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# Editorial

**Zuzana Čerešňová**

The topic of this special issue of Architecture Papers of the Faculty of Architecture and Design STU (ALFA) is focused on Design for All research in the field of human-centred design, architecture and urban planning that accepts the diversity of people, their different needs and requirements in the built environment. The Design for All methodology is based on the analysis of human needs and aspirations and requires the involvement of users in the participatory design process. This special issue aims to present and discuss a multidisciplinary design methodology that implements knowledge from social, psychological and neuroscience fields and information technology into architectural, urban and design work. Attention is paid to the psycho-social aspects of the environment and the study of the environment's impact on people and their health and well-being. In connection with human-centred design approach, an expanded understanding of the attributes of universally accessible environment is also applied. This includes physical, sensory and information accessibility, visitability, adaptability and flexibility of the environment for a wide range of people to ensure an inclusive environment.

The challenge for architects, designers and urban planners is to create an environment that is aesthetically appealing and at the same time responds to the functional and psycho-social needs of people. The question is how architects can improve the built environment for the well-being of all people. The focus is on creating an environment that is friendly, accessible, safe, healthy, and satisfying the requirements of a wide range of people. The recent initiative of the New European Bauhaus (NEB) spans across various disciplines to come up with tangible, sustainable, beautiful and inclusive solutions improving our daily lives. NEB strives to give citizens an active role in shaping their environment and draws on cultural and urban innovation to build a sustainable, inclusive and resilient society.

The variety of article topics in this issue reflects the broad spectrum of the Design for All methodology, which is not only focused on creating an accessible built environment for all people, but also includes new achievements in the field of digital technologies and robotics to maximize the inclusiveness of the environment.

The article *Using a digital participatory approach to facilitate inclusivity in Jordanian heritage Sites: Stakeholders' requirements and a proposed system* by Aseel Aljaafreh, Vanja Garaj, and Youngok Choi presents an exploratory quantitative study focused on identifying barriers affecting the implementation of inclusive approach in historical sites and defining challenges of digitally inclusive applications. Based on the study results authors propose a unique framework for remotely analysing target users within an immersive environment, which emphasizes the importance of user involvement in designing accessible and enriching tourism experiences. The combination of social engagement engines and immersive technologies (virtual and augmented reality), holds great potential for the development of tourism industry.

Likewise, new technologies and challenges are presented also in the article *Universal design and social care: Assistive robots as other users of the built environment*? by Lea Rollová, Peter Hubinský, and Natália Bošková Filová. The authors investigate the spatial requirements of people and robots and present the results of a simulation using Assistive and Butler Robots in a housing facility, where a social care is to be provided in the future with the help of robots. Manoeuvring of people in a wheelchair and robots is simulated in a floorplan of the chosen model project of a family type house. The paper concludes with several recommendations for the creation of residential buildings that support the symbiosis of humans and robots in an accessible environment.

Innovative health care institutions that pioneered social inclusion of patients through proper education and adaptable architecture are analysed in the article *Architecture of healthcare and social inclusion in interwar Czecho-slovakia: Pezinok Psychiatric Institute and the Masaryk Institute for Young People with Intellectual and Physical Disabilities in Bratislava* by Matúš Kiaček. It was believed that elementary education and practical skills would socialise patients, adapt them to general society, and decrease their dependence on the government and their relatives. The author highlights the importance of adapting architecture to the needs of people with disabilities, while simultaneously not creating a special environment with specific features only for them that would lead these people to feel stigmatised and segregated.

The connection between the quality of the urban structure of residential areas and residents' mental health is studied in the article *Mental health as determining factor of urban district's character: Case study Bratislava – the Pentagon* by Barbora Šimkovičová and Katarína Smatanová. A high incidence of drug addiction, as a mental disorder, in the residential area called Pentagon stigmatises the whole urban district, reducing the residents' quality of life significantly over the years. The authors proved in their study that the mental health status of the residents has an essential impact on the development of urban neighbourhoods and vice-versa. They have detected a number of environmental stressors that are present in the built structure.

The authors Jakub Hanták and Danica Končeková raise questions about how architectural and design thinking can contribute to the promotion of inclusive children's education. Their article *Positive effects of wood in Vorarlberg's (Austria) timber kindergartens* highlights the impact of wood materials in the interiors of preschool facilities, their positive influence on children's cognitive abilities, development and well-being. The authors prove that interiors with exposed wood can support social interaction and playful learning of children. The results of this study can present a strong argument for the support of the New European Bauhaus initiative, advocating for the implementation of renewable materials in accordance with the principles of biophilic, restorative, inclusive, and salutogenic design in practice.

This spectrum of articles shows that the Design for All methodology provides great inspiration to architects, urban planners and designers on how to improve the quality of well-being in the built environment.

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# Using a digital participatory approach to facilitate inclusivity in Jordanian heritage sites: Stakeholders' requirements and a proposed system

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**Abstract:** The combination of social engagement engines and immersive technologies, such as virtual reality (VR), augmented reality (AR), and digital twins holds great potential for the development of tourism industry during the designing and planning stages. When introduced to experts, this innovative approach allows us to advance creative solutions while keeping the community engaged and enhancing the decision-making process. Virtual designing and planning processes can significantly transform the workflows of professionals and promote inclusive practices in all Jordanian archaeological and heritage sites, particularly those involved in the "Accessible Tourism" project. This article presents an exploratory quantitative study conducted through a comprehensive literature review and participatory interviews. The study involved 23 participants from the "Accessible Tourism" project. It focused on identifying professionals' barriers affecting the application of inclusivity in historical sites. Additionally, the study defined challenges and requirements to determine digitally inclusive applications. The study results highlighted the challenges faced by stakeholders and experts in developing inclusivity in built heritage sites in Jordan, such as interdepartmental communication, historic preservation constraints, and comprehension of accessibility codes. It also addressed the difficulties in engaging users with disabilities or marginalized communities in developing inclusive facilities. Based on these findings, a unique framework for remotely analysing target users within an immersive environment is proposed. This framework has been developed in collaboration with key stakeholders and set the stage for further research and collaboration. Future research should emphasize the importance of inclusive practices and user involvement in designing accessible and enriching tourism experiences at Jordan's heritage sites.

**Keywords:** participatory approach, inclusive design, immersive technology, community engagement, built heritage sites

## INTRODUCTION

Built heritage refers to architecturally and historically significant structures, monuments, and buildings, it is a non-renewable and irreplaceable resource, but it is also susceptible to alteration (Tan, Ti, 2020; Azmi, Ali, Ahmad, 2020). In Jordan, over 20,000 documented archaeological sites are dispersed (Al Adarbeh, Haron, 2018), on the other hand, 13.2% of the population has severe disabilities, and out of those, 74% suffer from permanent ones (Thompson, 2018). Introducing inclusivity in built heritage can promote various positive outcomes, including social cohesion and cultural understanding and appreciation, equal opportunities, empowerment and representation, and economic benefits (Lewis, Arthurs, Berker, Bishop, Louis, Slack, Stenning, Thomas, Thomas, 2018), which means that architects and planners need to design places that take into consideration the life cycle of people with disabilities, senior tourists, those with temporary constraints, and people who are traveling with children (Darcy, McKercher, Schweinsberg, 2020; Shahzalal, Elgammal, 2022).

Recently, the Jordanian Ministry of Tourism and Antiquities has established the "Accessible Tourism" project to comply with legislation and encourage community and visitor inclusion. Nevertheless, inclusion in tourist design demands more than only responding to the demands of people with disabilities. This requires a grasp of their way of life, the dynamics of their social environment, as well as their behaviour in a variety of different circumstances. According to Zallio and Clarkson (2021), "Inclusive design" is a method that "defines accessibility" and *"seeks to design broadly a product or environment so that as many people as possible are able to use it."* Inclusive design approaches in cultural and historical sites prioritize authenticity, integrity, identifiability, readability, and sustainability. The objective is to maximize preservation with minimal intervention, incorporating diversity and social justice considerations.

Digital technologies have opened up opportunities for a more inclusive approach to cultural heritage, incorporating diverse perspectives and voices. Institutions must adapt quickly and transform their practices, using digital technology for recording, understanding and communication. Research on digital technology in the cultural-historical sector should focus on encouraging discussion (Jameson, 2022), engaging stakeholders (Spadaro, Pirlone, Bruno, Saba, Poggio, Bruzzone, 2023), and involving the community in heritage dialogues (Hasan, Chowdhury, Wakil,

2022). The transition from site visitors to heritage users is crucial, and heritage professionals must adapt to this transformation. A study of Jordanian stakeholders and professionals involved in the "Accessible Tourism" project is necessary to understand challenges and concerns in architectural design, planning, and implementing inclusive design principles in built heritage sites.

## RECENT DEVELOPMENTS AND PRACTICES IN THE FIELD OF DIGITALLY MEDIATED CULTURAL HERITAGE PROJECTS

Digital technologies have significantly impacted the integration of cultural heritage sites, revolutionizing the way we experience and interact with the past. These technologies, such as 3D photogrammetry and immersive techniques, are applied across various disciplines, including architectural and urban environments, archaeological and cultural heritage sites, building and site monitoring, mapping, and model making (Di Stefano, Chiappini, Gorreja, Balestra, Pierdicca, 2021; Cheng, Ch'ng, 2022). 3D photogrammetry is widely used in digital mapping (Hatzopoulos, Stefanakis, Georgopoulos, Tapinaki, Pantelis, Liritzis, 2017), heritage display (Montusiewicz, Barszcz, Korga, 2022), building ontology preservation (Cheng, Ch'ng, 2022), repair (Shabani, Skamantzari, Tapinaki, Georgopoulos, Plevris, Kioumarsi, 2022), structure precision measurement (Barrile, Bernardo, Bilotta, 2022), archiving (Poloprutský, Frommeltová, Münzberger, Sedlická, 2022), digital basic database construction (Zhang, Zhi, Xu, Han, 2022), industrial reverse engineering (Laroche, 2022), virtual reality (Bevilacqua, Russo, Giordano, Spallone, 2022), and other fields.

However, preservation, design development, and built heritage interventions are complex and cross-disciplinary processes (Besana, 2019). Collaborative methodologies leveraging 3D photogrammetry technology have demonstrated enhanced adaptability, enabling their application across a diverse spectrum of architectural heritage. The integration of 3D photogrammetry, 3S technology (Zhang, Zhi, Xu, Han, 2022), 3D virtual reality (Bevilacqua, Russo, Giordano, Spallone, 2022), 3D printing (Yu, 2020), and big data analytics (Wallace, Poulopoulos, Antoniou, López-Nores, 2023) has enabled flexible attainment of multiple goals, including digital preservation, interactive display functionalities, virtual restoration, and reconstruction methods, safeguarding authenticity and integrity, promoting suitability, optimizing sustainable heritage environments and facilitation of community involvement.

Digital technologies have also opened up new possibilities for community engagement in the heritage sector, improving opportunities for dissemination and access while establishing frameworks that facilitate grassroots involvement (Mattone, Frullo, 2022; Khan, Huda, 2023). Cultural institutions have adopted participatory design approaches to improve audience engagement and foster conversations with visitors. For example, cultural institutions have used participatory design methods to create interactive experiences for exhibition spaces (Smith, Iversen, 2014) and digitally augmented visitor experiences (Ciolfi, Avram, Maye, Dulake, Marshall, van Dijk, McDermott, 2016). These innovations provide cultural gatekeepers the power to decide what, where, and how to disseminate their own cultural content (Styliaras, Koukopoulos, Lazarinis, 2011). Technology solutions, such as Linked Data (Webster, Nguyen, Beel, Mellish, Wallace, Pan, 2015), crowdsourcing support systems (Bonacchi, Bevan, Keinan-Schoonbaert, Pett, Wexler, 2019), exergaming (Grammatikopoulou, Laraba, Sahbenderoglu, Dimitropoulos, Douka, Grammalidis, 2019), wikis (Giglitto, 2017), and virtual reality (Calil, Fauville, Queiroz, Leo, Newton Mann, Wise-West, Salvatore, Bailenson, 2021), have become increasingly used in community-led cultural heritage initiatives.

The roles of designers and developers in digital technologies are undergoing a transformation, with human-computer interaction now encompassing a broader range of cultural contexts. The emergence of "toolkits" has changed the responsibilities of technical specialists, enabling them to manage and lead digital projects. However, further work is needed to support cultural engagement with specific communities, such as people with disabilities and older individuals. Issues related to community engagement and participation, particularly for individuals with disabilities, include inadequate assessment of users' needs and expectations, incorrect assumptions about participants' digital literacy, and potential community divisions. The empirical study presented in this paper serves as a valuable contribution to filling this research gap by capturing the views and experiences of key stakeholders.

## METHODOLOGY

Participatory qualitative interviews were used to create the presented research. This method transforms the traditional passive questions and answers into interactive, productive sessions. Many scholars, including Schuler, Namioka (1993); Spinuzzi (2005); Simonsen, Robertson (2013), have provided in-depth definitions of the term "participatory design" and its application in the academic community. According to Spinuzzi, participatory design aims to achieve several key objectives. These include involving stakeholders in the innovation process, considering their feedback while developing design ideas, and fostering collaborative efforts to create novel design solutions. The utilization of participatory design has played a crucial role in deepening our understanding of the existing approach to design and development, particularly in enhancing accessibility in historical sites. Moreover, the active involvement of professionals in the design process has a positive impact not only on the design and development stage itself but also on the overall implementation of the workflow.

The research conducted involved all members who participated in the "Accessible Tourism" national project, which comprised 23 members. The participants were interviewed at their workplaces in Amman, Jordan, using a semi-structured interview format. The data were synthesized, coded, and analysed using NVivo software. After interviewing around half of the participants, the analytic codes reached saturation for the research. The final section elaborated on and expanded upon previously covered themes, provided fresh insights into the issues, and shed light on the bigger picture of the situation.

### Participants and procedure

The 23 participants in the national project "Accessible Tourism" were mostly relevant stakeholders and leading experts. The first group of stakeholders included legal affairs actors, technical and development architects and planners, heritage site staff, and project managers. These individuals provided valuable insights into the design and planning approach, preservation regulations, and implementations, as well as valuable input on challenges encountered during pre-implementation. The second group comprised leading experts on accessibility and inclusive design from private or public sector, as shown in Tab. 1.

The semi-structured interviews were conducted in two sessions, each lasting approximately 45 minutes. In the first session, the interviews focused on understanding user design and planning barriers, challenges, and requirements. The second session of the interviews centred on understanding participants' views on using digital technologies in the design and development process. The primary objective was to identify significant nodes and themes from the collected data and validate and integrate the

interview outcome to present an initial system design solution. The data facilitated the recognition of shared everyday obstacles faced by all participants in the "Accessible Tourism" national project and identified participants' positive perspectives, views, and concerns about using digital technologies in the design and development process.

**Tab. 1.** A summary table of all the participants. (Source: Authors, 2023)

| Participants | Role | Segment of expertise |
|---|---|---|
| P01 | Accessibility consultant | Accessibility auditing, Inclusivity research/Regulations development |
| P02 | Accessibility consultant | Accessibility auditing, Inclusivity research/Regulations development |
| P03 | Architect | Architectural Design / Digital Documentation and Visualization |
| P04 | Planner | Design and Planning |
| P05 | Project Manager | Design practice /Project design management |
| P06 | Legal Affairs Actor | Legal affairs and expropriation |
| P07 | Architect | Architectural Design / Digital Documentation and Visualization |
| P08 | Architect | Architectural Design / Digital Documentation and Visualization |
| P09 | Legal Affairs Actor | Legal affairs and expropriation |
| P10 | Project Manager | Engineering and Conservation of Antiquities |
| P11 | Legal Affairs Actor | Legal affairs and expropriation |
| P12 | Accessibility consultant | Accessibility auditing, Inclusivity research/Regulations development |
| P13 | Accessibility consultant | Accessibility auditing, Inclusivity research/Regulations development |
| P14 | Architect | Architectural Design / Digital Documentation and Visualization |
| P15 | Planner | Design and Planning |
| P16 | Accessibility consultant | Accessibility auditing, Inclusivity research/Regulations development |
| P17 | Heritage Site Staff | Cultural Resource Management |
| P18 | Heritage Site Staff | Cultural Resource Management |
| P19 | Project Manager | Design practice, /Project design management |
| P20 | Heritage Site Staff | Cultural Resource Management |
| P21 | Planner | Design and Planning |
| P22 | Project Manager | Design practice, /Project design management |
| P23 | Heritage Site Staff | Cultural Resource Management |

## FINDINGS AND DISCUSSION

### SESSION 1: UNDERSTANDING USER DESIGN AND PLANNING BARRIERS, CHALLENGES, AND REQUIREMENTS

In the initial phase, participants explained the difficulties and challenges faced while designing, planning, and implementing inclusive and accessible tourism. The data was used to identify common daily challenges and role-specific ones.

### Common challenges

Facilitating accessibility and inclusivity in cultural and historical sites posed various common challenges among participants. Data analysis revealed several challenges in adapting effective interdepartmental communication, balancing historical preservation limitations with the need for accessibility modifications, as well as securing funding for such projects. In addition, all participants considered engaging with users, particularly those with disabilities or from marginalized communities, a challenge that can be difficult due to factors like mobility limitations or limited resources. Obtaining diverse perspectives and conducting comprehensive user research, along with involving end-users from the early stages of the project, is important. Professionals need to devote time and resources to user engagement, use accessible communication methods, and adopt a user-centred approach to achieve true accessibility and inclusivity at historic sites.

### Role-specific challenges

1) Legal affairs actors

Legal affairs actors P06, P09, and P11 in heritage site accessibility design faced challenges in navigating complex legal frameworks, adhering to local, national, and international laws, codes, and guidelines, and staying updated with new requirements.

2) Architects

As regards facilitating accessibility projects, architects emphasized that they always need to find creative and sensitive architectural solutions to seamlessly integrate them without detracting from the site's historical value, pre-existing structures, and layouts. As emphasized by Participant P07, *"It is important to acknowledge that not every site lends itself to uniform architectural design solutions or interventions."* Moreover, Participants P03, P08, and P14 highlighted that *"We encounter different physical limitations in each site, such as narrow doorways, uneven terrain, or fragile materials."* Consequently, architects need to possess a comprehensive understanding of architectural history, technical expertise and thorough assessment of the structural conditions and spatial constraints specific to each site. Simultaneously, they must carefully address the needs of all users, including individuals with disabilities or limited mobility, ensuring that the chosen design solution is appropriate and efficient.

3) Planners

Urban planners possess knowledge and expertise in the strategic allocation and arrangement of spaces, site's layout, infrastructure, mixed-use development, public spaces and gathering areas, integration of public transport, and pedestrian-friendly infrastructure. Participants P04 and P15 stated that *"Managing these competing demands can be challenging and may require effective negotiation and compromise."* Therefore, this requires prioritization, trade-off analysis, and finding creative solutions that address these objectives simultaneously. In addition, participants P04, P15, and P21 stated that *"Incorporating inclusive features in archaeological and heritage buildings is a complex task due to the limited physical space and structural limitations"* and *"every time we need to assess the structural integrity of buildings and ensure that the modifications we make comply with safety regulations while preserving the historical fabric of the structure."* Therefore, innovative solutions allowing for timesaving are needed to facilitate more streamlined workflows, enabling professionals to allocate their resources more effectively and focus on developing appropriate solutions that strike a balance between safety, historic preservation, and inclusive design.

4) Heritage site staff

Heritage staff daily manage historical sites, coordinate visitor services, ensure safety, manage budgets, and work with contrac-

tors. In terms of providing accessibility, participants P17, P18, P20, and P23 face challenges in integrating accessibility features while ensuring that the overall visitor experience remains authentic and immersive. Therefore, heritage site staff requires training and education to effectively understand and address the needs of diverse visitors, including individuals with disabilities. As participants P17, P18, and P23 stated, *"Honestly, we need to acquire the necessary knowledge and skills related to accessibility and inclusive practices."* Other participant responses explicated the requirement for a guiding tool to facilitate a more comprehensive design process and augment comprehension of the user's journey, abilities, and desires. Sites management teams stated that *"having an assistance tool that can be uses as a monitoring tool is useful in collecting data on how people move through a site and interact with its features"* (P20 and P23). This tool can help to identify potential barriers to accessibility and inclusion, as well as understand visitors' needs and desires.

