, 2023b). Mechanical comfort ventilation with heat recovery ensures sufficient air quality. Electricity is supplied by a photovoltaic system on the roof, with excess energy fed back into the public power grid. The kindergarten was awarded the Austrian State Prize for Architecture and Sustainability in 2014 for its remarkable resource-saving design and construction.

According to the questionnaire (4 participants), teachers and educators believe that the use of solid wood walls makes children feel better and improves their ability to concentrate. Alexandra Zambanini says, *"Wood has a positive effect on children because the spatial climate has pleasant properties. I can confirm that wood has a calming effect on me, and children feel good in kindergarten, making it easier to work with them. It is appreciated that the children are not distracted by colourful surfaces."* Franziska Hammerer states, *"Thanks to wood, we feel closer to nature, the air quality is better, thus creating a better spatial climate."* Maria Stemer says that the warm colour of wood and soft surfaces make it an ideal material for the kindergarten, improving acoustics. She mentioned that when the kindergarten was built, the smell of wood was present, but now it is no longer noticeable. Concerning children's safety, she is worried about the risk of injury from splinters on solid wood surfaces. Dagmar Matt's opinion aligns with the colleagues' views regarding the positive qualities of wood; however, she has reservations about the type of flooring used and says, *"A clay floor is unacceptable in kindergartens."*

Fig. 13. The playroom, featuring elements of solid wood. (Photo: Jakub Hanták, 2023)

Kindergarten Altenstadt in Feldkirch by Rainer + Amann ZT GmbH, Feldkirch

The kindergarten management refused to let us into the Altenstadt kindergarten (Fig. 14), but they decided to participate in our research (8 participants). The kindergarten has four groups, two of which are inclusive groups, where they aim to create a suitable environment for children with "special needs," and the kindergarten actively promotes this aspect as well. The subject-matter of our study is the extension of the kindergarten, which was built as a wooden structure in 2010. Janine Geroldova says, *"Pine wood is good for health; its presence creates a pleasant and warm atmosphere."* Elke Schatzmann states, *"I believe that wood has a positive impact on the body and psyche, improves the air quality, and creates a pleasant feeling. I even think that wood positively influences the children's concentration because it calms them down."* There were also complaints about the dysfunctional connection between the original building and the new extension.

Fig. 14. The extension of the kindergarten building with a wooden cladding in Im Grisseler Street in the city of Feldkirch. (Photo: Jakub Hanták, 2023)

Kindergarten Susi Weigel in Bludenz by Bernardo Bader Architekten, Bregenz

Fig. 15. A view of a ventilated facade that has naturally changed to a grey shade due to weather exposure. (Photo: Jakub Hanták, 2023)

The Kindergarten Muntlix was constructed in 2013 and it is a two-story kindergarten located on the outskirts of the city of Bludenz, close to open countryside. Its placement on the plot was determined by the presence of a solitary mature tree on the site (Fig. 15). The playrooms are on both floors, and the layout of the kindergarten focuses on a central gallery with a staircase,

physically connecting learning and play areas. The architecture pays homage to the local environment in Bludenz and Vorarlberg, where all the wood (spruce used in the interior and pine used on the facade) comes from local forests and significantly influences the atmosphere of the kindergarten. The entrance to the kindergarten is located at the northern corner of the building. Behind the entrance there is a top-lit gallery with a central, linear staircase. The space reveals a subtle friendliness with its clear and diverse lighting in harmony with natural building materials. The modest and relatively unknown Susi Weigel, born in Prostějov, Czech Republic, lived in Bludenz. Weigel illustrated countless children's books, with the most famous probably being "Little-I-am-me." Her illustrations have also been incorporated into the architecture: sunny yellow and blue in various shades have been applied to chairs and upholstered furniture, wardrobes, walls, and even curtains (Bernardo Bader Architekten, 2013).