5) Project managers

A project manager plays a vital role in leading, coordinating, and overseeing the implementation of accessibility in Jordanian heritage sites. P05 stated that one of the main challenges faced is *"There are still no specific guidelines regarding implementing accessibility to Jordanian heritage sites"* and added *"Each heritage site has unique architectural components and its own preservation regulations."* This lack of comprehensive guidelines challenges individuals and organizations involved in enhancing accessibility in these sites, as they must navigate the process without standardized protocols or frameworks to follow. Furthermore, participants P10, P19, and P22 highlighted another challenge regarding *"monitoring the progress of implementing accessibility interventions and solutions"*, where the challenges are connected with ensuring that the implemented solutions meet the required standards. For this reason, a pre-implementation stage is necessary that includes evaluating proposed solutions with other stakeholders, including the local community and people with disabilities.

6) Accessibility consultants

Inclusive design advisors faced challenges due to differing perspectives and stakeholder engagement. P01, P02, P13, and P16 pointed out that *"Inclusive design requires input from various stakeholders; however, lack of knowledge of stakeholders as to accessibility regulations and guidelines is a major challenge faced during the development process," "We waste much time on explaining accessibility guidelines to the employees, especially during their official meetings"* (P02 and P13). This results in inefficient and less productive work.

## SESSION 2: PARTICIPANTS' VIEWS AND DISCUSSION ON USING DIGITAL TECHNOLOGIES IN THE DESIGN AND DEVELOPMENT PROCESS

During the discussion on digital strategies and immersive technologies' application in inclusive design, participants expressed various perspectives and concerns. Technical architects highlighted the benefits of digital tools, such as 3D modelling and virtual reality, for enhanced visualization of accessibility modifications. Improved remote communication and collaboration were recognized by participants, including technical architects, planners, heritage staff members, and project managers, who could easily share files, track progress, and engage in virtual meetings. Accessible digital platforms with project management features were suggested by accessibility consultants for effective stakeholder collaboration. Digital technologies were also seen as cost and time-efficient, allowing for early issue identification and virtual design testing.

However, concerns were raised by legal affairs actors about balancing accessibility with the preservation of historical integrity, addressing it by establishing comprehensive online archives. Technological barriers and the digital divide that some employees face were also acknowledged, where not all participants may have equal access to or proficiency with digital technologies, thus emphasizing the need for investment in digital infrastructure, workshops, training, and support to ensure inclusivity. Developing mobile applications and optimized websites for easy access to heritage site information was also proposed. Clear guidelines and protocols were recommended to address challenges and ensure that digital interventions align with historical standards.

## PROPOSAL FOR INITIAL DESIGN SOLUTION

The subsequent section introduced an initial system design diagram developed based on existing guidelines, design methods, user feedback, and in-depth discussions. A new workflow was conceptualized, incorporating cutting-edge, user-friendly immersive technologies to address accessibility issues and sustainable interventions in the design and planning process. As depicted in Fig. 1, this workflow involves capturing historical sites through 360-degree photographs or digitizing them into 3D models, making them accessible to a larger audience. It also includes identifying accessibility issues indoors and outdoors, such as pathways, entrances, handrails, signage, seating, and lavatory facilities. Specific instruments will be developed for each mission.

Advanced camera techniques and consumer devices such as iPhone 12 and iPad Pro 2020 enable the capture of 360-degree photographs and the creation of virtual tours. Applications such as "Matterport," "SiteScape," and "Polycam" offer user-friendly scanning and photogrammetry capabilities. The collected data is processed to generate a three-dimensional representation of the site. Once the historical site assets are created, they will be uploaded to an interactive online platform or imported into a virtual reality (VR) application. This allows users to engage in an immersive experience within a digital replica of the site, fostering inclusivity and drawing inspiration from the concept of a Digital Twin (Liu, Fang, Dong, Xu, 2021; Shabani, Skamantzari, Tapinaki, Georgopoulos, Plevris, Kioumarsi, 2022).

The primary phase of this workflow is identifying users' issues and needs, involving online communication and social engagement strategies. Crowdsourcing platforms, online surveys, and interactive platforms supported by 3D virtual models gather information about inclusivity needs and provide an interactive means for the public to experience the site's properties, as shown in Fig. 2. Stakeholders collect feedback, analyse, and develop initial solutions, considering factors such as budget, time allocation, regulations, and historical preservation (Fig. 3). The final phase is improving the final design, where stakeholders present initial ideas to users for input before implementing the design. The goal is to optimize buildings and sites for maximum value and usability, considering accessibility, inclusivity, and user preferences. Continuous engagement with users refines and enhances the final solutions, leading to an improved overall design outcome.

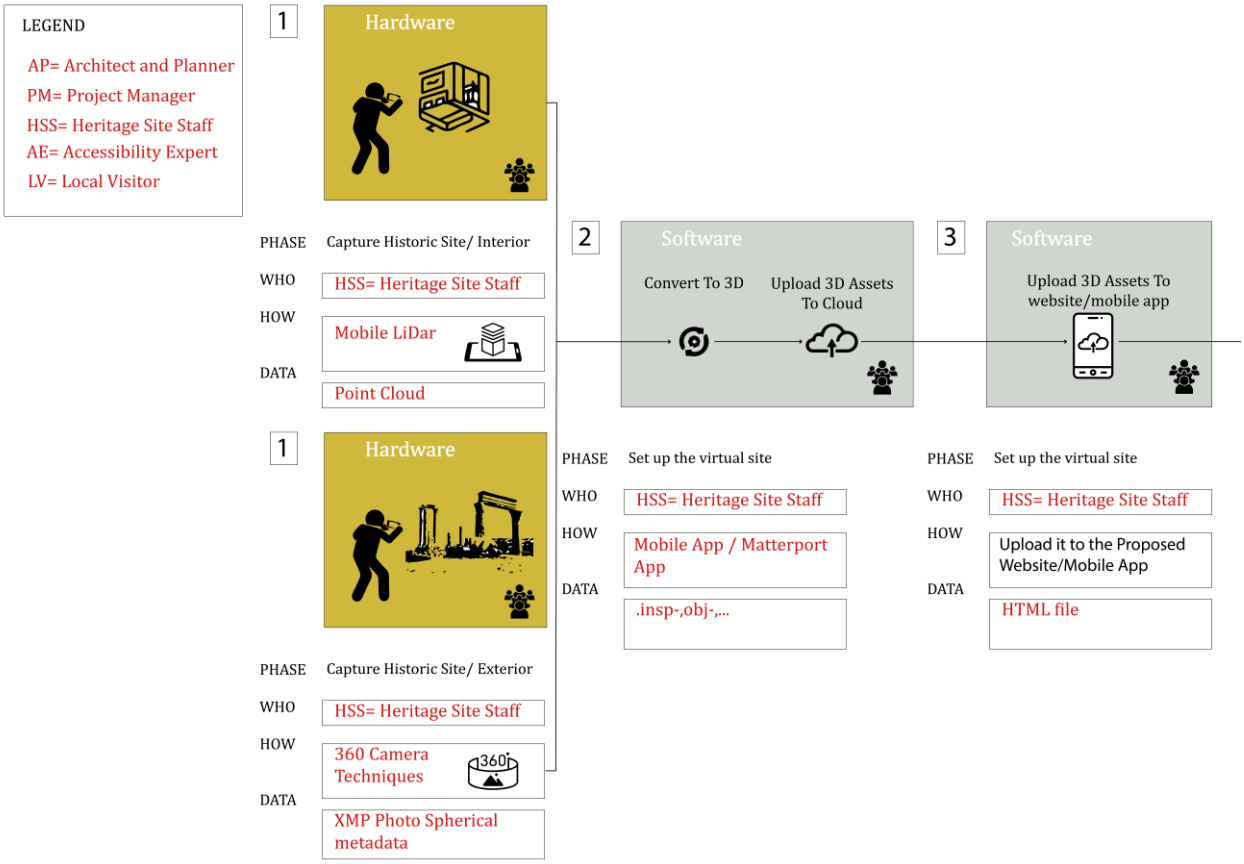


**Fig. 1.** Capture phase. Legend: A/P = Architect and Planner, PM = Project Manager, HSS = Heritage Site Staff, AE = Accessibility Expert and LV = Local Visitor. (Source: Authors, 2023)

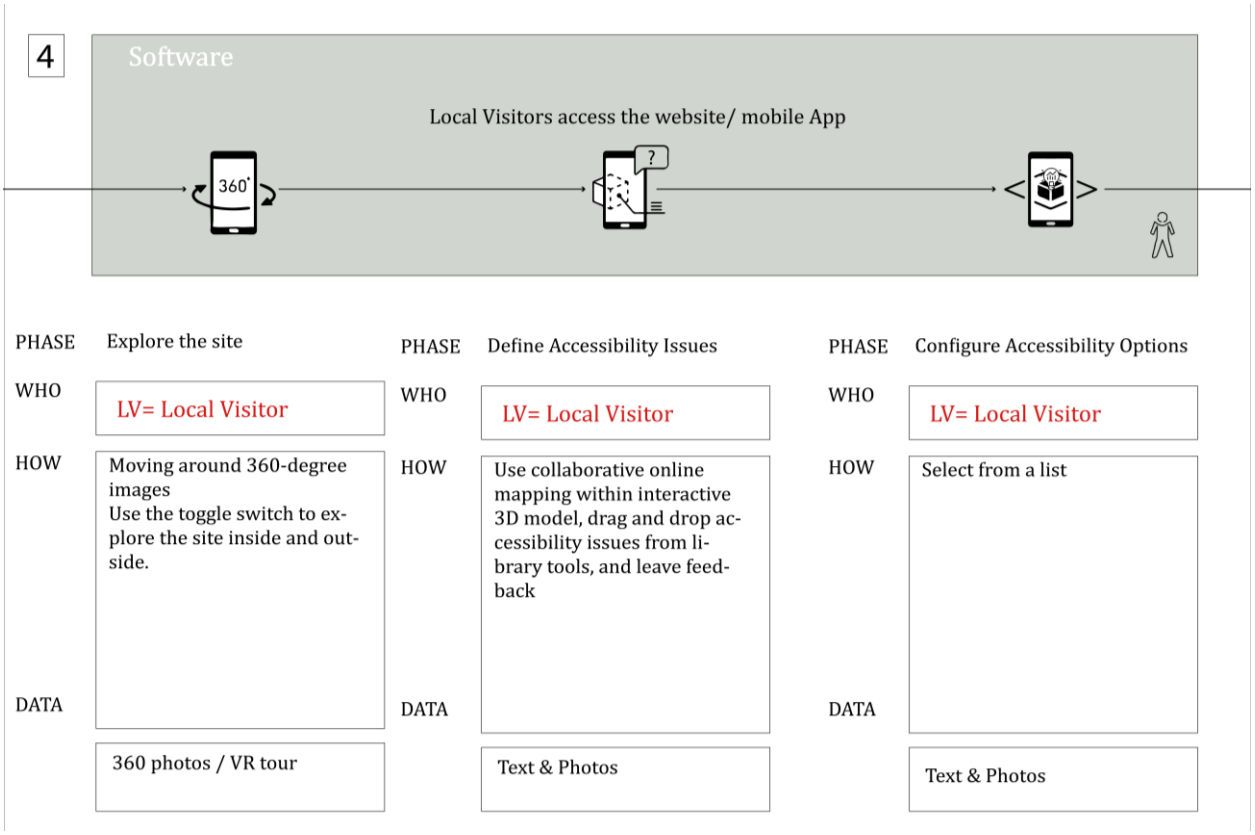


**Fig. 2.** "Explore the Site" and "Identify Users' Issues and Needs" phases. (Source: Authors, 2023)

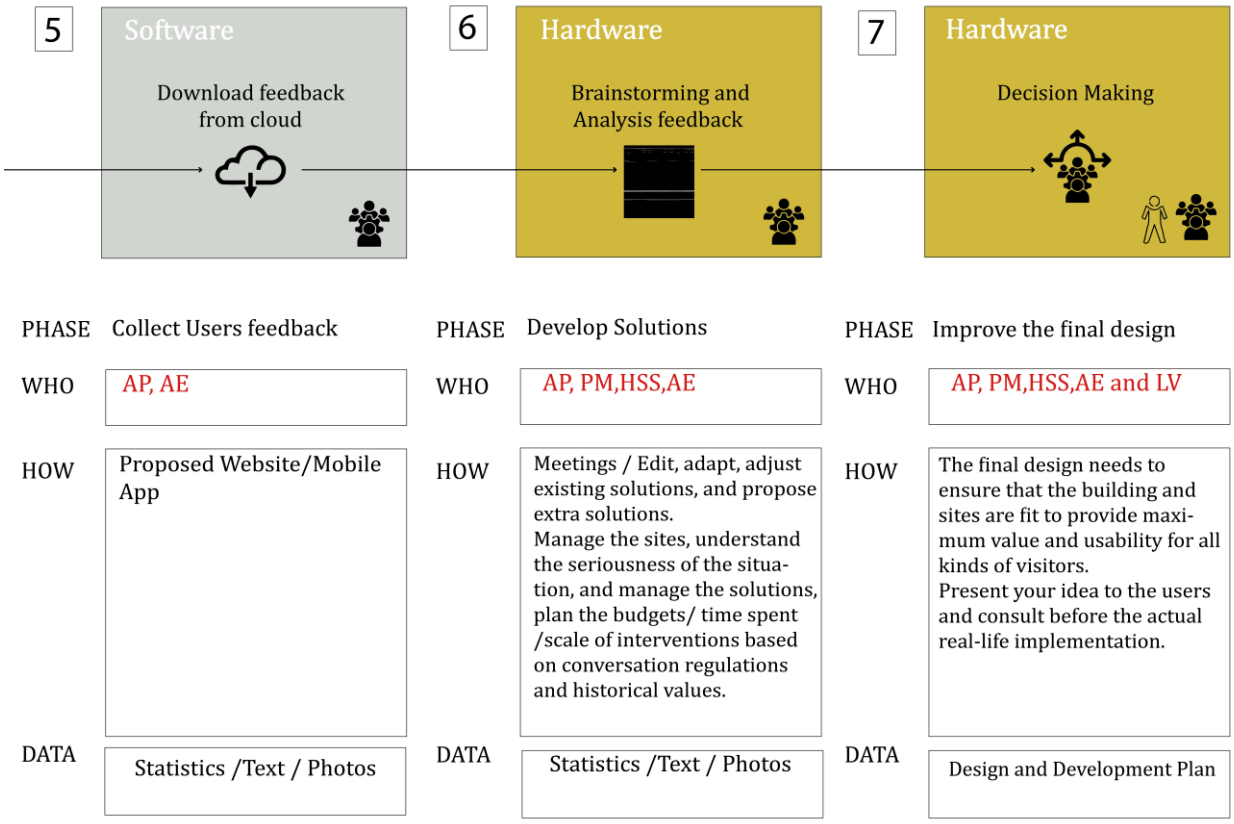


**Fig. 3.** "Collect User Feedback", "Develop Solutions", and "Improve the Final Design" phases. (Source: Authors, 2023)

## CONCLUSION

By conducting a qualitative analysis of interview data gathered from the national project on "Accessible Tourism," this study has successfully identified the primary daily challenges encountered by technical architects, planners, project managers, heritage site staff members, and legal affairs actors during the design, development, and implementation phases. Furthermore, the study has determined the potential advantages associated with the adoption of digital technologies in the design and planning process. Drawing upon the feedback and comments provided by the participants, this article presents a proposed workflow that integrates 3D capturing technology with interactive crowdsourcing platforms. This workflow includes a sub-platform functioning as a 3D viewer throughout the design and planning stages, with a particular emphasis on engaging the local community during the pre-implementation phase. Additionally, the study has collected and discussed the user requirements necessary for developing a first-generation prototype.

This study is a component of a broader PhD research project that aims to investigate the factors, challenges, and potentialities associated with implementing inclusive design principles in historically significant built environments. In the subsequent stages of the project, site surveys and user experience observations will be used to supplement the existing data and conduct a deeper investigation into the characterization of the targeted audiences, taking into account users' diversity from physical, psychological, and social points of view, especially users with disabilities. These studies will complete an understanding of the complex problems associated with promoting accessibility in cultural heritage sites. Following that, the research will expand to encompass the evaluation of existing commercial hardware and software tools. The primary objectives of this extension will be to determine the most suitable application for integration within the initial phase of the workflow and to capture the digital representation of the sites.

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# Universal design and social care: Assistive robots as other users of the built environment?

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**Abstract:** The importance of designing architecture and physical environment using the Universal Design method so that all people have the opportunity to reside and participate in the environment has long been recognised. This design approach is even more important in housing for older adults and people with disabilities. However, even in environments designed according to universal design principles, the assistance of human staff is often necessary. We consider some of the routine and physically demanding activities of caregivers could be possibly replaced by robots. This would offer people who require care a greater degree of independence and relieve the burden on staff to give them more time for activities that robots cannot yet do. Robotics is a discipline covering various aspects of robot design and use. Apparently, numerous robots and robotic devices being developed for the social or healthcare sector, called Assistive Robots, are still in the concept, design or testing phase. However, this may change with the increasing investment in robotics and there is a need to be realistic about their possible use in the near future. Another considered robot type is a Butler or Service Robot which helps with delivering various objects including food or medicine. These types of robots require a barrier-free, accessible space to move around, similar to what people in wheelchairs or bedridden persons need for their movement and transfer. This paper publishes the results of a simulation of Assistive and Butler Robots in an extra-care housing facility, where social services with the help of robots are to be provided in the future. Manoeuvring of people and robots is simulated in a floorplan of the chosen model project of a family type house. Research aims to investigate the robots' spatial requirements in a building project designed in accordance with universal design principles. The paper concludes with several answers to the questions posed and recommendations for the creation of residential buildings that support the symbiosis of humans and robots.

**Keywords:** architecture, built-environment, universal design, assistive robot, butler robot, social care

## INTRODUCTION

Population ageing is a serious problem, as confirmed by the results of all known national and international population projections. The negative impact of population ageing is manifested in almost all areas, especially threatening the sustainability of social and economic systems. From the point of view of public policies aimed at supporting the development of social services, it is not only the indicators of the growing number of older adults in the total population that are crucial, but also their health indicators, which determine their self-sufficiency and independence, or dependence on the help of another person in everyday life. *"According to the current mortality tables, men aged 65+ in Slovakia may live another 15.3 years and women 19.2 years, but men will survive only 3.8 years and women only 4.1 years of this period in good health"* (Ministry of Labour, Social Affairs and Family of the Slovak Republic, 2021, p. 6). The strain on social and health systems requires much more funding, but also an increased number of carers, assistants and nurses, who are in demand in almost every country. Therefore, solutions are being sought to help people in need of care while also relieving the burden on care staff through technological innovations, including robots. Assistive robots can help older adults and people with disabilities to move around, perform daily activities and enjoy their environment (Fasola, Matarić, 2013), even enabling them to remain living in their home environment (Balaguer, Giménez, Jardón, Correal, Martínez, Sabatini, Genovese, 2007), which is in line with the current trend of deinstitutionalisation of social services. The current question is: can robots replace the hard work of carers and caregivers?

The topic of the use of robots in care providing has been the subject of much research for more than 10 years, and several papers have been published in this context (Broekens, Heerink, Rosendal, 2009; Bemelmans, Gelderblom, Jonker, de Witte, 2010; Bemelmans, Gelderblom, Jonker, de Witte, 2012; Prescott, Caleb-Solly, 2017; Cifuentes, Pinto, Céspedes, Múnera, 2020; Andtfolk, Nyholm, Eide, Fagerström, 2022). *"There is growing interest among care providers, charities, and academics in using robotics to improve the quality of care and ease pressure on the social care system"* (Wilson, Kenny, 2018, p. 1). The need to explore the potential of robots has also been declared: *"We know that carers are critical to the increasingly fragile care sector, but being a carer impacts individuals emotionally, mentally, financially and physically. Our discovery phase focussed on the potential for robotic solutions to help address the physical impact of caring"* (Isle of Wight Council, 2018, p. 2). Putting human safety first, it is important to test

the transfer of a dependent human in the context of assistive robots' centre of gravity retention. Several experiments with such robots show effective real-time imitation and dynamic behaviour adaptation (Arduengo, Arduengo, Colomé, Lobo-Prat, Torras, 2021); optimal motion also in relation to the gravitational acceleration is being calculated (Kim, Kim, 2023). However, it is an active area of research and development, and any type of a new assistive robot that carries people must first pass stability tests. When analysing the available literature, we mainly searched for papers where the relationship between assistive robots and the built environment is discussed. An important piece of information is that a barrier-free environment is ideal for a robot, similar to that of older adults or people with various disabilities. Thus, our research aims to deepen the knowledge in the field of accessible environment design, specifically in the universally designed environment of social service facilities.

Today's inaccessible built environments are the result of inattention to the needs of diverse users. The term "architectural disability" (Goldsmith, 1997) probably best describes the relationship between disability and the environment. Barrier environments severely restrict people with disabilities and hinder their inclusion; this is also true for older adults. At the turn of the millennium, a movement emerged in the field of architecture and design that promotes a new way of thinking that focuses on the needs of people, called human-centred design, which has several streams – Universal Design, Design for All, or Age-Friendly Design, among others. In many strategies and international documents, accessible environments are considered essential and one of the conditions for achieving sustainability of social and economic systems.

In the UN Convention on the Rights of Persons with Disabilities (United Nations, 2006, Article 2), *"'Universal design' means the design of products, environments, programmes and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialised design. 'Universal design' shall not exclude assistive devices for particular groups of persons with disabilities where this is needed.*" It is clear from the definition that it is not just about designing for people with disabilities, but designing for "all people". For people with disabilities, but also for older adults with a variety of health impairments, an accessible environment is essential because it enables them to be more independent. It should be noted that the definition of universal design recognises that "assistive devices" may be used for certain groups of people. This means the use of a variety of technological devices and assistive aids that help people with disabilities to "function" in the community with as little dependency as possible (e.g. aids to overcome architectural barriers in the built environment, induction loops for communicating with people with hearing impairments, guiding lines, navigation systems and special software for people with visual impairments, etc.).

Implementing assistive robots is also significant when caring for a person with an infectious disease, as it prevents the spread of infection in comparison to care by human assistants (Holland, Kingston, McCarthy, Armstrong, O'Dwyer, Merz, McConnell, 2021). When caring for people with various diagnoses, the use of different robots providing diverse help needs to be considered. There are for example several assistive robots that have been developed to help people with dementia, providing companionship, safety checks and engagement in activities and events (Ozdemir, Cibulka, Stepankova, Holmerova, 2021; Law, Sutherland, Ahn, MacDonald, Peri, Johanson, Vajsakovic, Kerse, Broadbent, 2019), or a soft robotic glove designed to facilitate home-based rehabilitation for stroke survivors with hand impairment (Polygerinos, Wang, Galloway, Wood, Walsh, 2015), and many other specialised assistive robots. Of course, each diagnosis and also each individual require different approach concerning robots, so every case has to be considered separately.

As mentioned above, today it is also necessary to consider the use of assistive robots helping people with various needs and also butler robots, which could replace some of the activities related to household maintenance, and perform more difficult activities that are currently carried out by personal assistants or carers.

## THE POTENTIAL OF ROBOTS IN SOCIAL CARE BUILDINGS

When investigating the relationship between robots and the built environment, it is necessary to analyse the robots' ability to move in the environment, and also the possible ways of handling various objects, studying the robots' possible actions in the environment in which social services are provided. It is also important to create an infrastructure for locating robots in the indoor environment, recharging them, and ensuring the appropriate type of wireless communication between the robot and the building's infrastructure.

### Different types of robots' movement in the environment

A robot that is designed to assist in loading or carrying loads in cooperation with a human operator will have a different construction from that handling objects by itself and must therefore be equipped with one or two handling hands with a suitable type of gripper capable of grasping the relevant object(s) without damaging them. A big challenge for the robot is mounting or descending stairs or overcoming other vertical obstacles. If the robot moves using wheels, it can be easily deduced that the force required to overcome a step-like obstacle with its height compared to the radius of the wheel increases sharply to infinity when reaching a height equal to the radius of the wheel. At an obstacle height equal to 68% of the wheel radius, the force required to overcome the obstacle is three times the wheel's weight.

We will consider this variant as borderline due to the power limitations of the mobile robot drives. Therefore, we can talk about overcoming step-like obstacles only with a height less than 1/3 of the wheel diameter. Equipping the robot with a suspension chassis (which is not standard for robots intended for indoor environments) or even an active mechanism that lifts the wheel when passing an obstacle, this limit can be slightly increased. For example, a door threshold with a height of 2 centimetres can be insurmountable for a robot with smaller wheels (e.g., swivel wheels in the case of differential chassis). The robot should also overcome small fallen items, cables on the ground, or a wavy carpet. The ground clearance of the chassis can also be a limiting factor, which is, for understandable reasons, limited by the radius of the robot's drive wheels.

Walking chassis with 2, 4, or 6 legs represent the ultimate solution in terms of the ability to overcome obstacles. However, they are more likely to be used in applications outside of urbanised areas and are structurally more complex and, therefore, much more expensive than robots with wheeled chassis. A compromise can be the application of chassis with rubber tracks. However, they can destroy the used floor surfaces, especially during turning manoeuvres. In addition to the limited speed of motion, they also have other disadvantages in indoor spaces. Furthermore, it is necessary to consider that the robot spends a lot of energy when overcoming obstacles, which could be used more efficiently for the tasks for which it is intended. For the use of a robot as a human assistant in a social services building, it is optimal to ensure a completely barrier-free environment. The limited performance of the robot's drives, especially when transporting heavy loads, will also result in a limited ability to drive on an inclined surface. In extreme cases, impaired chassis stability can also play a role, which would be in danger of overturning. Through testing and calculating, we have found that robots can also overcome

barrier-free ramps, implemented for the motion of people in wheelchairs, but again at the expense of higher energy consumption.

Another limitation of the motion of mobile robots in an indoor environment is their ability to manoeuvre in confined spaces. In this sense, the omnidirectional chassis is the best – either based on 3 or 4 standard wheels (while each wheel has a pair of motors, which allow simultaneous turning and driving of individual wheels) or based on 3 or 4 omnidirectional wheels of standard or Swedish type (Mecanum wheels). In the first case, we encounter the problem with the price of the solution due to the necessary number of motors and electronics related to their control, and in the second, the fact that the limited possibility mentioned in the previous paragraph when overcoming step-like obstacles refers to the diameter of small passive rollers located around the circumference of the main wheel.

Chassis with a differential drive without supporting wheels (of the Segway or dicycle type) or with some supporting wheels (often of swivel type) have slightly worse manoeuvrability. The supporting wheels are typically smaller in size, which can cause previously mentioned problems with overcoming step-like obstacles. Bigger wheels could be used for a Segway-type robot, but this type of chassis is not very convenient in terms of energy consumption given the constant need to stabilise the body. Its safety when interacting with people with mobility restrictions is also questionable. Robots based on differential chassis cannot move to the side, and their motion trajectories are composed of circular arcs with any radius – at zero radii, it is rotation in place, and at infinite radius, it is rectilinear motion. The lateral motion must be composed of a sequence – turning in place, moving in the desired direction, and, if necessary, turning to the original orientation. When rotating in place, it is necessary to ensure a free space corresponding to the largest dimension of the robot's footprint.

The car-like, so-called Ackerman chassis has the worst manoeuvrability, which can only move in circular arcs from minimum radius to infinity. Unlike a differential chassis, it cannot turn around its centre. When operating in limited spaces, it requires the implementation of a sequence of several manoeuvres in both directions – exactly in the style of parking manoeuvres of a car. In addition to the above-mentioned aspects, it is necessary to ensure a sufficient wireless data network signal for robots in the entire operating space because a robot must communicate both with the infrastructure of the building (doors, elevators, lights, security systems) and with the higher level computers (which have much higher computing and memory capacity) when solving more complex tasks, coordinating robot's work, during software updates, etc. For specific operations (such as transmission of a larger volume of data, video transmission), it may be necessary to ensure a stable connection with sufficient transmission bandwidth.

### Robot infrastructure in the environment

Another condition for the undisturbed work of assistive mobile robots is the existence of a charging infrastructure. Like a mobile phone or an electric car, a mobile robot has a limited operating time and must be charged when such time expires. There are contact chargers in the style that robotic vacuum cleaners use today, or inductive-type charging can be used. In the second case, the robot can receive by induction the energy within a certain space in which electromagnetic waves of the desired properties are available at sufficient intensity. Where continuous robot availability is required, such charging option can be offered in certain parts of the track along which the robots move most frequently. However, the use of electromagnetic wave charging is not suitable for buildings for human occupancy in view of the anticipated health risks. Another option is to provide a redundant number of robots, some of which are working at a given moment and the rest are being recharged.

Finally, for the application of mobile robots in indoor spaces, it is necessary to ensure the infrastructure for their localization given the absence of a GPS signal inside the building. With today's technological possibilities, this can be ensured either by a system of radio beacons located at the edges of the operating space or by means of optical markers without obstacles visible from the path along which the robots are moving. Typically, such signs are installed on the ceiling or on walls at a greater height, where there is no risk of overlapping with parts of the interior, their pollution, or other damage. For the navigation of robots based on visual systems, sufficient lighting is also necessary, which can be ensured by existing lighting remotely turned on by the robot itself. Alternatively, when working in dark spaces, it is possible to use infrared vision with illumination by its own source of infrared radiation on the robot.

In human-robot communication, various ways are possible, e.g., voice commands and hand gestures. If these are repetitive and well-definable actions (help when getting out of bed, help when walking to the toilet, to common areas, etc.), simple voice communication specifying the trip's destination or the required action would be sufficient. With non-standard requests, it would be possible to combine this type of communication with hand gestures when the operator can call the robot to them, give commands for different types of motions, and the like.

## RESEARCH MATERIALS AND METHODS

A team of experts in Universal Design and Robotics from the Slovak University of Technology in Bratislava, Slovakia, investigated whether it is possible to reconcile the demands of humans and robots in the built environment and whether the environment designed according to the preferred Universal Design method would be suitable for the functioning of Assisted Robots. The following research question was hypothesised: Can a building that is designed according to Universal Design principles be suitable for Assistive Robots?

For the purposes of the investigation, a building known as supported housing was selected, in which the social service is to be provided. The selected model project Type B – Family type house (Rollová, Filová, 2022) is one of 20 model architectural studies of buildings suitable for providing community-based services, designed at the Faculty of Architecture and Design of the Slovak Technical University in Bratislava, Slovakia. The catalogue of architectural studies was prepared for investment purposes within the framework of the Recovery and Resilience Plan of Slovakia, Component 13 – Affordable and quality long-term social and health care, commissioned by the Ministry of Labour, Social Affairs and Family of the Slovak Republic. All model designs of buildings for the provision of community-based social services take into account the basic principles of Universal Design and the requirements of the European standard EN 17210:2021 Accessibility and usability of the built environment – Functional requirements.

The selected model building, Type B – Family type house, is an adaptable house with a capacity of 4 to 12 inhabitants, depending on the needs of the service provider, location or size of the plot. This building consists of specialised residential placements that provide ongoing assistance and access to as-needed specialised therapies or treatments. The modular house project offers 5 size variants of the objects, namely XS, S, M, L, and XL with alterations of both pitched and flat roof, as can be seen in Fig. 1. We chose the type L for this study because it shows two types of apartments

and two floors, so it presents majority of aspects of the proposed design. The selected model project is located on a very narrow plot of land, which is typical for the Slovak rural environment. The width of the plot in this case was less than 14 metres. The architectural design is shown in Fig. 2.

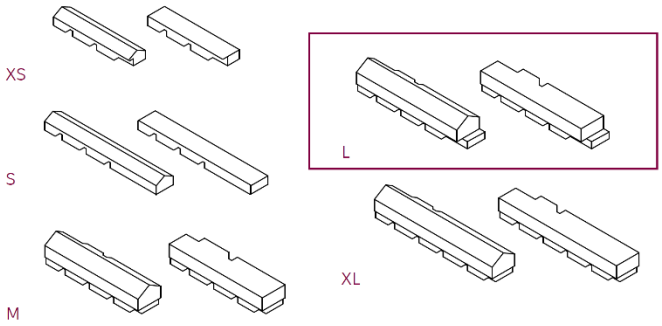


**Fig. 1.** Size variants of the model building – Type B – Family type house. (Source: Rollová, Bošková Filová, 2022)

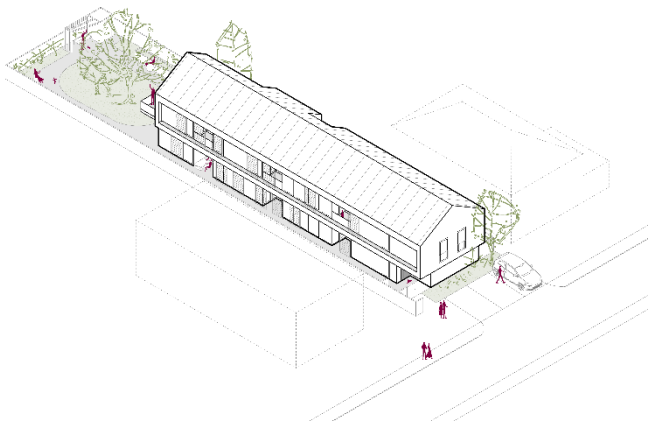

**Fig. 2.** Axonometric view of the model building – Type B – Family type house and its surroundings. (Source: Rollová, Bošková Filová, 2022)

The rooms in the large flat on the left can be single or double, they can be equipped and arranged in different ways according to the needs and wishes of the recipients, they are also suitable for the placement of adjustable beds accessible from three sides. The advantage is that the rooms can be merged and divided at any time and according to the needs without difficult structural modifications by means of a removable (non-masonry) partition. The bathrooms are large enough to allow for showering or bathing of persons in a lying position, or to leave enough space for a washing machine or other necessary equipment.

**Robot manoeuvring in the house**

In the premises of the selected model project Type B, size "L", the movement and functioning of assistive and butler robots was simulated. Our research investigated the functioning of robots in the selected model building, which, together with digital assistants of other kinds, could also provide people with some forms of social care support. We analysed the demands and needs of the robotic devices in performance, and the analysis was carried out using the "Pre-Occupancy Evaluation" method to evaluate a design prior to construction by simulating user behaviour or movement directly in the drawings. This helps verify the functioning of the existing design solution and the need for subsequent modifications to the design. In particular, the spatial requirements of the robots were verified, and it was investigated whether the layouts, room sizes and placement of built-in elements (e.g. in the bathroom) designed according to universal design principles were suitable for the movement of robots. Furthermore, it was examined whether the spaces are large enough for a person in a wheelchair and the assistive robots to function in parallel in each room under consideration. Appropriate placements of charging spots for both assistive and butler robots were also studied. Two selected robot models were researched, whose dimensions and the method of movement were taken into consideration during the investigation:

(1) Assistive Robot "RIBA II", short for Robot for Interactive Body Assistance, which was developed by the state research centre RIKEN (RIKEN, 2021) and Tokai Rubber Industries. RIBA will assist the care receiver in carrying or lifting the person or patient. For our research, the platform size (60 cm wide, 85 cm deep) and the method of locomotion on an omnidirectional wheeled chassis with a tall body (140 cm) and 2 arms are relevant (when arms are folded, the robot is 75 cm wide). The RIBA motor is quiet and thanks to the omnidirectional wheels it can move even in narrow spaces. Other features of the robot include voice and face recognition, as well as the ability to respond to voice commands or recognize co-workers and their location.

(2) Butler Robot "RELAY+S", a service robot, which was developed by Savioke, a Silicon Valley startup. Relay+S is one of 3 different payload configurations of the RELAY+ robot. We chose the Relay+S model, which contains open shelves that can be configured according to the customer's needs. The user interface communicates transparently by always disclosing robot activities. This is achieved through simple messages displayed on its screen and iconic eyes, which are meant to evoke empathy without overestimating its intelligence (Mucchiani, Sharma, Johnson, Sefcik, Vivio, Huang, Cacchione, Johnson, Rai, Canoso, Lau, Yimat, 2017). The robot can press a button to open a door, summon a lift, and so on which does not require investment in electronic communication with control units of these elements (Oitzman, 2021). The robot is on a circular omnidirectional chassis with a diameter of 51 cm.

These two robots are illustrated in Fig. 3.

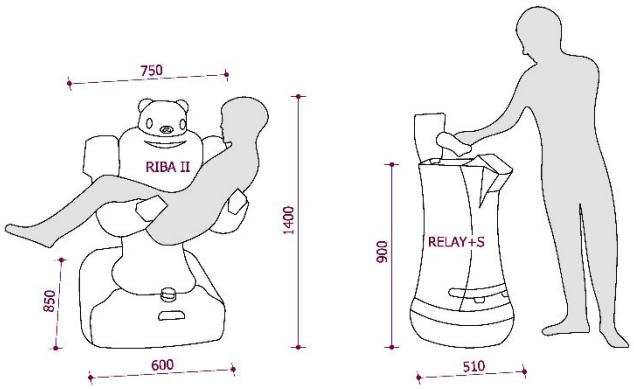


**Fig. 3.** Illustrations of the assistive robot RIBA II and butler robot RELAY+S. (Source: Bošková Filová, 2023)

**RESEARCH RESULTS**

The premises of the Type B – Family type house model building were analysed for the requirements and functioning of the Assis-

tive Robot (route marked in red) and the Butler Robot (route marked in blue). The analysis is carried out sequentially according to a defined route that passes through all rooms. In each room, the role of the robot is defined and its space requirements and the required hardware are examined. Commands to the robots are given by humans – Care Receivers (CR) or Caregivers (CG).

The model building has integrated multiple Robotics and Automation Society (RAS) and Internet of Things (IoT) technologies with interfaces to enable user control (by CRs or CGs). Appropriately configured robots could help CGs to be more efficient in expertly supporting CRs and reduce their physical care requirements (such as lifting and carrying). However, the principle applies robots mainly perform tasks that CRs cannot do unassisted, supporting CRs to live independent lives. The following is a description of cooperation between humans and robots in the model project example. CRs can move around the apartment and the garden on their own, but also be accompanied by robots if they need their help or want their presence at a certain time.

**Parking and entering** – An autonomous robotic car (robo-car) will bring a CR with walking disabilities or a person in a wheelchair to the house. Assistive Robots will help in getting out of the car or transferring to a wheelchair, in traversing a ramp with a slight incline into the lobby. From the lobby, the human and robot can proceed to the 2nd floor or to one of the apartments on the 1st floor. The door of the apartment is unlocked by the CR themselves, e.g. by using their fingerprint, or opened by the robot using radio waves. The door opens automatically (it has a motor drive) when unlocked.

**Apartment** – In addition to human care staff, there are multiple robotic devices in the apartment that perform various activities based on commands from the CG or CR. The Assistive Robot assists with walking and transferring to a bed, sofa, bench, shower chair, or recliner or toilet, and can lift heavy loads. It also pushes a human on a bed out onto a terrace. The Butler Robot is used to carry various objects within the home and garden, for example, carrying food, drink, medicine. Cleaner Robots can vacuum and wash floors, wash windows, mow the lawn, etc. If needed, a social "Entertainer" Robot can also function in the apartment, with capacity such as talking to the CR, playing [e.g. games or music] and so on. Robotic devices will help evacuate the building if necessary.