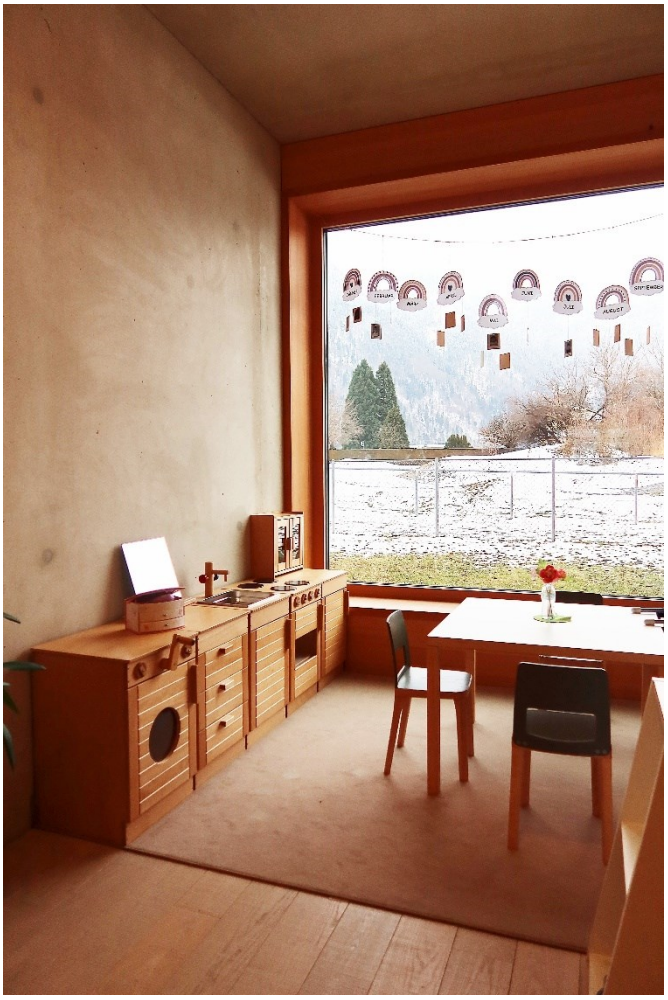


Fig. 16. Teachers have complained of headaches due to inadequate air supply. It would help to have a more efficient air exchange or more adjustable windows in all rooms. (Photo: Jakub Hanták, 2023)

From the survey (12 participants), it is evident that teachers believe that solid wooden walls create a warm, humane feeling. However, it is essential for the wood to be in its natural state or oiled, at maximum. Tereza Ruetz says, *"The smell of wood makes you feel better and safer, whereas concrete is the complete opposite. Since a wooden structure feels pleasant to me, I also have a sense of security. I have not noticed a positive impact on the children's concentration. Strongly scented wood (like pine) has a calming effect and can bring peace to the children during a normal day."* From an architectural perspective, respondents would prefer smaller corridors and larger classrooms. They perceive a problem with ventilation in case of larger groups and would appreciate the use of operable windows (Fig. 16). Tereza Ruetz explains the issue, *"With a combination of wood (which breathes) and concrete (which absorbs), headaches occur frequently. More efficient air exchange or more adjustable windows in all rooms would help."* They consider solid wood as somewhat risky because splinters can form on its surface, posing a risk for small children. They would also welcome a different type of flooring that requires less maintenance.

Kindergarten Mellau in Mellau by Dorner & Matt Architekten, Bregenz

Fig. 17. The two new forms of monolithic wooden buildings of the kindergarten and community hall in the village of Mellau. (Photo: Jakub Hanták, 2023)

Fig. 18. According to teacher Ursula Kündig, wood is a regional building material in Vorarlberg that evokes a good mood and supports creativity, and well-being. (Photo: Jakub Hanták, 2023)

Kindergarten Mellau (Fig. 17) is part of a community centre located in a centralized position in the ski resort town of Mellau in Bregenzerwald. Five buildings are clustered around the square, forming the new town centre. The parish church is to the east, the municipal office to the north, the elementary school to the west, and to the south are two new structures - the kindergarten and the community hall. The new buildings are constructed with regional solid wood (Fig. 18) and laminated veneer lumber as load-bearing elements. Load-bearing walls, ceilings, and beams are prefabricated from beech laminated veneer lumber, which has exceptionally high load-bearing capacity, allowing for material-saving construction. The basement of the common hall, ceiling, and floor slab of the kindergarten are made of concrete (Baunetz, 2023a). The facade is composed of vertically arranged spruce slats. Thanks to the uniform design, the buildings appear to be a whole, with the dominant construction material being local wood and glass.