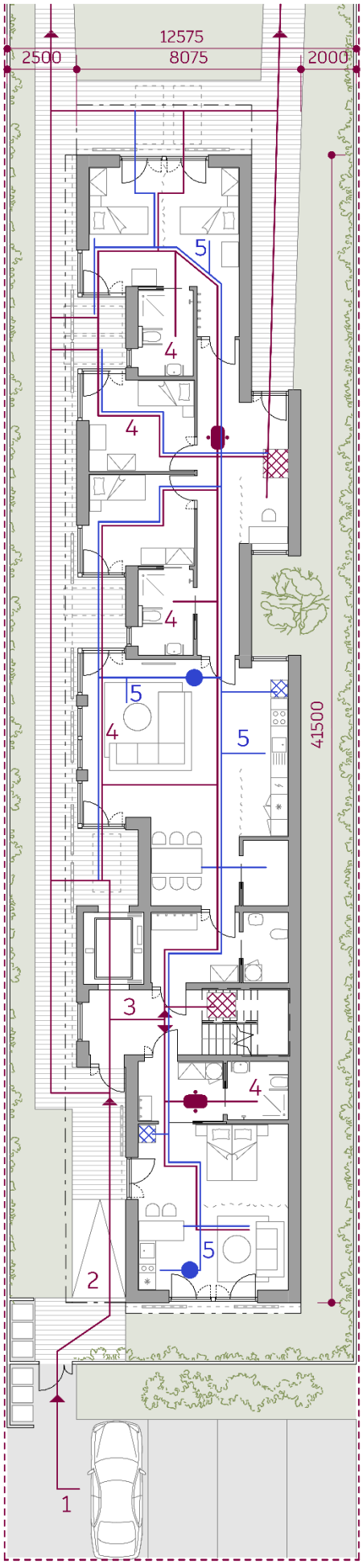


**Fig. 4.** Floor plan of the 1st floor of the building – Type B – Family type house and its surroundings with marked robots' paths and charging spots:

1 – The Assistive Robot assists in getting out of or into the car or transferring to a wheelchair.

2 – The Assistive Robot assists in traversing a slightly inclined ramp into the lobby.

3 – The Assistive Robot assists in opening doors using radio waves, if people want or need it.

4 – The Assistive Robot assists in transferring from a wheelchair to the couch, toilet, shower bench, bed, etc. and vice versa.

5 – The Butler Robot brings desired beverages, food, medicine, pillows, blankets, towels, remote controls, books etc.

(Source: Rollová, Bošková Filová, 2023)

**Living Room and Kitchen** – the CG prepares food, puts food onto plates and places them on Butler Robot, the CG gives orders for food delivery. The robot will take food to rooms if requested by the CR. Then the Butler Robot will bring the used dishes back to the kitchen. The CR chooses whether to eat in the room, at the dining table in the kitchen, or in the patio with other household members. The Assistive Robot can help transport the CR from the room to the dining room, or to the patio. If assistance is needed when walking, the CR can walk alone with the support of the robot (a standard mobile robot with handles at the back or a horseshoe-shaped robot with handles at the front). If the CR is immobile, the robot can help, for example, to push the CR on the bed into the common room or onto the terrace. The robot helps to transport a person in a bed or wheelchair to the living room, and helps to transfer to the couch.

**Bathroom** – the Assistive Robot brings or carries the CR to the bathroom, helps them to get on the toilet or on the shower chair and assists the CG in wet activities (robots cannot yet be used, for example, for showering). After drying, the robot again carries and transports the person as necessary.

**Bedroom** – the Assistive Robot performs simple tasks, assists in getting up and down, getting dressed, it assists a person in a wheelchair getting into bed. The Butler Robot brings the required items such as beverages, medications, the remote control, pillow, book, etc. If needed it can assist with eating (feeding) or monitor the current health status of the CR.

**Doors** – In addition to manipulating objects, robot's hands may also be used for opening and closing doors. However, it should be clearly stated that for the robot the operation of opening and closing of a standard door is not straightforward due to the need to coordinate the movement of the chassis, hand and of the gripper when opening the door, especially towards itself. In this sense, there is a requirement of the application of non-contact operated motorised doors, preferably of the sliding type. With a door of this type, the robot would only communicate via radio waves (either by command via a central system building or based on the NFR technology) and would not come into physical contact with them. The butler robot can also press buttons, such as the motorised door opener button.

The motion paths of the Assistive Robots and Butler Robots and their charging stations are indicated in Fig. 4.

## DISCUSSION

The integration of robots into the manufacturing process is now commonplace and the use of robots in health and social care is probably the near future. Robots should not be seen as a technology that takes away people's jobs, but as intelligent technology that can work with humans, to be a tool to carry out difficult or routine tasks, for example, to supplement the labour market where there is a shortage of workers. In our research, the aim was to investigate how humans and robots can use a shared space and perform model tasks together. There is a need to distinguish which processes in human care remain more efficient when done by humans and which could be replaced by robots.

In our research, we analysed several robot models that are constantly evolving. For research purposes, information about the way the assistive robot moves, the size of the chassis and the necessary size of their manoeuvring space was particularly important. The RIBA II robot fulfilled the basic requirements. The size of the RIBA II chassis, which is derived from the size of the payload weight, is dimensionally appropriate and it will probably not be possible to develop an assistive robot with a smaller chassis in the future. We envisage that assistive robots will be able to perform more tasks in the future than it is today. In contrast, a butler robot may have a smaller chassis because it does not work with heavy loads. The service robot RELAY+S was chosen mainly because of its functionalities. The location for contact charger spaces in the model home was investigated. We account for the fact that there will be two robots of each type in the apartment, one of which is working at a given moment and the other one is being charged, so that there will always be one available whenever needed.

We compare the space requirements in terms of accessibility for people using wheelchairs and accessibility for robots. The major problems associated with the robot operation in the model project are summarised. In the selected model project, the requirements for bed mobility were taken into account in the design of spaces and doors. Thus, the bi-fold doors can be opened to a width of 120 cm if required. The more frequently used, wider door leaf is 90 cm wide, which is suitable not only for people in wheelchairs but also for robots. The manoeuvring space of a person in a mechanical wheelchair has a diameter (Ø) of 150 cm, which is significantly more than the assessed robots need. This circle must be planned around objects which are being handled for example in front of a door, a table, a cupboard, or by a bed. The circle can interfere under some objects to some extent, like the sink, the table – where the person can put their knees. There are solutions also for the wardrobe or bed with using retreat space or completely free space underneath – where one's feet will fit, so that one can approach and reach this piece of furniture and the spaces within it more easily.

The Assistive Robot RIBA II can rotate around a point, hence the manoeuvring circle is Ø 110 cm. The circle can partially interfere above some objects, because the arms of the robot's body are the widest, so the lower part of the body, the platform touching the ground, is narrower, only 60 cm. Therefore, the robot can also be inserted into narrower spaces about 60 cm wide, but then it needs a sufficiently high free space, e.g. under the bed or toilet, in order to be able to turn into the working position (the 85 cm long part of the base will thus be inserted under the bed). The Butler Robot RELAY+S rotates around a point, so the manoeuvring circle is only Ø 51 cm.

The following are the main findings from the application of robots to the floor plan: The model building project, i. e. the Type B – Family type house, is largely suitable or adaptable for the purposes of robot movement and operation. We proposed several modifications to it to enable robots to manoeuvre and be used in all spaces as required. More fundamental modifications had to be made in the bathrooms. We took into account the requirements of people with the greatest need for assistance, for example people with muscular dystrophy who need assistance to be transferred from a wheelchair to a toilet or to a shower chair. Adjustments were necessary because the robot needs more space next to a toilet or a shower than a human assistant does when "operating".

The sanitary items (toilet, sink and shower) in the bathrooms were reorganised to allow access to the toilet bowl from two sides, while maintaining the dimensions of the bathrooms. In order for the assistive robot to assist with repositioning, it would be inserted on one side of the toilet bowl and a person in a wheelchair would be inserted on the other side. Of course, it is also possible to move the person frontally from the wheelchair to the toilet bowl and vice versa, but this is especially the case if the person is able to stand on their feet. In the larger apartment, in order to maintain the adaptability of the bathroom accessible from the corridor as well as from the room, a shower without a folding shower seat had to be designed. However, the functionality of the

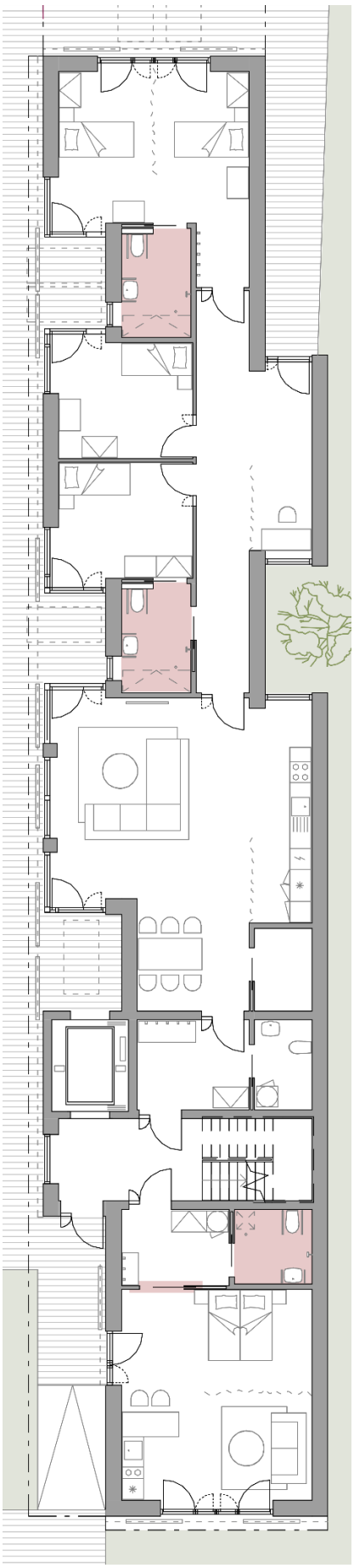

**Fig. 5.** Original floor plan design of the building – Type B – Family type house with the marking of spaces to be changed. (Source: Rollová, Bošková Filová, 2023)

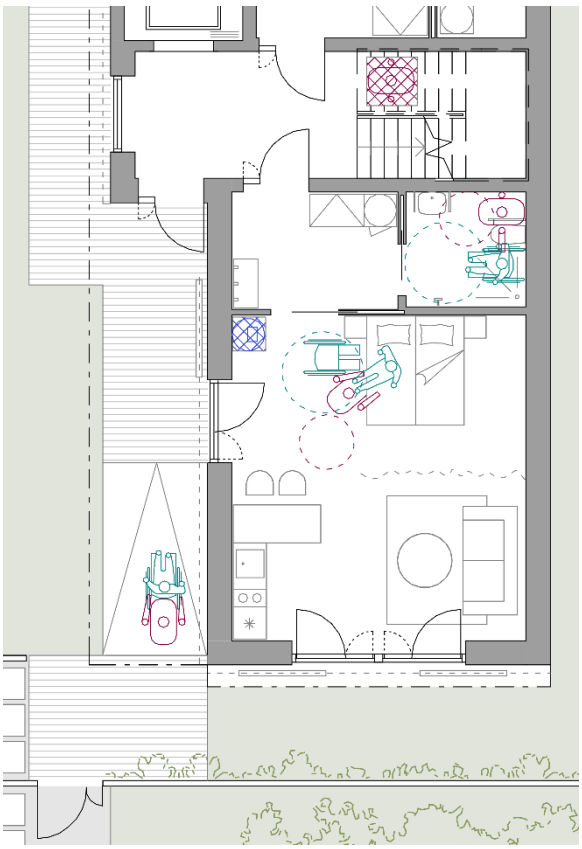

**Fig. 6.** Detail of the revised design of the building – Type B – Family type house. The entrance area and smaller flat. (Source: Rollová, Bošková Filová, 2023)

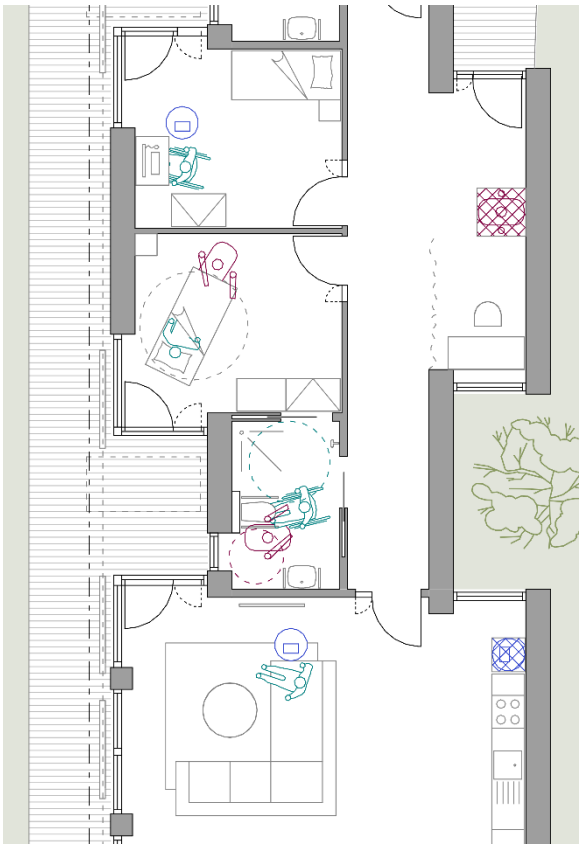

**Fig. 7.** Detail of the revised design of the building – Type B – Family type house. Part of the bigger flat. (Source: Rollová, Bošková Filová, 2023)

bathroom is not significantly reduced as a shower chair or a movable shower lounger can be used.

We design the charging spots separately for each type of robot to avoid collisions. In the smaller apartment it is difficult to find suitable charging points for both robots. Therefore, the larger assistive robot could be charged under the stair arm in a shared entrance area. The butler robot could be charged directly in the apartment, behind the entrance door. To this end, we have proposed a slight offset of the door from the original design to create a "bay" for parking this robot. Originally designed floor plan with marked areas that would need adjustments is in Fig. 5. Fig. 6 and 7 show parts of the floor plan with human-robot interactions in more detail.

## CONCLUSION

Catering to all the unique needs of older people can be a difficult task for those providing personal care, especially as they have many other important responsibilities. Many older adults who are cared for feel boredom, illness, sadness, pain, and loneliness. Current research is looking at the extent to which robots could improve the quality of care. The environment also plays an important role in wellbeing. In this article, we reviewed research related to the functioning of assistive robots in a specialised facility (extra care home). In the future we plan to continue with this research, for example, we aim to investigate the movement and functioning of robots in a regular home so that older adults can be cared for in their own apartments. Research can also be focused on other building typologies (for example, for education and work) or compare the needs of humans according to the 7 principles of Universal Design with the requirements of robots. We see interdisciplinary research as crucial because assistive systems that can help people "age in place" in their own homes can increase the wellbeing and independence of older adults and people with disabilities, reduce the societal cost of care, and at the same time solve the problem of workforce shortages in the health and social care sector.

## Acknowledgements

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# Architecture of healthcare and social inclusion in interwar Czechoslovakia: Pezinok Psychiatric Institute and the Masaryk Institute for Young People with Intellectual and Physical Disabilities in Bratislava

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**Abstract:** The formation of an independent Czechoslovak Republic created a space for the institutionalisation of health and social care as a reflection of the government's social policy. It became crucial to modernise and expand the network of health and social facilities. Although there were medical advances in institutional care for people with mental and physical disabilities, attempts at social inclusion were rare. Few innovative institutions existed that pioneered social inclusion of clients through proper education and adaptable architecture. This topic, as reflected in the architecture of the Institute for People with Nervous and Mental Health Disorders in Pezinok and the Masaryk Institute for Young People with Intellectual and Physical Disabilities in Bratislava, is the focus of this paper. The Pezinok Institute was the first clinic in central Europe to offer treatment of children with epilepsy. It was believed that elementary education and practical skills would socialise clients, adapt them to general society, and decrease their dependence on the government and their relatives. So, in addition to effective work therapy and hippotherapy, the institute also planned to educate clients in the envisaged school. The Masaryk Institute, as the first of its kind in Slovakia, aimed not only to establish institutional health and social care of people with both intellectual and physical disabilities, but also to integrate them into the society. Its initiator, Karol Koch, was convinced that it was indispensable to adapt the architecture to the needs of the people with disabilities, while not allowing the people with disabilities to feel that their environment differs from that of the others. The innovative nature of the institute's programme was imprinted in its progressive functionalist design. This paper aims to identify crucial problems, confront visions and reality, and to prove that, despite difficulties and minor results, even at that time, there were innovative architectural and medical reflections on the needs of people with disabilities.

**Keywords:** health, social care, social inclusion, disabilities, youth, psychiatric institute, interwar Czechoslovakia, Frič, Harminc

## HEALTH AND SOCIAL CARE OF PEOPLE WITH INTELLECTUAL AND PSYSICAL DISABILITIES IN INTERWAR CZECHOSLOVAKIA

The formation of an independent Czechoslovak Republic created a space for the institutionalisation of health and social care and the institution of a new legacy, e. g. Act No. 2/1918, as a reflection of the government's social policy (Falisová, 2004, p. 365). In addition to social and medical work in the field, as well as improvements in housing and hygiene conditions in both cities and the countryside, it became crucial to modernise and expand the network of healthcare and social facilities, including those for the people with disabilities. Although there was a significant success in the decline of social and venereal diseases, due to the construction of modern county and city hospitals, and sanatoriums, the care of people with intellectual and physical disabilities only improved slightly. (Capíková, Falisová, 1999, pp. 137–139)

After the First Czechoslovak Republic came into existence, clients with mental illnesses were treated in neurology clinics at the state hospitals in Bratislava and Košice. As late as 1929, Slovakia still lacked even a single specialised psychiatric treatment facility. In 1937, three psychiatric institutions were recorded in Slovakia. (Falisová, 1999, p. 140) Improvements occurred when the Clinic for Nervous and Mental Illnesses of Košice State Hospital was affiliated with Plešivec (the former Dr. Blum Institute for Epileptics) and the one of Bratislava State Hospital was affiliated in Pezinok, in the Cajla neighbourhood. On the other hand, according to current perception, a progressive western-European concept was adopted by the county hospital in Nitra, whose clients were treated by receiving home nursing care. (Falisová, 1999, pp. 144–146) However, such a model would not be adopted by the Slovak interwar social policy, as its aim was particularly to institutionalise the healthcare facilities.

Although there were medical improvements in institutional care of people with intellectual and physical disabilities, such as rehabilitation, hydrotherapy, hippotherapy, electroconvulsive therapy, or therapy at work, attempts at social inclusion were rare. As a result, clients were very limited in their future, most of them depended on the government and their relatives. Still, there were some innovative institutions that pioneered social inclusion of clients, through proper education and adaptable architecture. This paper seeks to examine the subject of healthcare and social inclusion of young people with mental and physical disabilities in interwar Czechoslovakia, which is reflected in the architecture of

the Institute for People with Nervous and Mental Health Disorders in Pezinok (1930s–1940s) and the Masaryk Institute for Young People with Intellectual and Physical Disabilities in Bratislava (1935). The aim is to identify crucial problems, confront visions and reality, and to prove that, despite difficulties and little results, even then there were innovative architectural and medical reflections on the needs of the people with disabilities.

## MATERIALS AND METHODS

The subject of the welfare state and forms of health and social care and social housing was characteristic of 20th century architecture. The current issue of the Architektúra & urbanizmus (Architecture and Urbanism) scientific journal also deals with these topics. (Dudeková, Haberlandová, 2022) The paper "The Pavilion Plan and Harminc – The Interwar Architecture of the Martin Hospital" mentions construction of several pavilion hospitals, healthcare tendencies and the supporting legislation (Pohaničová, Kiaček, 2022). Period Slovak architectural journals also reflected published healthcare facilities. Particularly, Slovenský staviteľ (lit. Slovak Builder) mentions the competition for the Masaryk Institute and has partially formed the basis of the research. (Koch, 1935; Harminc, 1935; Markovič, 1935) Crucial sources of the research have been historiographic studies of the Slovak interwar and war healthcare system and legislation (Capíková, Falisová, 2015; Falisová, 1999) and the historiographic chronicle of the Slovak State. (Hallon, 2022)

The paper uses qualitative architectural-historical research with a continuous verification of the results. The main method of the study was archival research conducted in the State Archives in Bratislava, Slovakia, the Modra branch, in combination with the study of Slovenský staviteľ (Slovak Builder), and the study of the above-mentioned publications. Complementary methods included comparison, photography, and field research. As a part of a complex research study of Rudolf Frič's work in the context of Czechoslovak interwar architecture, this paper should allow Frič's architectural and construction projects to be distinguished and his direct contribution to be assessed.