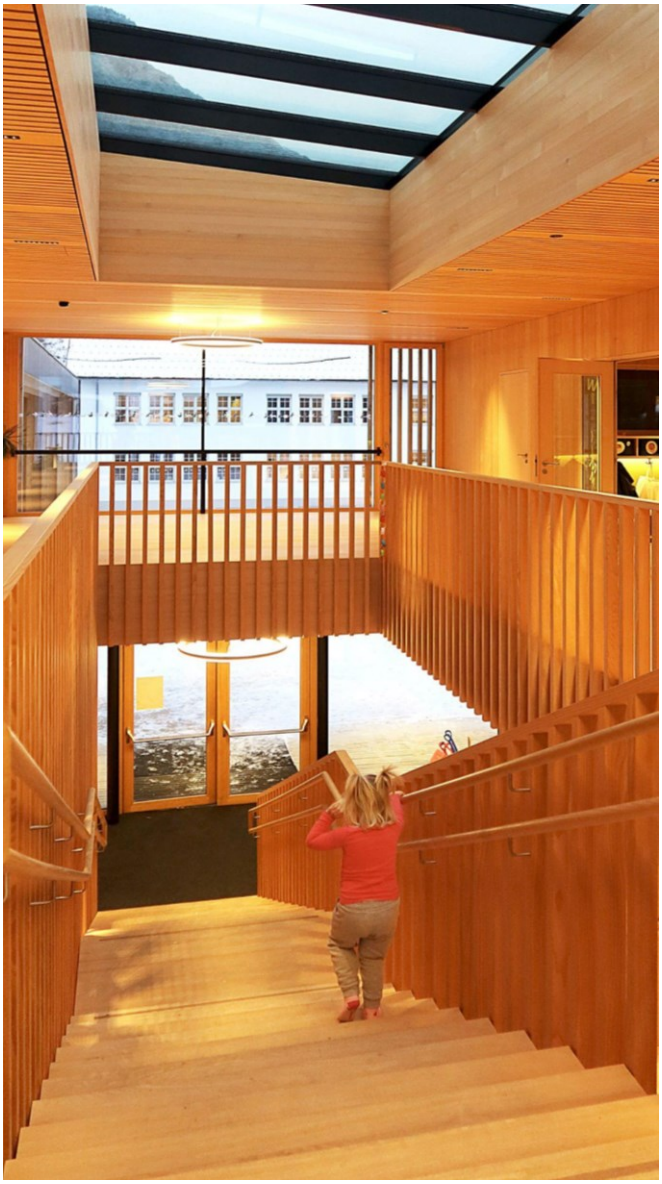


Fig. 19. Central space of the gallery with a skylight and a linear staircase. (Photo: Jakub Hanták, 2023)

The two-story kindergarten is designed for three groups and is complemented by a school sports and event hall with a music rehearsal room and underground parking, providing ample space for children from the kindergarten, students from the adjacent elementary school, and various other groups. Both buildings are designed to be barrier-free. The kindergarten is sunny, cozy, bright, and very well-organized: a central entrance with a covered outdoor area, where at the heart of the building, there is an airy wooden linear staircase illuminated by a skylight (Fig. 19) with a wooden railing (Marboe, 2020).

As in other kindergartens, the teachers and educators in this kindergarten are satisfied with the materials used (7 participants). Lena Moosbrugger says, *"The rooms feel brighter and cozier thanks to the wood. The kindergarten floor feels warmer than any floor made of other materials."* Ursula Kündig says, *"Wood is a regional building material in Vorarlberg, it evokes a good mood, supports creativity and well-being. It is healthy."* Andrea Hänsler-Herr says, *"Children are familiar with the smell and presence of wood because they know it from home, and they associate it with good feelings. Wood calms them and radiates peace."* Regarding criticisms of the architecture, we encountered only the opinion of Bianca Kohler, who claims that the kindergarten becomes very warm in the summer due to the large windows. Exterior shading might help.

RESULTS AND FINDINGS

The kindergartens in this article were selected because they exemplify the design principles of biophilic, restorative environmental and salutogenic design. Using theoretical framework, we explored the positive effects of solid wood material in the physical environment of kindergartens, in connection with Maslow's hierarchy of needs. The research aimed to determine whether the presence of solid wood material could positively influence educational processes in kindergarten settings. Our focus was primarily on the behaviour, attention, and concentration of children, assessed through a questionnaire oriented towards teachers and educators.

Partial survey results from the Vorarlberg region indicate that up to 77% of the 51 respondents, including teachers and educators, believe that the presence of solid wood material in kindergarten spaces positively affects children's psychological well-being. Respondents also expressed their own positive impressions of the material. According to them, wood creates a homely atmosphere, contributes to a pleasant spatial climate, evokes a strong connection with nature, radiates tranquillity and has an overall positive impact. The users also value the scent of wood, which evokes a sense of connection with nature. The response that wood is a living material, evoking nature and creating a warm and pleasant atmosphere, was quite frequent.

Studies supporting the idea that wood can lower blood pressure and pulse (Sakuragawa, Kaneko, Miyazaki, 2008) were known to many teachers from Vorarlberg, reinforcing their belief that wood has a calming effect on children. Lena Moosbrugger says, *"Rooms feel brighter and cozier thanks to wood. The floor in the kindergarten feels warmer than any other flooring material."* Ursula Kündig states, *"Wood is the regional building material in Vorarlberg, evoking a good mood and supporting creativity and well-being. It is healthy."* Andrea Hänsler-Herr mentions that *"Children are familiar with the scent of wood and its presence because they know it from home; they associate it with positive feelings. Wood calms them and radiates peace."*

When asked whether teachers believed that children attending wooden kindergartens felt safer, 65% of respondents answered positively. This perception is related to the ecological sustainability of wooden structures, which are seen as a more responsible and ecologically friendly alternative to traditional building materials because wood is a renewable resource. Children growing up in such an environment may become more aware of environmental protection, sustainability, and related issues,

contributing to building a better and safer future. In connection with the negative aspects of using solid wood in kindergarten interiors, some respondents expressed concerns that children could get hurt on wood splinters or deeper knots. Therefore, it is crucial for wooden walls to be sufficiently smooth and treated to minimize the risk of injury.

Some respondents mentioned that wooden floors cannot be cleaned with water, and their maintenance is very difficult and complicated. They would prefer a more easily maintainable flooring option. There was also a reservation regarding the non-covered exterior terrace floor, which is very slippery, and from the perspective of safety and functionality, it definitely needs a different solution. The safety of children should be a priority, and therefore, it would be appropriate to consider a solution that eliminates the risk of a child slipping, falling, or even injuring themselves. One of the options is the application of anti-slip treatment for wooden materials or an impermeable covering for the terrace.

Partial results further indicate that as many as 69% of surveyed teachers and educators feel more comfortable in their current workplace than in their previous ones. Alexandra Zambanini from Kindergarten Muntlix states, *"Wood positively influences children because the spatial climate has pleasant qualities. I can personally confirm that wood has a calming effect on me, and children feel good in the kindergarten, making it easier for me to work with them. Thanks to the hygroscopic properties of wood, there is a better spatial climate in the wooden structure of the kindergarten, which enhances this feeling. Light wood, in combination with windows, creates a pleasant atmosphere that has a positive and pleasant impact on people."* Manuel Reis says, *"As a friend of wood, I feel good in this environment."*

According to 61% of respondents, the presence of massive wooden material calms children, which is one of the conditions for concentration. Wood provides a pleasant tactile experience due to its natural texture. The contact interaction between wood and a child can be both calming and stimulating, which can increase their attentiveness and concentration. In the study (Zingerle, Beikircher, Philippe, Flach, 2015) conducted by the Institute of Construction and Material Sciences at the University of Innsbruck, participants indicated that natural materials (including wood) have a positive impact on performance and recovery abilities. A doctoral thesis (Fell, 2010) at the University of British Columbia in Vancouver examined the extent to which wood-furnished rooms have a calming effect on individuals. Skin conductivity in the room with wooden elements was lower, and participants experienced a decrease in blood pressure and heart rate. Wood has a calming effect on humans.