## INSTITUTIONAL CARE OF PEOPLE WITH MENTAL DISABILITIES IN PEZINOK

The Pezinok Institute for People with Nervous and Mental Health Disorders was established by adapting the former Pezinok Ferrous Iron Spa (1925) and an antimony factory (1939) in the Cajla neighbourhood. The oldest building in the spa dates back to 1777. The institution was owned by the joint-stock company *Pezinské železité kúpele* (Pezinok Ferrous Iron Spa, Fig. 1), established by the construction entrepreneur Rudolf Frič. As its majority shareholder, Frič financed the establishment and reconstruction of the institution as a part of his social portfolio. In an expert capacity, the project was professionally overseen by Karol Matulay (1906–1998). Frič redesigned and rebuilt the clinic and added new functionalist buildings (1930s–1940s). The amenities added to the clinic campus included a park with exotic orchards, a volleyball and football field, a grass tennis court, and a swimming pool. (Fig. 2) The institution had standard and private wards for men and women, as well as a specialised ward for children with epilepsy and intellectual disability (1941). (Hallon, 2022, p. 87) It was the first clinic in central Europe to offer treatment of children with epilepsy (1941). Its professional initiator, Matulay, specialised in researching the co-occurrence of epilepsy and intellectual disability in child clients, as well as the influence of polio on these disorders. (Tichý, Sedláčková, 1996, p. 182)

According to the register of health facilities in Slovakia, the institution had 185 beds and one permanent medical practitioner in 1937. In addition, there were only two more similar institutions in Slovakia, with 945 beds in total. However, up to 6,000 psychiatric clients in Slovakia failed to receive medical help, which was even more critical with child clients. (Falisová, 1999, p. 145) The institution hospitalised chronic psychiatric clients, mainly those suffering from schizophrenia, general paresis, and alcohol-induced psychosis. (Morovicsová, 2018) Treatment consisted of pyrotherapy (inducing a fever), modern electroconvulsive therapy (ETC; first conducted in Italy in 1938 by neurologist Ugo Cerletii), which was first introduced in Czechoslovakia by Karol Matulay in Pezinok in 1941, and insulin and Cardiazol shock therapy. For chronic child clients with epilepsy and intellectual disability, work therapy and hippotherapy were particularly effective. For this purpose, the facilities established workshops, ovens, and greenhouses where clients learnt practical craft skills.

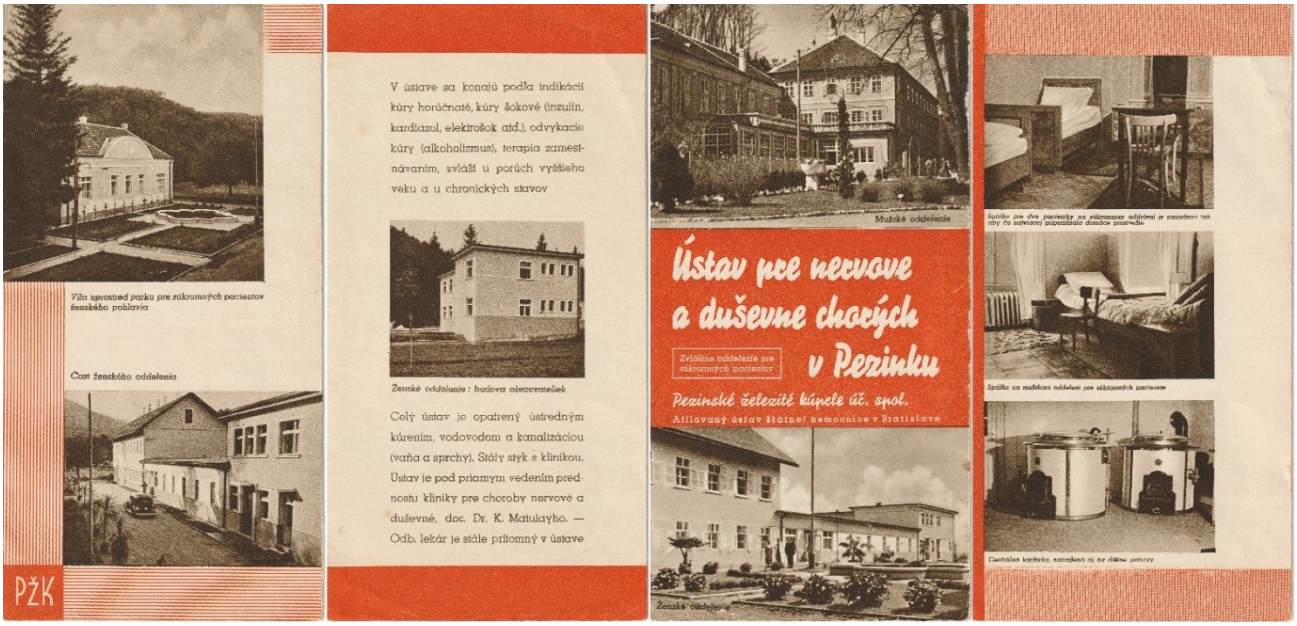


**Fig. 1.** The Pezinok Institute for People with Nervous and Mental Health Disorders. Period brochure of the joint-stock company *Pezinské železité kúpele (Pezinok Ferrous Iron Spa)*. Left to right: women's private and standard ward; nurses' pavilion; men's and women's standard ward; women's and men's private client rooms and kitchen. (Source: private archive of Elena Frič, personal estate of Rudolf Frič, 1941)


**Fig. 2.** The Pezinok Institute for People with Nervous and Mental Health Disorders. Site plan. Left: Antimony factory, Right: Ferrous Iron Spa. Later, these two sites were merged. (Source: State Archives in Bratislava, Slovakia, 1939)

Since most of the children who received care came from disadvantaged environments, lacking appropriate schooling and education, the institution also planned to ensure their education. There was a plan to create a school for 100 children on the campus. (Hallon, 2022, p. 87) The institute believed that elementary education and practical skills would socialise clients, adapt them to general society, and decrease their dependence on the government and their relatives. This might have been considered as an innovative idea of social inclusion of young people with mental disabilities. However, the increasing social hate and the feeling of being superior to any minority, including the one with disabilities, as claimed by the Nazi ideology, limited further development of the institute. Parental alcoholism was considered the main cause of epileptic seizures in children. Therefore, the demanding treatment of alcoholism became another crucial part of institutional healthcare in Slovakia and especially at the Pezinok Institute. The architecture of the institution had never been examined before. Archival research was performed by the author at the Modra branch of the State Archives in Bratislava, Slovakia, in August 2022.

The first phase of the institution's construction consisted of rebuilding the ferrous iron spa in the early 1930s, which resulted in minor changes in the layout. Glassed-in porches and social halls, as well as a sunroom with extended terraces were added between the three original spa buildings. (Fig. 3–5) This concept not only optimised the layout, but also responded to the modern call for sun hygiene. In the second phase (1939–1940), the campus was expanded by absorbing the neighbouring plot of land with the former antimony factory. The factory building was adapted and extended. It included 20 bedrooms, a social room, 5 workshops for work therapy, a kitchen, a bathroom, a boiler room, a storeroom, a washroom, and 3 sets of toilets. (Fig. 6, 7) The finished conversion was supposed to serve as housing for clients until the planned third phase, and later to be only used for the workshops. (State Archives in Bratislava, Slovakia, 1940) The former spa was designated for men, while the former factory was designated for women. The gardens of the two sites were connected.

During the third phase (1940–1941), a housing pavilion for women with a chapel, and a separate nurses' pavilion were erected. In the gardens of the women's section, a housing pavilion was established for private female clients. (Fig. 8) The office building in the men's section was reconstructed and expanded (Fig. 9), and the women's section received a new outbuilding and a gatehouse. In the fourth phase (1942), the garden was modified. In addition to a 15-meter-tall bell tower, which was built on a hillock in the middle of the park (Fig. 10), new structures included garden pavilions with terraces, a colonnade, water jets, a pool, sports pitches (volleyball, football, tennis), a bowling alley, and therapeutic greenhouses. A henhouse, kennels and stables for therapeutic horses were erected on the other side of a stream as part of the then progressive hippotherapy. The site was also extended to include the neighbouring forest with horse riding paths. The further planned expansion of the facility, based on the pavilion plan, including the construction of new wards and a school, was halted by the worsening war situation and the

increasing social hate and feeling of being superior to any minority, including the one with disabilities, as claimed by the Nazi ideology. After the nationalisation, further expansion was suspended until the 1970s, when the pavilion plan was reconsidered in an atrium-based concept of the current Phillip Pinel Hospital.

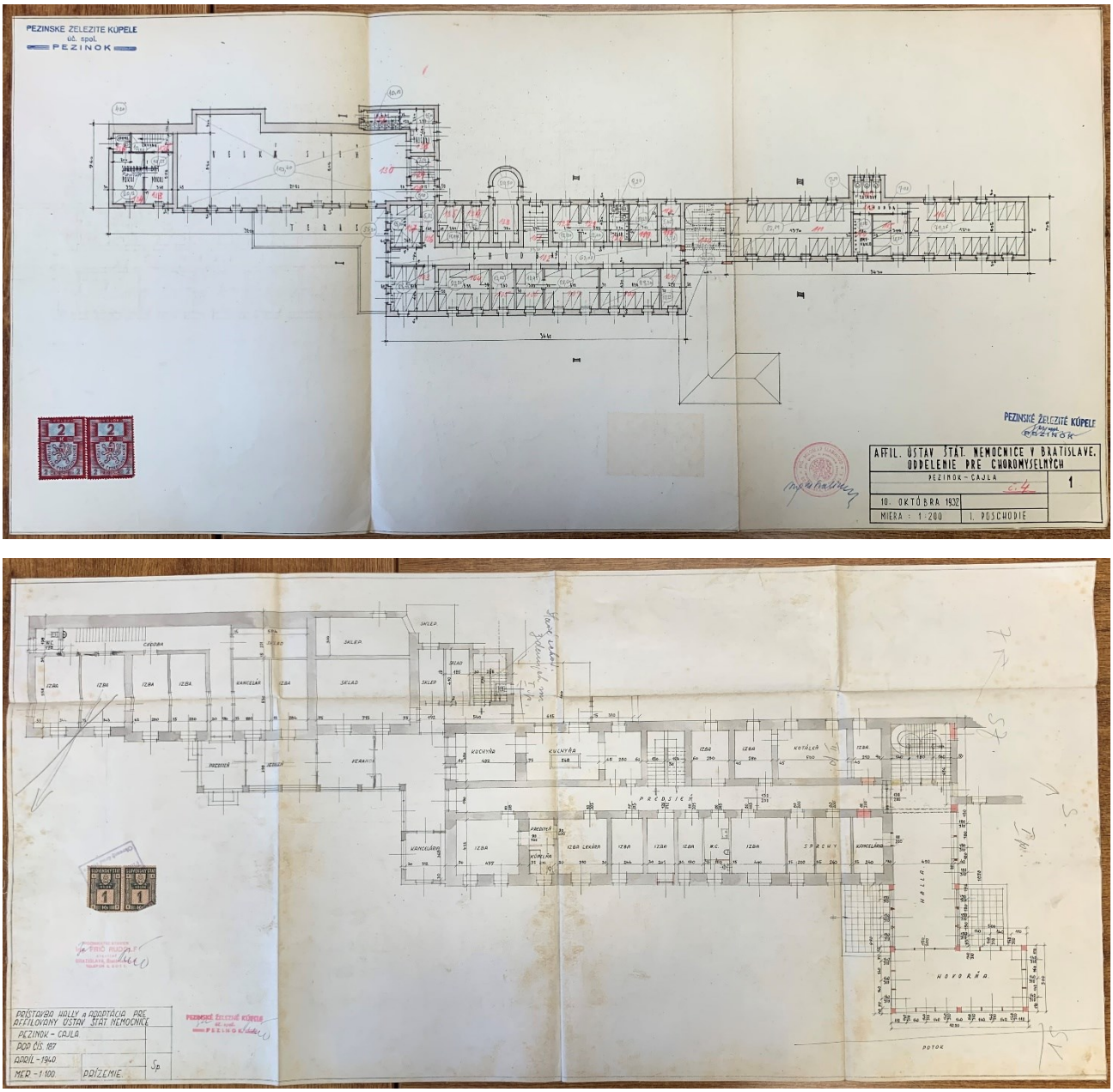


**Fig. 3, 4.** The Pezinok Institute for People with Nervous and Mental Health Disorders. Adaptation of the Ferrous Iron Spa building to a men's standard ward with extended terraces. Top: First floor with clients' rooms and the great salon; Bottom: Ground-floor plan with terraces. (Source: State Archives in Bratislava, Slovakia, 1939)

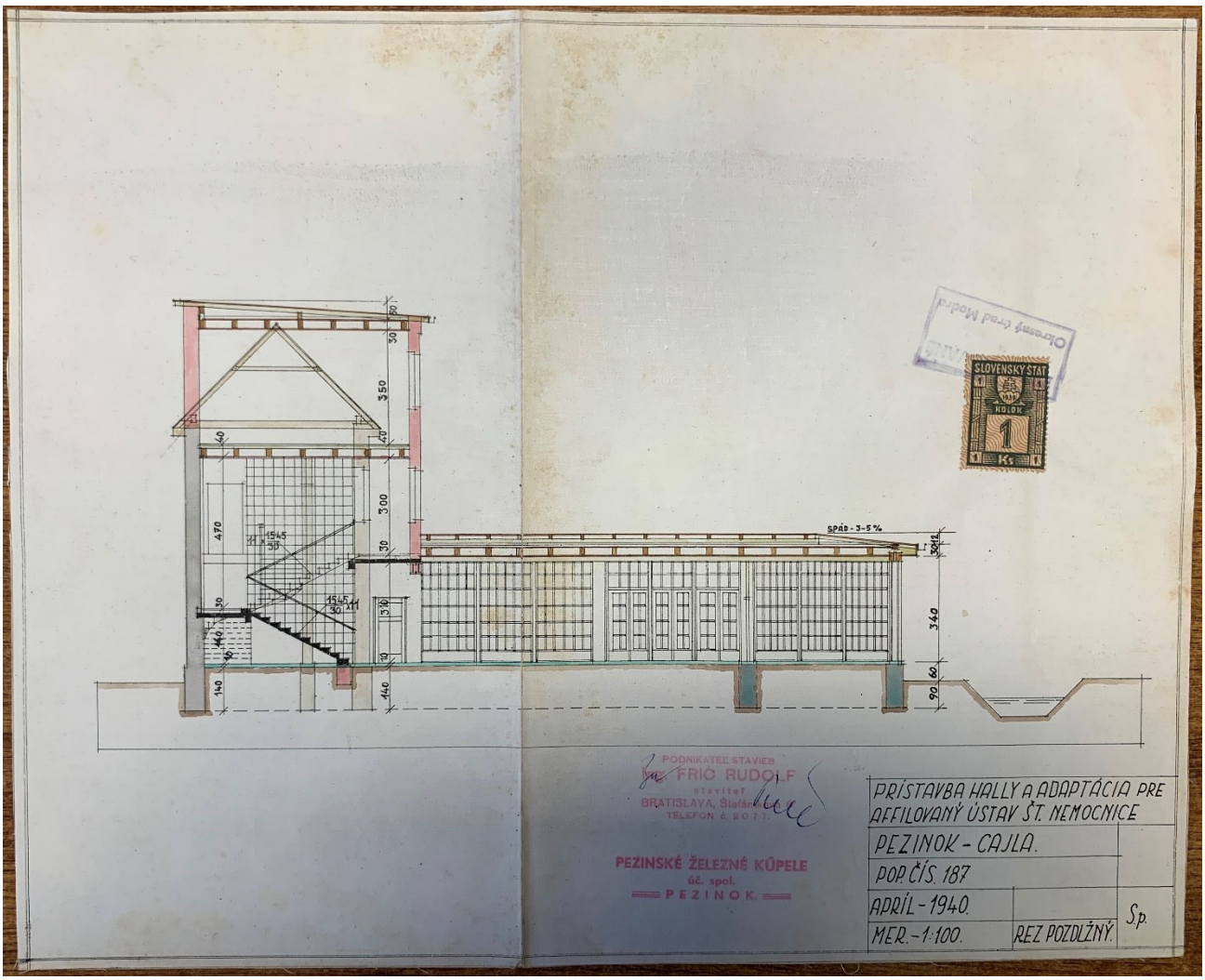


**Fig. 5.** The Pezinok Institute for People with Nervous and Mental Health Disorders. Adaptation of the Ferrous Iron Spa building to a men's standard ward with extended terraces. Cross-section of the added terrace and porch. (Source: State Archives in Bratislava, Slovakia, 1939)

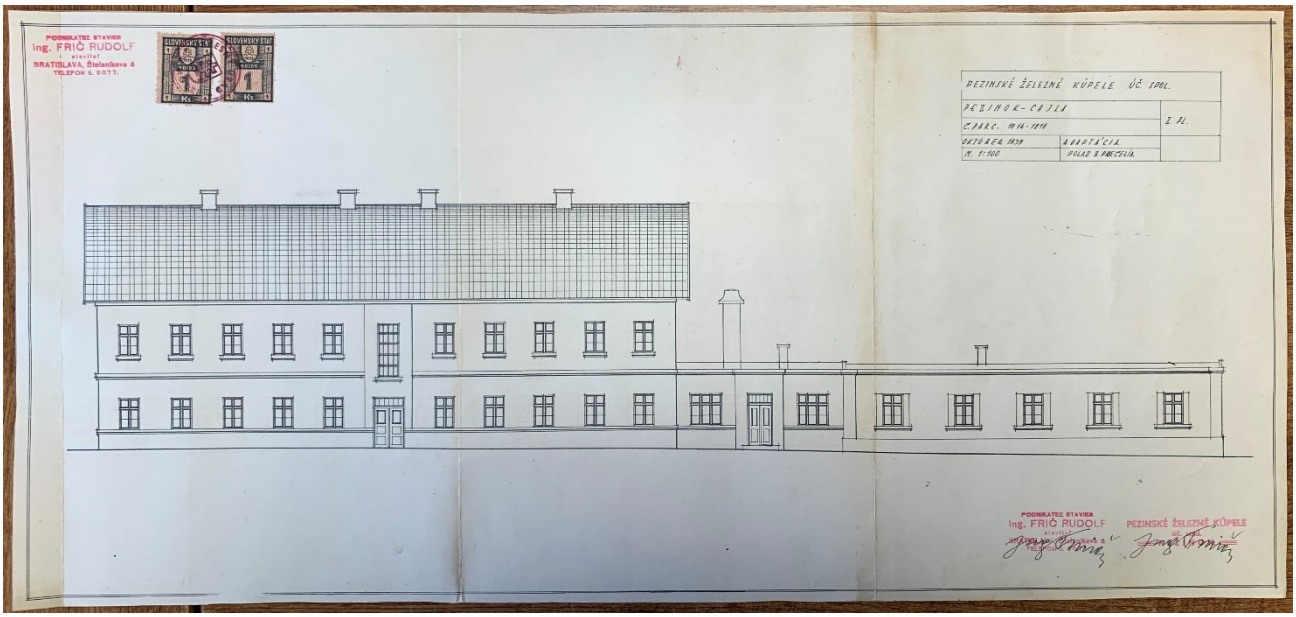


**Fig. 6.** The Pezinok Institute for People with Nervous and Mental Health Disorders. Adaptation of the Antimony factory building to a women's standard ward with an added extension. Elevation. A new women's pavilion with a chapel was built in 1941. (Source: State Archives in Bratislava, Slovakia, 1940)