The question of better concentration of children interacting with solid wood is suitable for further research and hypotheses within the context of the author's dissertation. In relation to a case study from the Vorarlberg region, Cornelia Mennel from Kindergarten Wallenmahd expressed her thoughts regarding concentration: *"Wood increases children's interest and curiosity. They ask why wood has a scent, which contributes to their language development."* Elke Schatzmann from Kindergarten Altenstadt believes, *"I think wood has a positive impact on the body and psyche, improves the air, and creates a pleasant feeling. I even believe that wood positively influences the concentration of children because it calms them."* Franziska Hammerer adds, *"Thanks to wood, we feel closer to nature, and there is better air quality and therefore a better spatial climate."*

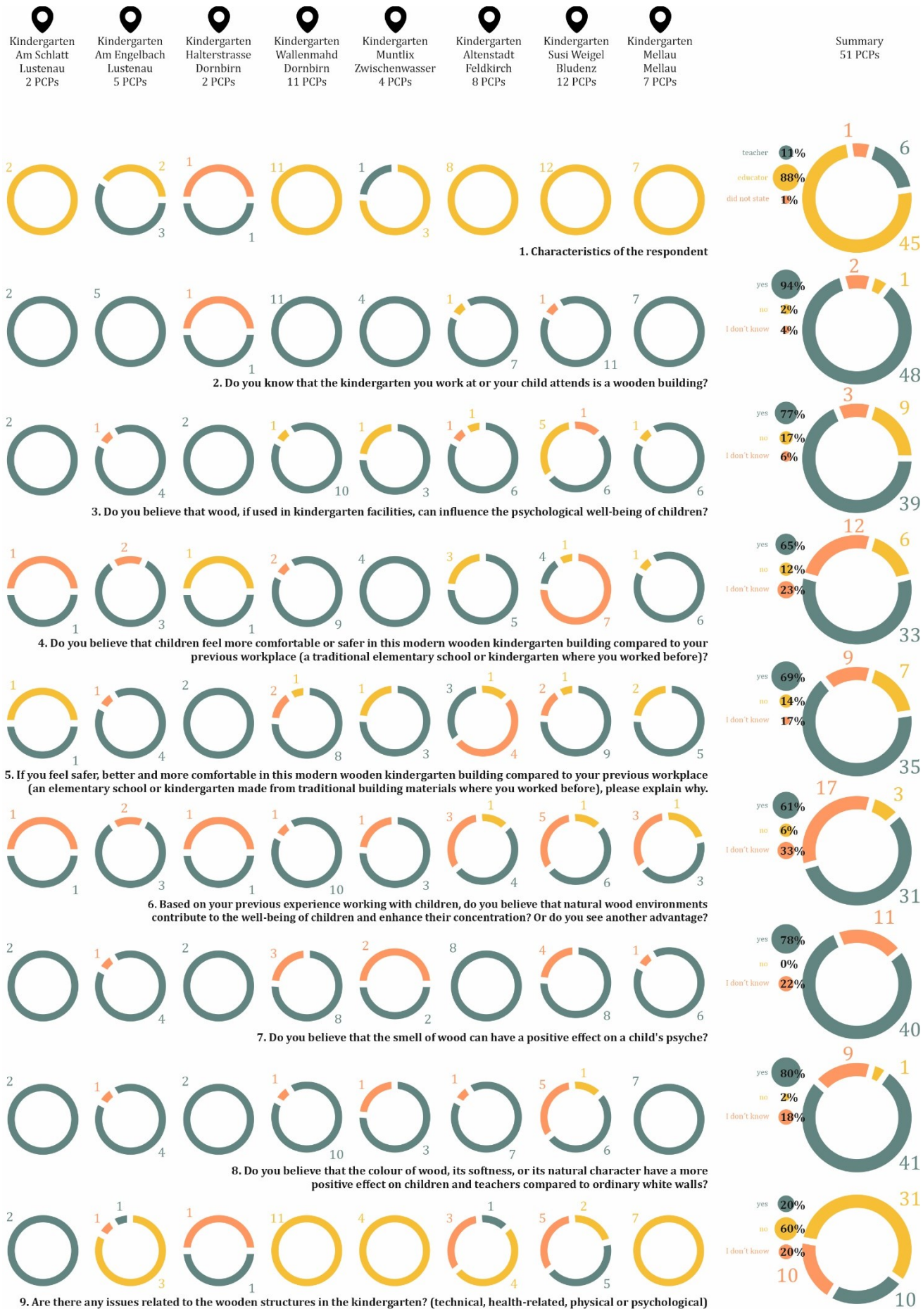
Partial results from the survey indicate that as many as 78% of respondents believe that the smell of wood has a positive impact on the psyche. The aroma can stimulate the senses, and a pleasant and natural wood scent can help reduce anxiety and stress, creating a sense of relaxation and peace. Children may perceive this scent as safe and calming, which helps them feel better. It may even have emotional significance for them. Growing up in an environment where the smell of wood is present can create positive associations and memories for children in the future. Cornelia Mennel from Kindergarten Wallenmahd states, *"Essential oils in wood have a positive impact on people, which is why pine cushions and oils are currently experiencing such a boom."* Maria Stemer adds, *"Thanks to the warm colour of wood and soft surfaces, it is an ideal material in schools, creating good acoustics. When the kindergarten was built, there was the smell of wood, but it's not the same anymore."* Tereza Ruetz from Kindergarten Susi Weigel says, *"The scent of wood makes a person feel better and safer, while with concrete, it is quite the opposite. As the wooden construction has a pleasant effect on me, I also feel a sense of security. I have not observed a significant impact on children's concentration. Strongly scented wood (like pine) has a calming effect and can bring peace to children during their day."*