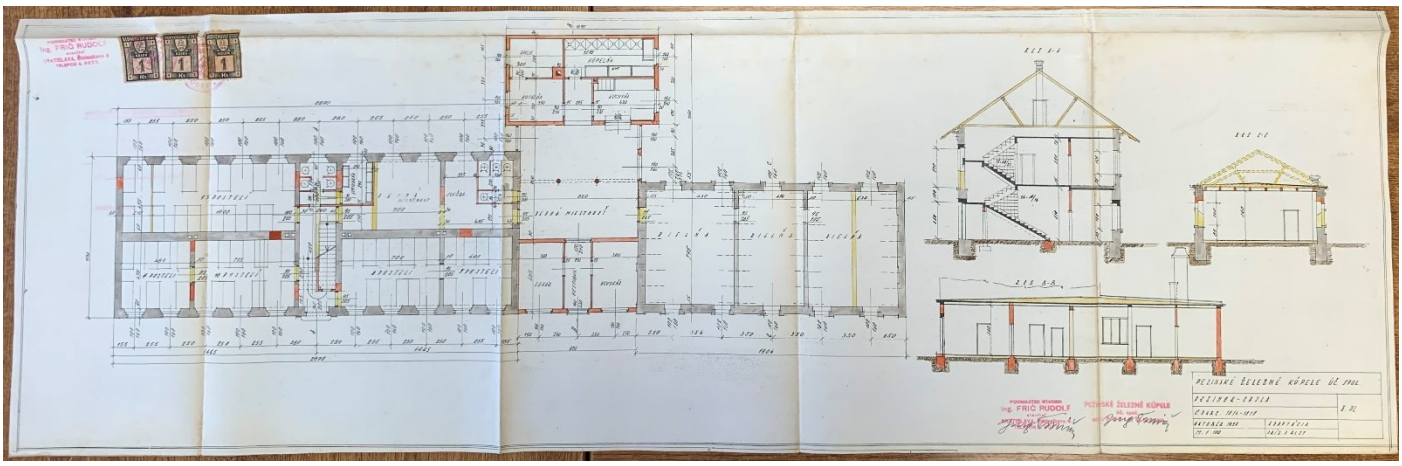

**Fig. 7.** The Pezinok Institute for People with Nervous and Mental Health Disorders. Adaptation of the Antimony factory building to a women's standard ward with an added extension. Ground floor. A new women's pavilion with a chapel was built in 1941. (Source: State Archives in Bratislava, Slovakia, 1940)

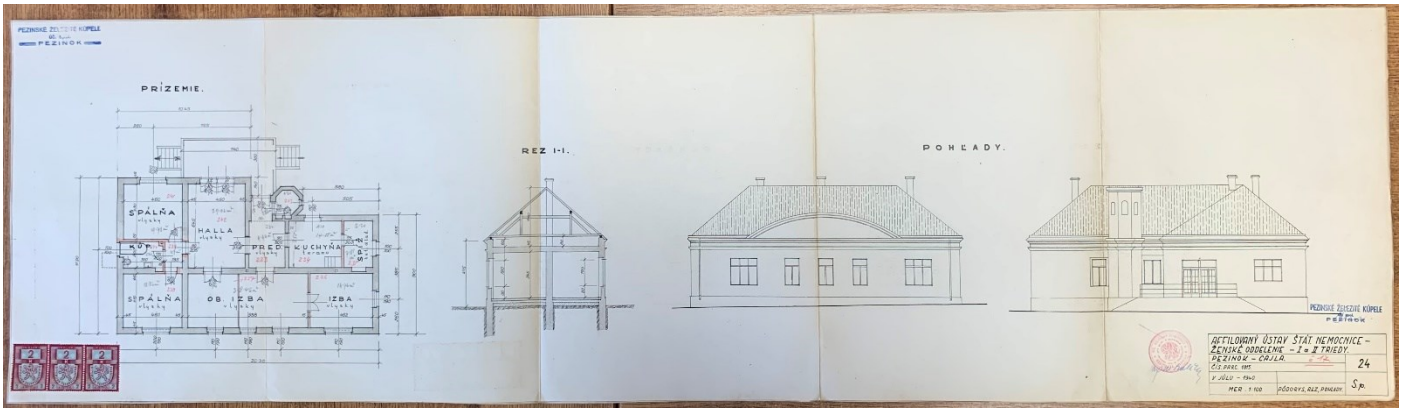


**Fig. 8.** The Pezinok Institute for People with Nervous and Mental Health Disorders. Private female clients' pavilion. Left to right: Ground-floor plan, Cross-section, Elevations. (Source: State Archives in Bratislava, Slovakia, 1940)

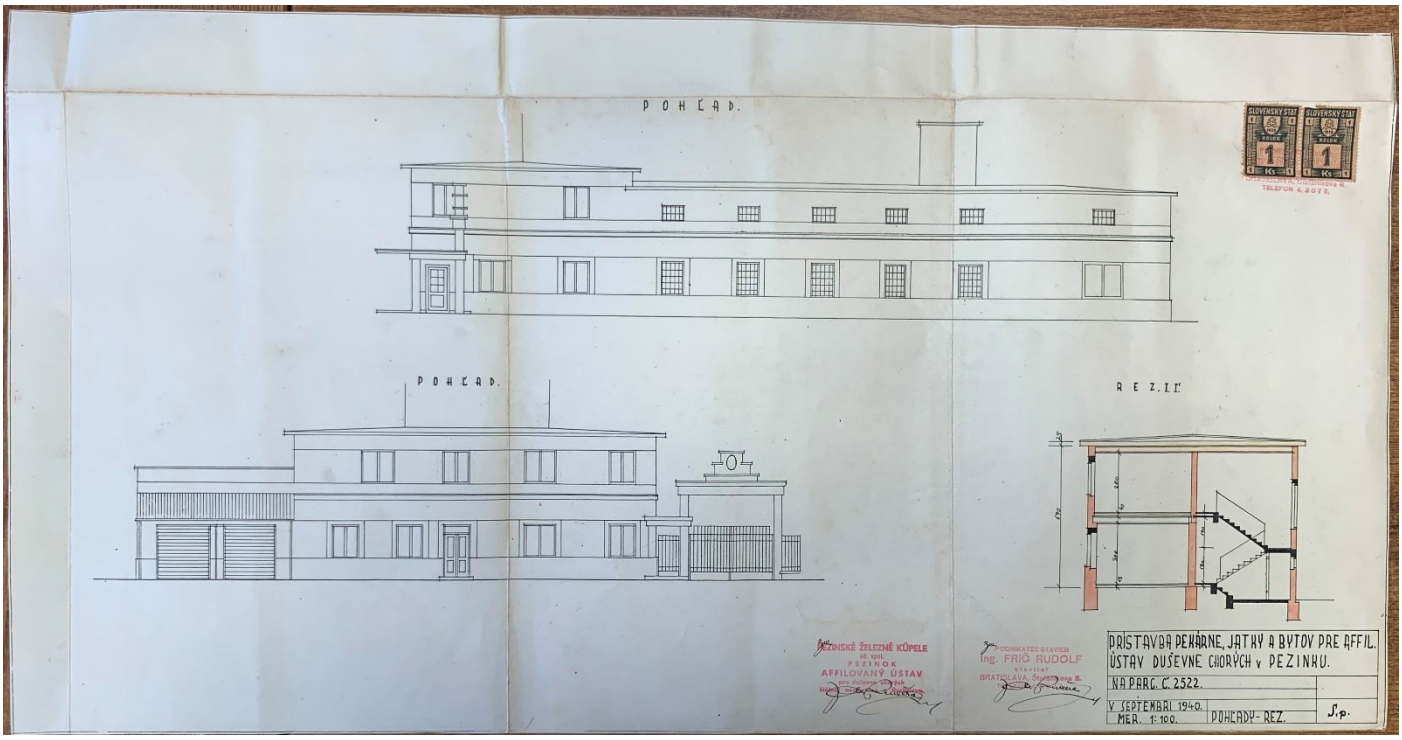


**Fig. 9.** The Pezinok Institute for People with Nervous and Mental Health Disorders. Administration and entrance building. Elevations and cross-section. (Source: State Archives in Bratislava, Slovakia, 1940)

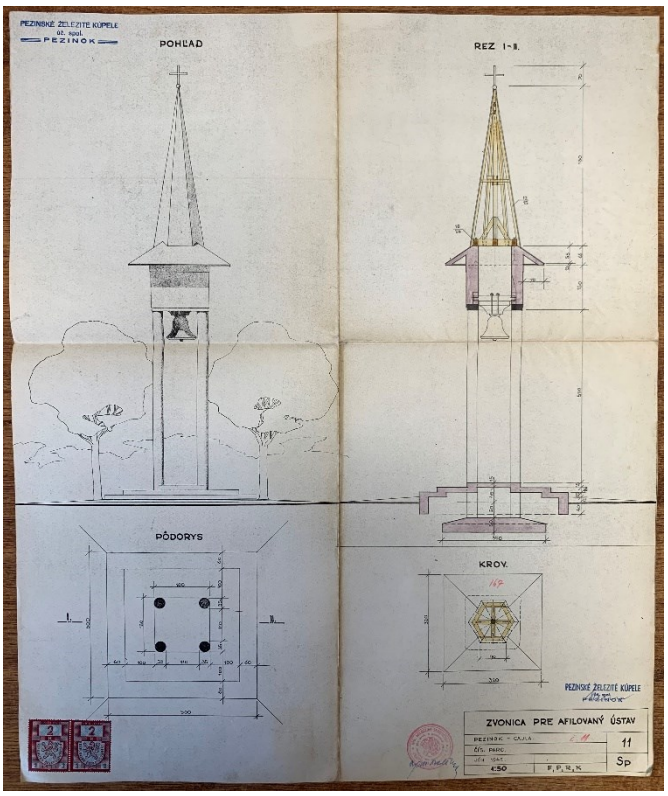


**Fig. 10.** The Pezinok Institute for People with Nervous and Mental Health Disorders. The Bell Tower. Elevation, cross-section, and plan. (Source: State Archives in Bratislava, Slovakia, 1942)

## INSTITUTIONAL CARE OF YOUNG PEOPLE WITH INTELLECTUAL AND PHYSICAL DISABILITIES AT MASARYK INSTITUTE IN BRATISLAVA

The interwar attempt to institutionalise health and social care, particularly of young people with disabilities, is reflected in the winning proposal for the Masaryk Institute for Young People with Intellectual and Physical Disabilities in Bratislava (1935) designed by Milan Anton Pavol Harminc (1905–1974). The institute, as the first of its kind in Slovakia, aimed not only to establish institutional health and social care, but also to integrate its clients into the society. Its initiator, Karol Koch, then asked*: 'When democratic freedom has given young people with no disabilities the full right to an education in a social form – a school – why would it deny it to those poor deformed and lacking the good will to fill their unique childhood with beautiful content? […] It is necessary to express to the people with disabilities a tense relation to the people with no disabilities in the discreet separation of work, but to open, symbolically and unobtrusively, possible gateways to the everyday life of people without disabilities who are prepared for the already prepared people with disabilities. […] The entire institution consists of the curls of a great play, which is not only to restore a healthy life, but also to teach a sense of it – to inhale the self-esteem of a depressed soul.'* (Koch, 1935, p. 237) According to Koch, it was requisite to adapt the architecture to the needs of the people with disabilities, while not allowing them to feel that their environment differed from that of the others. Therefore, the facilities would include ateliers, workshops, aulas and studies, a theatre hall, and a library, to educate and socialise the clients. (Fig. 14) Furthermore, the multifunctional theatre room with a stage and an auditorium would be open to the public to view the scene of integration.

**Fig. 11.** The Masaryk Institute for Young People with Intellectual and Physical Disabilities in Bratislava. Cascading structure of three pavilions on a hill. (Source: Anon, 1935, p. 230)

The innovative nature of the institute's program was imprinted in its progressive functionalist design, with a pavilion for people with physical disabilities, another pavilion for people with mental deviations, and one central social and educational pavilion with a hospital ward. The cascading structure of buildings located on a hill (Fig. 11) made it possible to organise the buildings in a more concentrated manner, ensuring sufficient ventilation and sunlight, as well as the separation and segregation of clients and facilities. Despite the separation and a half-level difference, the pavilions were connected with overglazed ramps, making them easily accessible at every level. Clients could pass through all three pavilions, even though their segregation was considered to be unavoidable in practical care, especially at night. The cascade roof-terraces were fully accessible for sunbathing, especially for clients with bone tuberculosis. (Harminc, 1935) (Fig. 15) For physical rehabilitation and exercise and to deepen the social ties in the client community, there was a gymnasium and outdoor courts, and a special indoor swimming pool for hydrotherapy. (Fig. 13)

Although the south orientation of the lot was adequate, its steep slope and small size were criticised by the very architect. Taking into account the future extension by another three pavilions, there would only be 40m$^2$ of land per client. But the slope was considered to be a more crucial obstacle, as it would seriously limit the clients' mobility. (Harminc, 1935, p. 238) Due to this and financial shortages, and a strategic change in the institutionalisation of government healthcare, the Masaryk Institute for Young People with Intellectual and Physical Disabilities has never been built. It proved that as opposed to the society, the government was not prepared for the ambitious vision of inclusion of people with disabilities. However, through his signature architectural style and the more convincing functionalist expression of the Masaryk Institute and other healthcare buildings, Milan A. P. Harminc became architecturally distinct from his father, Michal Milan Harminc (1869–1964), whose work had been based on tradition and craftsmanship. (Pohaničová, Kiaček, 2022)

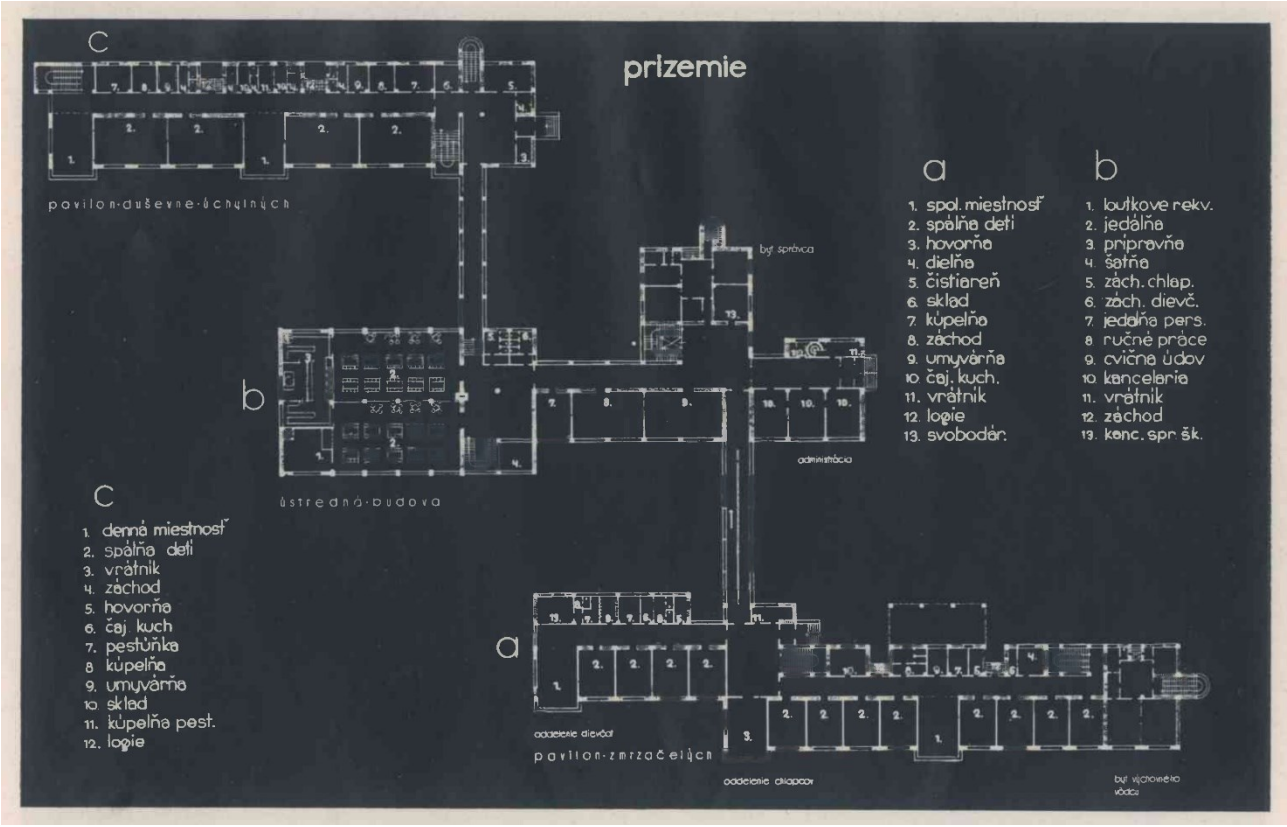


**Fig. 12.** The Masaryk Institute for Young People with Intellectual and Physical Disabilities in Bratislava, Slovakia. Ground-floor plan. Top to bottom: Pavilion for people with intellectual disabilities, Central social and educational pavilion with dining room, Pavilion for people with physical disabilities. (Source: Anon, 1935, p. 230)

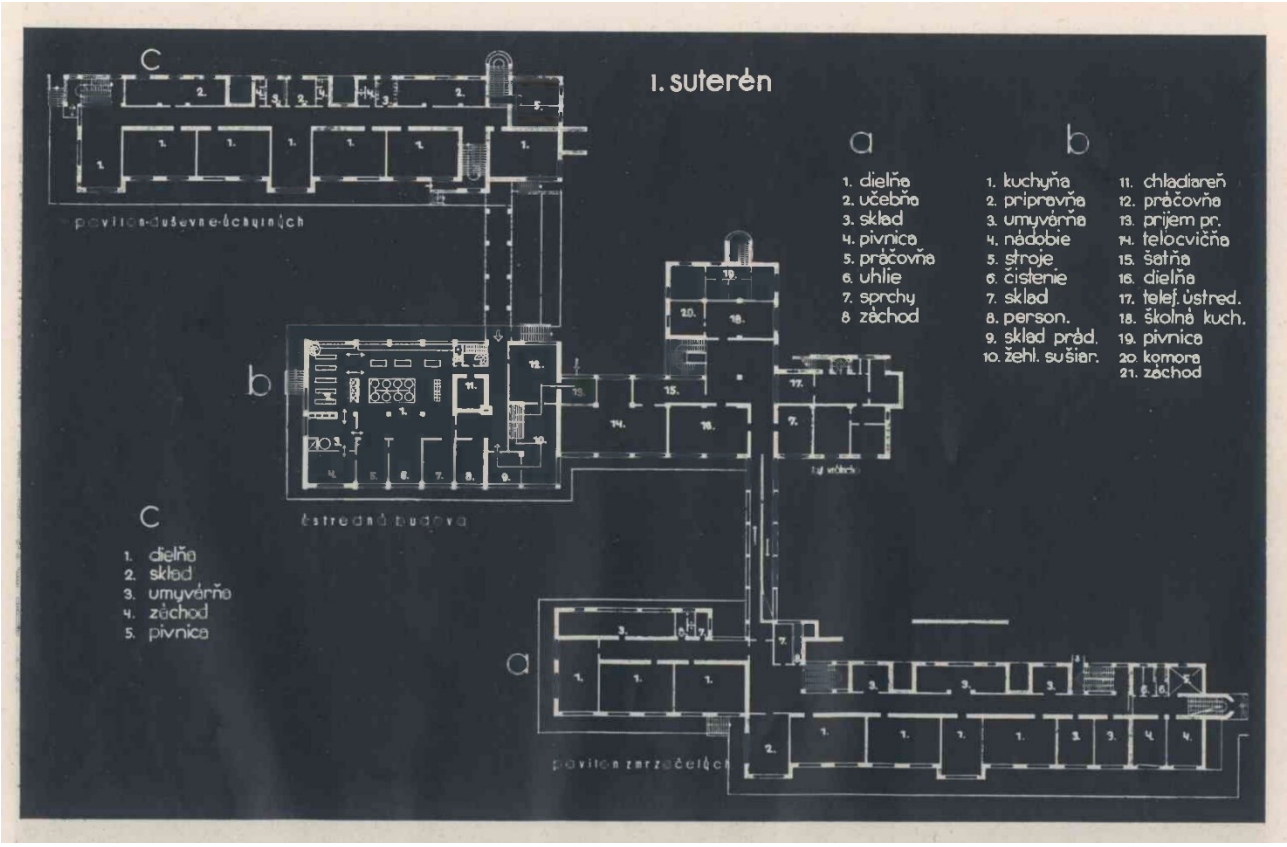


**Fig. 13.** The Masaryk Institute for Young People with Intellectual and Physical Disabilities in Bratislava, Slovakia. Underground-floor plan. Top to bottom: Pavilion for people with mental disabilities with workshops, Central social and educational pavilion with kitchen, Pavilion for people with physical disabilities with a pool and a gymnasium. (Source: Anon, 1935, p. 230)

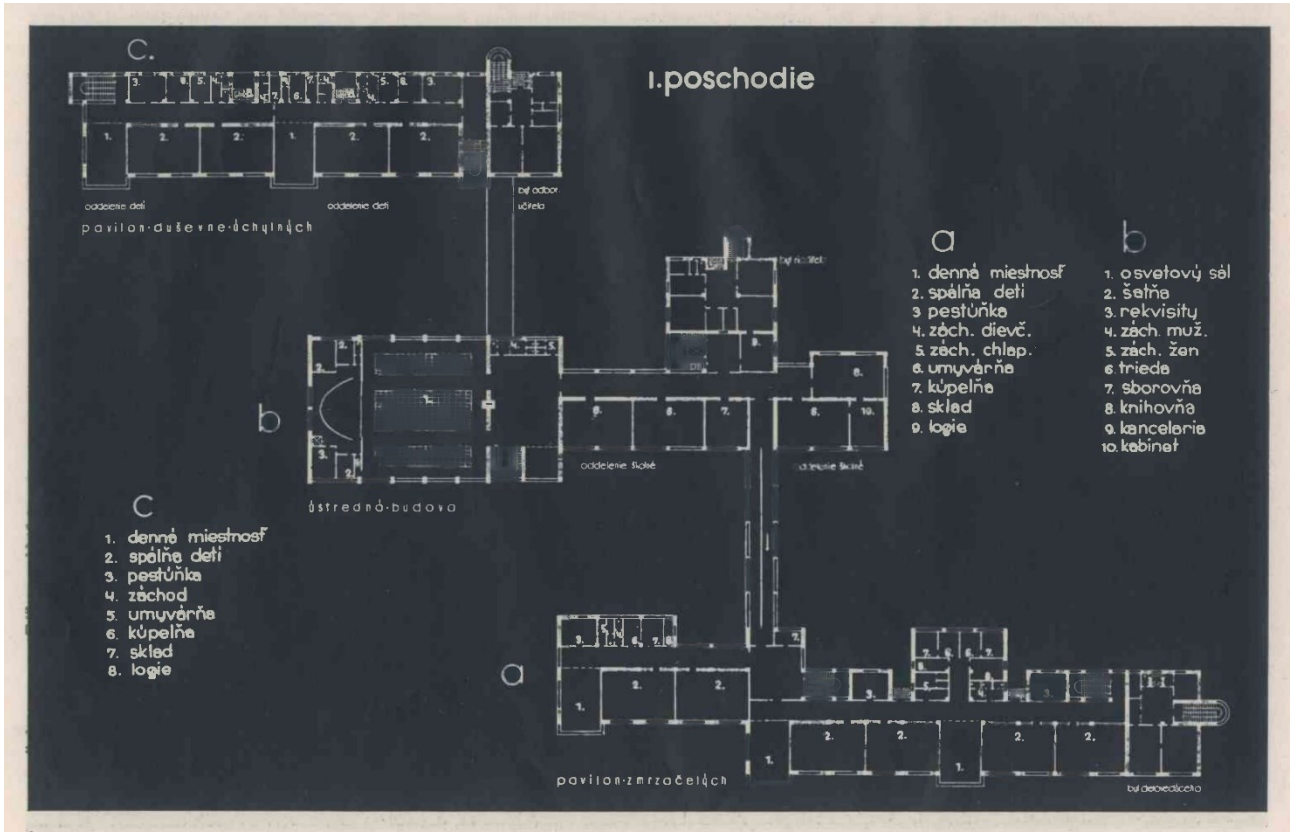


**Fig. 14.** The Masaryk Institute for Young People with Intellectual and Physical Disabilities in Bratislava, Slovakia. First-floor plan. Top to bottom: Pavilion for people with mental disabilities with clients' rooms, Central social and educational pavilion with a theatre hall and a library, Pavilion for people with physical disabilities with clients' rooms. (Source: Anon, 1935, p. 230)

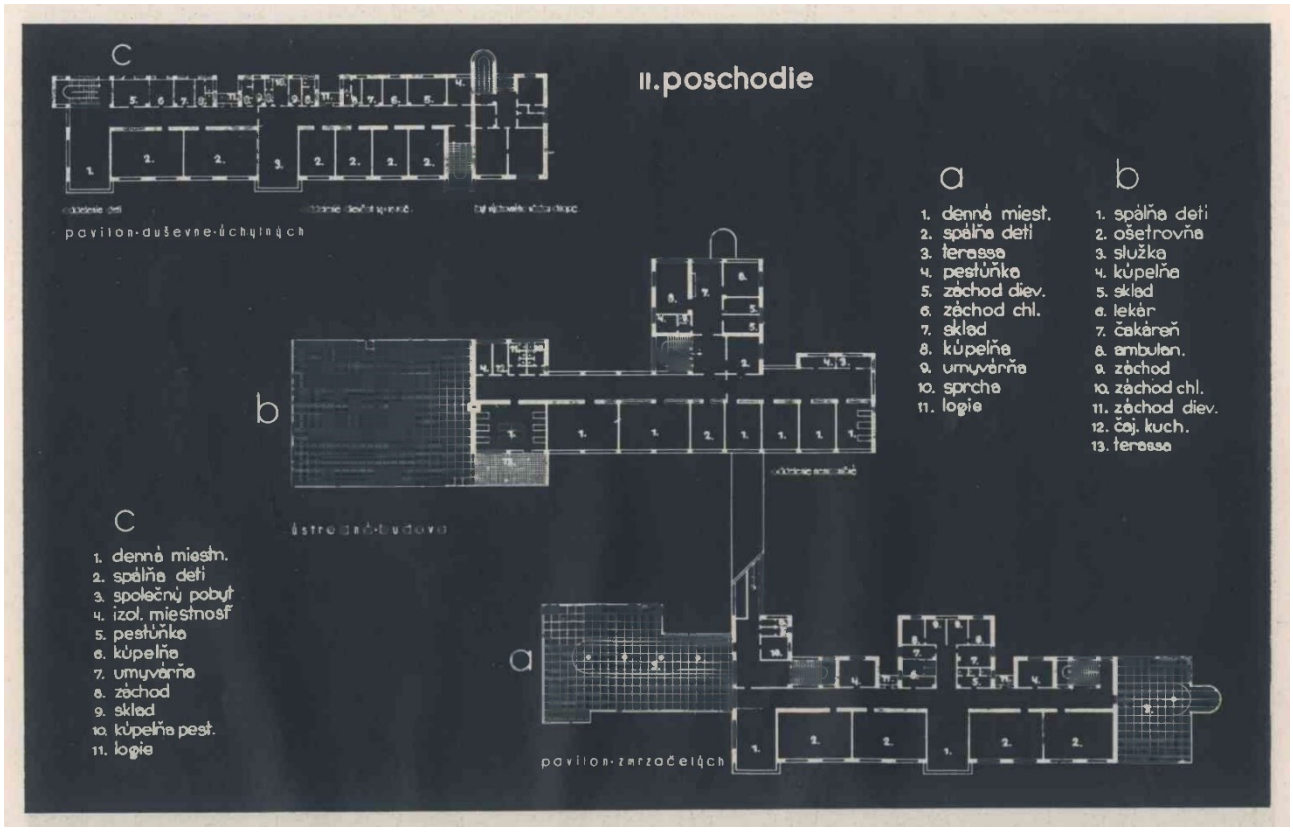


**Fig. 15.** The Masaryk Institute for Young People with Intellectual and Physical Disabilities in Bratislava, Slovakia. Second-floor plan. Top to bottom: Pavilion for people with mental disabilities with clients' rooms, Central social and educational pavilion with aulas and terrace, Pavilion for people with physical disabilities with clients' rooms and a terrace. (Source: Anon, 1935, p. 230)

## CONCLUSION

During the First Czechoslovak Republic, the region of Slovakia was one of the regions to offer space for the institutionalisation of health and social care and the modernisation of its facilities. However, improvements in health and social care of the people with intellectual and physical disabilities, especially the youth, were only partial. It faced continuing obstacles, different priorities in the institutionalisation of government healthcare system, financial shortages, and the spreading idea of superiority of the Nazi-oriented war society. Despite the limits, there was an improvement, particularly in treatment, education, and in attempts at social inclusion of clients. A few specialised institutions were established by state-owned or private organisations. Their architecture reflected both health and social demands, modern typology, and preferred pavilion plan. The pavilion plan effectively segregated clients in separate wards according to the level of dependence, improved ventilation and sunlight, and was looser between outdoor spaces, adapted to treatment and leisure activities. The pavilions also provided clients with extra facilities dedicated to innovative programmes like workshops, ateliers, libraries, aulas, theatre halls, etc.

In the context of the critical lack of institutional health and social care for psychiatric clients in Slovakia, the Pezinok Institution with its unique treatments represented an important milestone on the modern government's path to social values. Research has identified architecturally conventional pavilion buildings arranged in gardens with generous outdoor facilities and an innovative treatment and education programme. The private funding of the institute proves the philanthropy of wise sponsors. However, it also shows the government's insufficient efforts to achieve social and healthcare goals, as well as the slow construction of state-owned medical facilities. The Masaryk Institute became a prototype of a modern pavilion-style facility for young people with intellectual and physical disabilities, even though it has never been realised. It embodies the attempt at complex health and social care, including treatment, education, and social inclusion of the people with disabilities. Moreover, it stands for Milan Anton Pavol Harminc's architectural distinction from his rather traditional father.

The paper has verified that, despite obstacles and partial achievements, the Czechoslovak interwar architecture managed to reflect the actual demands of health and social care of people with both intellectual and physical disabilities. It provided clients with modern treatment and education that lead to their future social inclusion and relative independence from the government and their relatives. The architecture tried to adapt to the special needs of people with disabilities, while not looking at their environment as being too different from that of the others. Upon examining the pieces of Czechoslovak interwar architecture of health and social care for clients with intellectual and physical disabilities, we can conclude the design was friendly. However, both examples prove only partial fulfilment of the medical and social goals of the Czechoslovak interwar health and social care for the people with disabilities.

### Acknowledgements

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# Mental health as determining factor of urban district's character: Case study Bratislava – the Pentagon

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**Abstract:** Drug use and drug addiction have a high prevalence in the population, which has been widely documented since the 1980s. According to the United Nations, the physical environment in which we live is one of the strongest determinants of our health. In the case of drug abuse concentration in a particular urban space, one of the points to consider is the architectural and urban form of the location. In the Slovak context, a significant representative of concentrated drug activity is a part of the Medzi Jarkami housing estate, nicknamed the "Pentagon". In an effort to eradicate drug activity, local residents fortified the Pentagon, changing its urban landscape and furthering its ghettoisation. Although drug abuse is a criminal act, it is imperative to acknowledge that drug addiction is a mental illness. Therefore, it is not sufficient to look at spaces such as the Pentagon from a criminal perspective but also from that of mental health. Our study aims to explore the connection between the residents' mental health and the quality of the urban structure they live in. We performed a urban design analysis, utilizing on-site participant observation and structural interviews supplemented by desktop research. The case study analysis proved that the mental status of the local residents has an essential impact on the development of urban neighbourhoods. A number of environmental stressors were detected as present in the built structure. Furthermore, there is the stigmatization of whole urban districts caused by a high incidence of drug addiction as a mental disorder that, in the bigger terms, influences the "image" of the area. The drug problem in the Pentagon left its marks on the whole urban district of Vrakuňa, reducing the residents' quality of life significantly over the years.

**Keywords:** design for mental health, urban design, crime prevention, drug addiction, segregated urban areas

## INTRODUCTION

The topic of mental health is on the fringe of the interest of architects and urban planners. But the physical environment in which we live is one of the strongest determinants of our health. From the perspective of health determinants, architecture and urban planning is considered to contribute principally to an unhealthy lifestyle (United Nations, 2015). The decisions made by city inhabitants are influenced by many factors, including how the built environment is designed and constructed. This means that certain patterns of behaviour are inherently built into the environment (Rice, 2019). Sometimes, we overlook these issues – or they remain unobserved behind more visible phenomena. This article argues that drug addiction, as a mental disorder, determines the character of a whole spatial entity, according to which a locality is hugely stigmatised and segregated.

Illegal drug activity is seen as an almost irrepressible social phenomenon. The drug problem carries not only economic and social consequences but is also primarily linked to human health. According to the resource of diagnostic criteria for all mental disorders called the Diagnostic Statistical Manual (DSM), drug use and drug dependence are both recognised as chronic mental health and brain disorder (American Psychiatric Association, 2013). In Slovakia, addictions are the third most prevalent driver of mental health issues (Novák, 2021).

Drug activity has an extensive impact on the everyday life of a community and its reputation (Lupton, Wilson, May, Warburton, Turnbull, 2002). It is not only the adverse effects on society that set drugs to the illegal side of the law but also the criminal activity to which it is connected. Overall, criminal activity may be reasoned by a complex of factors, but its geography depends on the situational opportunities that arise from the environment (Weisburd, Wyckoff, Ready, Eck, Hinkle, Gajewski, 2006; Johnson, 2010; Sherman, Gartin, Buerger, 1989; Tharkanyan, 2015). This sheds light on the architectural and urban qualities and the spatial composition of areas where drug activity concentrates. (Brichtová, Valachovičová, 2015; Suchý, 2017)

An example of a location incorporating all these features forms a part of the housing estate Medzi Jarkami in Bratislava, Slovakia, commonly known as the Pentagon. This spatial unit is recognised as the symbol of the area, although it regrettably holds a negative connotation. Straddling Bratislava's Vrakuňa

and Podunajské Biskupice neighbourhoods, the Medzi Jarkami housing estate lies on the capital city's outskirts. The entire locality is deeply rooted in the minds of many Slovaks as a drug ghetto. When these urban districts are mentioned, there is no one who would not picture the Pentagon and drugs. The infamous reputation is also underlined by the data on the crime rate, which annually report the highest figures within the city in these parts of the capital (the Bratislava II administrative district) (Ministry of Interior of the Slovak Republic, 2022). The stigmatisation and reputation of the locality has several underlying effects, including notably lower real estate values as compared to any other Bratislava's urban districts and reduced educational opportunities and possible achievements.

## LITERATURE REVIEW

Mental health as a factor defining architectural characteristics of a building or space is a topic viewed mainly through the lenses of health institutions. Extending the topic to a urban scale to provide guidelines on designing a space that supports good mental health is a relatively new research focus, yet without a robust base for architectural and urban design approaches. On the other hand, the literature is solid in environmental psychology determining environmental factors affecting mental health, known as environmental stressors. Even though mental health is a structured phenomenon that involves various individual and social factors, including a sense of community, safety and security, social cohesion, or place attachment, research suggests that the environment a person lives in can protect from or catalyse the development of a mental disorder. Its direct or indirect influence depends on the exact environmental stressor. These factors, or stressors of a place, affect mental health at both psychological and physical level. The psychological level is affected by raising or lowering stress levels (Helbich, 2018); while the physical level is demonstrated through changes in brain structure and function (Bick, Nelson, 2016). What the factors are and how they are experienced depends on where one spends time socially, where one works or goes to school, and, obviously, also where one lives.

Even though nowadays, most of the city's residents spend their days mostly at work or school, residential areas are still considered impactful. The environmental stressors one is often exposed to in residential areas involve, for example, air pollution, climate, or environmental racism and poverty in some areas, but one of the most concerning environmental stressors overall is crime. A 2016 study by Dustmann and Fasani has determined that crime is a stressful but temporary event creating only provisional mental distress without immediate consequences for long-term mental status. Despite that, results interpreted that living in an area with high crime rates can have a significant impact on mental health in cases when a crime is a repeated shock that can occur frequently. This means that individuals who live in areas with frequent crime shocks may experience more mental distress, which can have ripple effects on their behaviour, productivity and relationships. (Dustmann, Fasani, 2016) However, the study results reported that if a person is exposed to higher crime levels for a long time, the risk of developing anxiety or depression increases (Dustmann, Fasani, 2016).

The correlation between location and crime has been a long-standing subject of study. According to environmental criminology, crime occurs due to the availability of criminogenic opportunities within the environment, which are known by individuals with criminal motivation via their daily interaction with the surroundings (Felson, Clarke, 1998). Through Daily Routine Theory (Felson, Cohen, 1980), authors also suggested that three conditions must collide to make a crime possible to happen in a specific place and at a given time. The location must dispose of a motivated individual and an available target or victim while social control over the place is not being ensured. If any of the above is missing, the likelihood of possible crime is reduced. Applying this to the drug crime problem, in order for it to occur, a drug dealer and a potential drug buyer must come to the same place. If the social control of the place is not provided, or it is provided insufficiently by someone corrupted or unable to prevent it, it is most likely for crime to happen (Tharkanyan, 2015).

According to the crime pattern theory (Brantingham, Brantingham, 1981), crime targets are identified by criminals as a by-product of daily routine activities. They suggest how street network affects offenders' route choices and contributes to their overall awareness of space and criminal opportunities. (Benkovičová, 2015) Authors of this theory divide activities and awareness spaces into three categories: nodes, representing an actual place where activities occur; paths, representing a route both criminals and targets take to navigate between nodes; and edges, referring to the physical and notional boundaries in places of a particular change in urban form (Brantingham, Brantingham, 1981).

In the context of the mentioned theory, there have been various studies and debates regarding the correlation between illegal drug activity and crime. Some researchers, such as Bennet and Sibbitt, Chaiken and Chaiken, and Parker and Newcombe, have suggested that drug use may lead to other types of crime, including robbery, burglary, and violent crime. However, others have argued that there is little evidence to support a direct link between drug use and criminal behaviour. More recent research findings indicated that community-based policing interventions targeting drug hot spots in partnership with local communities are more effective than only using law enforcement approaches. (Haracopos, Hough, 2005; Mazerolle, Ransley, 2006; Weisburd, Eck, 2004). One thing that is clear, though, is that illegal drug activity can have a negative impact on the social organisation of a community and can contribute to the fear of crime among local residents (Cyster, Rowe, 2006). As a result, researchers suggest that, to combat street drug dealing, specific locations should be targeted instead of individual dealers or gangs. Collaborative strategies involving multiple agencies have been found to be the most successful (Tharkanyan, 2015).

## METHODOLOGY

The goal of our study is to understand the connection between and the impact of the mental health of residents and the urban structure they live in through the identification of particular physical aspects of their environment. The complexity of the situation required continuous data collection. First, the literature review of theories connecting mental health and physical aspects on the urban scale was completed. After that, an analysis of the Pentagon case study was elaborated at two levels: on-site participant observations and structured interviews. On-site participant observations comprised three phases. Each phase took place in a different season – the first phase took place during June, July, and August 2022; the second phase observations were realised during winter months – from October 2022 until early January 2023; and the last, third phase took place during the spring of 2023 – from April to late May.

Structured interviews were conducted in parallel with the participant observation. Based on Haracopos and Hough (2005); Mazerolle and Ransley (2006); Weisburd and Eck (2004), findings mentioned in the literature review, at first, relevant stakeholders were identified. The low-threshold Centre MIX Klub takes care of children and young from the locality. Poverty experienced by low-income social groups living here is also respon-

sible for young people spending their free time on the streets, exposed to contact with dealers, sex businesses and drug addiction. The K2 Centre – Odysseus organisation deals with drug activity and drug users. The goal is to cultivate and reduce the activity to the smallest possible well-controlled space, clean up the environment from drug waste, and, where possible, help drug addicts with their situation. With approximately 60 clients daily (500 clients annually), the centre assists with sharpened conflicts between addicts as well as with addicts' homelessness and camping in the inner block. Lastly, the municipality's urban field team works with around ten clients annually, providing them with social assistance. The Municipality office is on the 2nd parterre floor.