As many as 80% of respondents are convinced that because of wood's colour, texture, smell, and natural patterns, construction elements made of wood, are a better choice and have a more positive impact on children and teachers than plain white walls. The survey shows that teachers and educators believe that solid wooden walls are a better choice than ordinary white plastered ones. This assertion is consistent with the study (Tsunetsugu, Miyazaki, Sato, 2007) conducted by the Department of Wood Engineering, Forestry, and Forest Products at the University of Tsukuba (Japan), where authors set up three rooms with different percentages of wood (0%, 45% and 90%). The room without wood was considered artificial, while rooms with varying amounts of wood were perceived as pleasant up to a certain wood content.

Participants evaluated the room with 45% wood as the most peaceful and relaxing. There was a significant decrease in blood pressure and a notable increase in heart rate. In our conducted research, Manon Starcevic states: *"Concrete and raw walls are unpleasant, repulsive, and sound spreads on them."* Janine Gerold says, *"Pine wood is good for health, and the presence of wood creates a pleasant and warm atmosphere."* Petra Haon adds, *"Wood is a material from nature, and nature is good for the psyche."* Jasmin Ebner speaks very positively about wood: *"Wood is warm, and being in its presence feels pleasant. It is friendly and visually appealing. I love its natural, non-chemical scent."*

Only 30% of respondents encountered negative associations related to wood as a material. Teachers and educators from Kindergarten Susi Weigel complained about headaches, likely due to ineffective ventilation in the building. They would welcome more adjustable windows. From an architectural perspective, they would prefer smaller corridors and larger classrooms and they have noticed ventilation issues in case of larger groups. Tereza Ruetz from Kindergarten Susi Weigel elaborates on the issue: *"When combining breathable wood and absorptive concrete, frequent headaches occur. More efficient air exchange or more operable windows in all rooms would be helpful."* Solid wood is also considered somewhat risky, as its surface can produce splinters, posing a risk for young children. They would also appreciate a different type of flooring that requires less intensive maintenance. A more detailed evaluation of the questionnaire is provided in Tab. 2.

Tab. 2. Graphic interpretation of the obtained results from Vorarlberg, Austria. Legend: green – teacher / yes, yellow – educator / no, orange – did not state / I do not know. Note: PCPs stands for participants. (Source: Authors, 2023)



DISCUSSION AND CONCLUSION

When examining and evaluating subjective feelings (soft data), it is important to realize that such data can lead to bias. Subjective data can be influenced by personal opinions, emotions, suggestion, and respondent tendencies, which can impact the interpretation of final conclusions. In an effort to minimize potential bias, we compared certain assertions with objective data, studies or statistics (hard data) to achieve a comprehensive view and reliability of the results. In the scope of our conducted research, we have observed certain indications suggesting that the presence of wood can influence children's concentration, which we find to be one of the most significant findings. According to 61% of respondents, the presence of solid wood material calms children, which is one of the conditions for concentration and enhances their attention. We want to test and confirm this hypothesis through thorough research on how wood affects children's focus and attention when learning. The case study highlights the importance of studying the impact of wood on children's concentration levels regarding their attentiveness to the presented educational content. These findings serve as a compelling argument for engaging in follow-up research to achieve a more comprehensive understanding of this matter.

The questionnaire survey conducted in Vorarlberg, Austria, suggests that the presence of solid wood in the physical environment of kindergarten interiors has a positive impact on children, teachers, and educators. Wood also has a calming effect, creates a pleasant atmosphere and improves the mental well-being of children. The smell of wood is familiar to children and evokes a sense of security, contributing to their comfort and concentration. Additionally, the presence of wood can promote environmental sustainability and raise children's awareness of nature conservation. However, it is essential to consider potential dangers associated with wood usage, such as the risk of splinters forming on untreated wood, which could pose a risk of injury to children. It is crucial to ensure that the environment is always safe for children and to take into account the demanding nature of wood maintenance. Despite these challenges, the advantages of using wood outweigh the disadvantages. Wood has a positive impact on children's mental well-being, enhances their concentration, and creates a stimulating and friendly environment for them. Nevertheless, it is necessary to consider not only its aesthetic and natural properties but also to ensure safety and appropriate maintenance. The use of solid wood elements in construction, architecture and design can help alleviate feelings of anxiety and stress, improve mood, comfort, and promote inclusive education.

Due to the language barrier and the absence of an interpreter, it was not possible to conduct the research using oral interviews, and for this reason, the study was only directed at educators and caretakers rather than children. However, it is crucial to continue the research of this issue and conduct further studies to refine the results and confirm the effect of wood on educational processes in kindergartens. The research could also compare wooden and non-wooden interiors in kindergartens to better understand differences in behaviour, performance and feeling of well-being among children. Studies could also examine the effects of different types of wood. The results of these studies could serve as a basis for adapting and optimizing kindergartens to better meet the needs of children and support their growth, learning and development.

The timber constructions of kindergartens included in this study stem from a long tradition of regional building materials, which has a deep-rooted history in Bregenzerwald (region in the Austrian state of Vorarlberg). However, it is not only about tradition, it is also about climate protection. In Vorarlberg, public buildings are required to meet a certain level of sustainability. This mechanism is documented through building certifications with varying ratings that result in assigned point values, determining the eligibility for financial subsidies (Gruber, 2019). The Austrian federal government plans to support timber construction as a climate protection measure on the path to climate neutrality by 2040, as stated in their governmental program. Notably, there is significant future potential in multi-story residential buildings and public structures (Giselbrecht, 2020).

The architecture of kindergartens in Vorarlberg serves as an excellent reference example for the creation of new school projects that, through the use of natural materials such as solid wood, could provide a stimulating and safe environment for children in the context of the New European Bauhaus initiative (European Union, 2023). The results of studies on the impact of wood in kindergarten interiors, together with this initiative, could serve as a strong argument supporting the implementation of renewable materials like wood, in line with the principles of biophilic, restorative environmental and salutogenic design. This philosophy could have an impact on the educational sector in the future and contribute to the creation of modern, innovative, and sustainable educational institutions for children across the entire European continent.

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