To understand the broader context, inhabitants of other octagonal units of the Medzi Jarkami housing estate were also interviewed. Structured interviews took place directly in the locality and its immediate surroundings, while a maximum of two people were interviewed at once. In the latter part of this analysis, Pentagon residents are marked as Respondents 1–5; organisation employees are marked as Respondent 6 and Respondent 7. Medzi Jarkami residents are marked as Respondents 8–14. In the meantime, desktop research was conducted to gather information on the building itself and the locality's history. Secondary data comprised open-source data, including press articles, news reports and architecture magazine articles.

## LOCATIONAL BACKGROUND

Medzi Jarkami is an experimental residential complex built in the 1970s. The area where the whole housing estate is situated was initially filled with the water branches of the nearside river Malý Dunaj (Little Danube). Most of the terrain irregularities created by the water were evened out when Medzi Jarkami panel blocks of flats were being built, but at the Pentagon's site, terrain irregularities were incorporated into the building concept (Varga, 2023). Medzi Jarkami consists of four octagonal units and was the first housing estate in Slovakia to prioritize public space and recreational activities while keeping traffic to its outer edges. (Fig. 1)

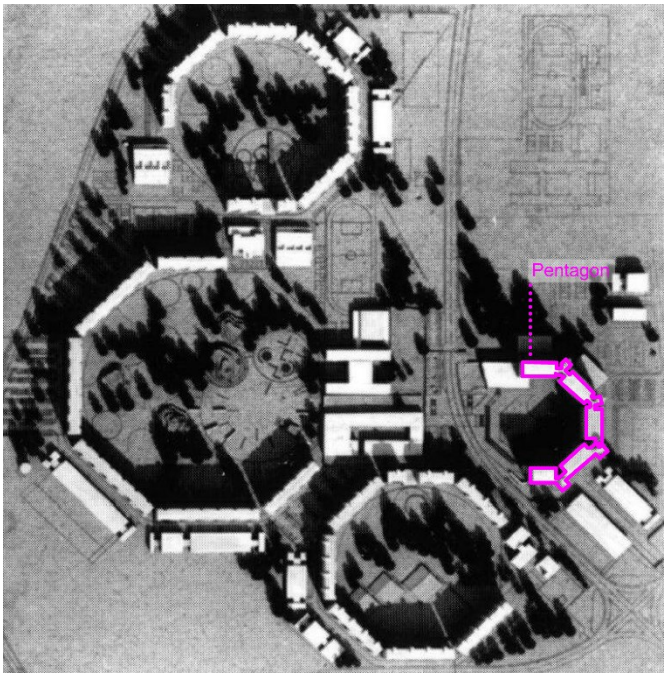


**Fig. 1.** Model of Medzi Jarkami housing estate. Architects: Štefan Svetko, Štefan Ďurkovič. (Source: Slovak Chamber of Architects, 2023)

The smallest unit of the complex, the Pentagon, comprises five objects connected through vertical cores. Compared with the architecture of the other three octagonal units, it was a very different architectural approach that was also reflected in how the building was positioned on the site. The existing terrain formed a two-storey base space with spaces for commercial services. In contrast, the terrain break on the vacant side of the site plot was filled with a built-in staircase and a driveway on its edges – situating the whole inner block of this site below the street level (Varga, 2023).

The reasons for building the Pentagon differently from the other octagonal units came from an initial intention to provide temporary housing for employees of large state-owned companies (Janák, 2020). The social intention led to filling all five objects with only two types of small apartments (a total of 450 flats) where rooms are only 2.5 meters wide with an overall size of an apartment of 38 square meters (Varga, Kvitkovský, 2023). The original plans for the construction envisaged a community kitchen situated at the base of the objects as well as a swimming pool and spaces for other recreational activities on its outer facades (Varga, 2023). Unfortunately, free-time spaces and ambitious plans to create a collective living house have never seen the light of day.

The change in the political system brought owner-whip rights modification and characterised the era of the 1990s. The lack of diversity in flats predestined the locality to only be interesting to specific social-income groups, mainly with low economic status and racial determination. Principally, the greater the concentration of a particular social group, the more protuberant and visible the social group's issues. Around this time, drug activity gained its place, and the locality started to be seen as problematic.

## FINDINGS

The observations and interviews conducted in three phases corresponded to the changes and developments that occurred in the study area during the research period. Tab. 1 provides a summary of the main issues raised by various respondent groups during the interviews, specifically relating to the built environment.

**Tab. 1.** Overview of main issues concerning the built environment of the Pentagon and its surroundings raised during interviews, information by respondent groups. (Source: Authors, 2023)

| | Research phase 1 (Jun – Aug 2022) | Research phase 2 (Oct – Jan 2023) | Research phase 3 (Apr – May 2023) |
|---|---|---|---|
| Respondent group 1 – residents of the Pentagon (1–5) | Acoustic pollution caused by doorbells | | Reduced night pollution |
| Respondent group 2 – organisations employees (6–7) | Neglected vegetation, missing safe spaces | Drug users present in other parts of the neighbourhood | |
| Respondent group 3 – residents of Medzi Jarkami (8–14) | | | |

At the beginning of the first observation phase, drug dealing concentrated mainly around the building (Fig. 2). A few weeks later, a fence surrounding the building was built, and the drug activity returned to the inner block of the Pentagon and dominated the built-in staircase of the terrain break. None of the people had any inhibitions when using drugs anytime during the day. The space of the built-in stairs lies next to the Odysseus

Centre, which equipped the area with trash bins for syringes and systematically cleans the environment. Since the inner block space was mostly occupied, other resident groups used urban spaces adjacent to the Pentagon. A very visible social group in the area are the Roma people who live in the non-residential premises in the Pentagon (2nd parterre floor). The youngest children were mostly seen playing on the paved area next to the street market, forming an entrance into the pedestrian zone from the Pentagon. This pedestrian zone is bounded by a low-rise building with an active parterre with pubs, where many Roma adults and seniors spend their time. At the end of the pedestrian zone, in a small round square with benches, older children and young adults could be seen mainly in the evening. Other social groups of residents were less visible and more deconcentrated in the broader area of the whole housing estate, using parks, cycle paths and playgrounds. (Fig. 3)

During the on-site observation phase, several environmental stressors were detected. The most evident proved to be the acoustics of the Pentagon's inner block. The internal facades of the building's half-circle-like composition reflect all the sounds from the inner block, causing acoustic pollution. It is common for residents to hear everything that is happening there, which was referred to in the interviews as unsettling and especially stressful at night (Respondent 1, 3-5). This stressor is reinforced by the absence of doorbells. Many people often resort to shouting at each other to get the building's front door open, which creates a lot of unnecessary tension and anxiety (Respondent 1-5). The second environmental stressor present here was characterised by low social control. This is caused by the low utilisation of the parterre floors, mainly the first one, which is in direct contact with the inner block. Commercial services situated there have storefronts plastered with advertisements through which one cannot see in and out or they are unused since they were covered with metal sheets to prevent addicts from gathering under the arcades. (Fig. 4) On the one hand, the metal sheet solution reduces the permeability of the whole structure, which is desired in locations affected by drugs and crime (Tharkanyan, 2015). On the other hand, the suitability of the used material is questionable since it reduces the friendliness of the environment and increases acoustic stress when it is hit by the wind, or sometimes even a person.

While the intention of having green spaces in a neighbourhood is to encourage relaxation and a sense of tranquillity, in Pentagon, the condition of the vegetation space contributes to elevated stress levels (Respondent 1, 3-7). Neglected vegetation maintenance and surfaces destroyed by drug users and homeless' camping foster the residents' fears of crime, feelings of apprehension and discomfort as cited by the residents. Lastly observed are the dark and "invisible" corners referring mainly to the built-in staircase in the terrain break. This predicament is primarily attributed to the terrain, which renders certain sections of the inner block difficult to discern from other vantage points, resulting in isolation from the surroundings. Approximately a quarter of the inner block is concealed from the view, and when combined with the surrounding vegetation, the issue extends to roughly a third of the entire area. This fact is subconsciously realised by both inner block users and residents. For one group, it forms a space to hide from the "outside" world, while the other sees it as a concern for their safety. (Fig. 5)

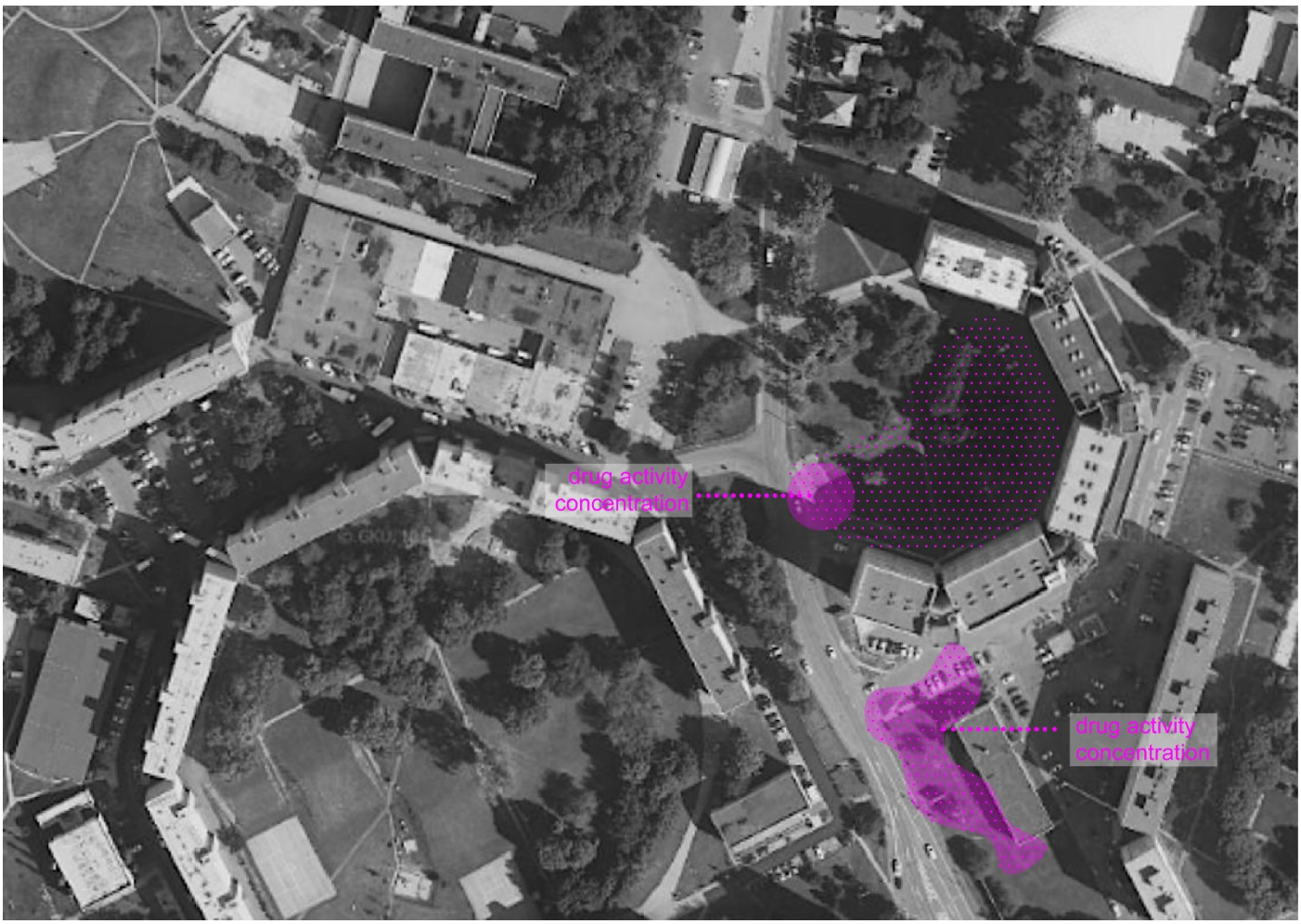


**Fig. 2.** Areas of drug concentration at the beginning of the first observation phase. (Source: Authors, 2023)


**Fig. 3.** The movement of drug activity during the first observation phase. (Source: Authors, 2023)

**Fig. 4.** Pentagon's parterre covered with metal sheets. (Photo: Šimkovičová, 2023)

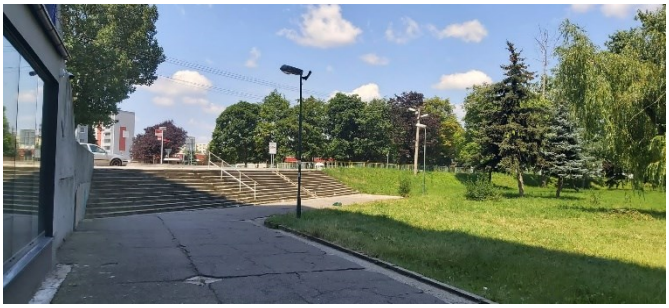

**Fig. 5.** Photo of the terrain break and built-in staircase. (Photo: Šimkovičová, 2023)

The need for residents to protect themselves is evident and appropriate. The other measures arise from drug use in the common interior spaces and the building's base (1st and 2nd floors). The situation led the residents to implement measures ranging from simple non-reproducible magnetic keys to complex surveillance systems installed in every single space of the entrance and along the vertical communications, which the elected person controls round the clock. The outer spaces, especially the spaces of the lower parterre arcade, were covered with metal sheets to prevent the gathering of drug users (Respondent 2, 5, 11, 12).

The second observation phase took place after the opening of a new police station. The Municipality decided to locate it in a parterre of the Pentagon next to the aforementioned staircase and Odysseus Centre. The establishment of the police station in September 2022 partially changed the spatial pattern of drug activity. Drug dealing and using moved from the outer edges – behind the terrain block – to the other side of the street. During winter, drug activity could be observed at the entrance of the pedestrian zone, a space where young Roma children used to play. Plus, at the corner of the small health centre situated nearby. (Fig. 6) At this time of the year, any other social groups were not visible in the adjacent urban public spaces (Respondent 6, 8, 10)

The third phase of observations demonstrated the drug activity still occupying the outer edges of the Pentagon. Corners of the health centre were widely being used, along with the neighbouring parking lots and their vegetation belt. With warmer weather, the Roma social group returned to the pedestrian zone to the same places as described in the first phase. (Fig. 7) During the last observations, it was evident that the locality reports lower acoustic pollution. The functioning of the police station helped reduce the noise rate, mainly during nighttime, which raised the

quality of life and is highly appreciated by the residents. (Respondent 2-4). The provided social control helped to strengthen the feeling of safety (Respondent 2, 4, 7, 10, 12, 13).

## CONCLUSION

As we can see from the site-specific findings, the observations proved that there is a direct correlation between the urban structure of the neighbourhood of Medzi Jarkami and the mental health of its residents. Firstly, it is the stigmatisation of the whole urban district caused by a high level of incidence of drug addiction as a mental disorder that, in the bigger terms, influences the "image" of the area, which affects the further social structure of the residents. The drug problem in the Pentagon left marks on the whole urban district of Vrakuňa. The quality of the residents' life has significantly reduced over the years. Moreover, this unfavourable and stigmatised perception also leads to diminished educational opportunities and achievements within the community. Even though many measures to prevent drug activity in the locality were taken, the study showed that the mental health of the local residents has an essential impact on the development of urban neighbourhoods.

Furthermore, the on-site observations also clearly identified a number of physical features of the built structure of the area – environmental stressors (acoustic pollution, low social control, etc.) – that have a strong influence on the unhealthy mental status of the residents and actually contribute to its worsening. Therefore, when addressing the problems of the Pentagon, this perspective cannot be overlooked. In similar urban districts, behind the high crime rate lies drug addiction as a mental disorder that has its connections with the settings of the surroundings. Thus, in order to propose a sustainable solution parallel to "soft" interventions (medical, social help), the above-mentioned environmental features must also be addressed in an architectural way.

This can be further observed in the situation with the opening of the police station, which has significantly reduced the use of the built-in staircase as the place most frequently used for drug dealing and drug use. Since it is seen that drug activity moves from place to place within a few hundred meters of the locality, however, in the minor concentration, it would be worth researching if the drug activity is reduced or just deconcentrated into the other parts of the Medzi Jarkami housing estate as it used to be several years ago. Another point for further research is the inner common spaces – vertical cores, hallways and corridors, of the Pentagon itself and determining the architectural stressors that make the interior unfriendly and crime-encouraging. The same applies to researching methods of architectural regeneration. Examining the overlooked areas from a mental health perspective is a valuable contribution to addressing problematic spaces, forming the potential for a discovery of effective regeneration solutions.

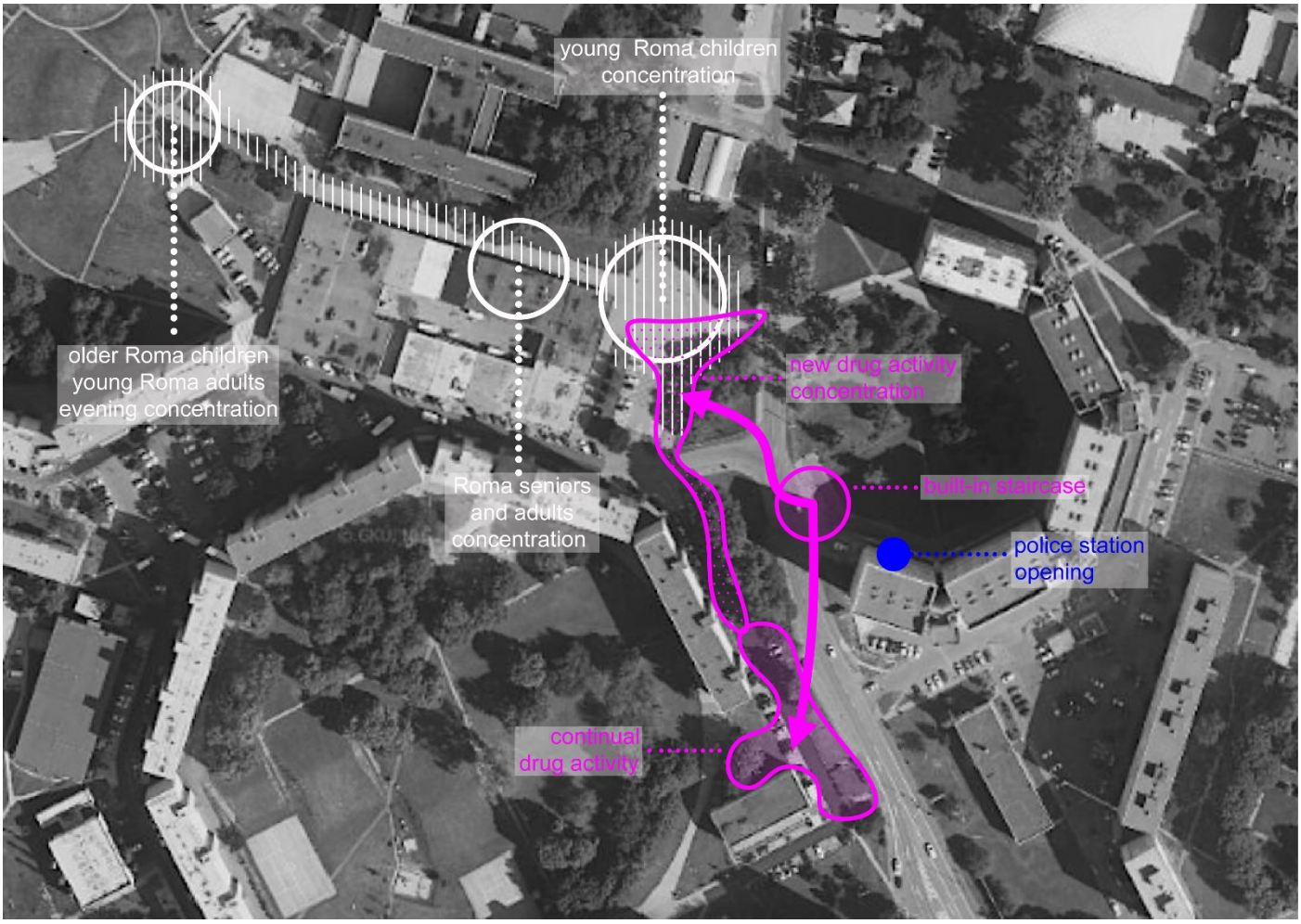


**Fig. 6.** The movement of drug activity during the second observation phase. (Source: Authors, 2023)

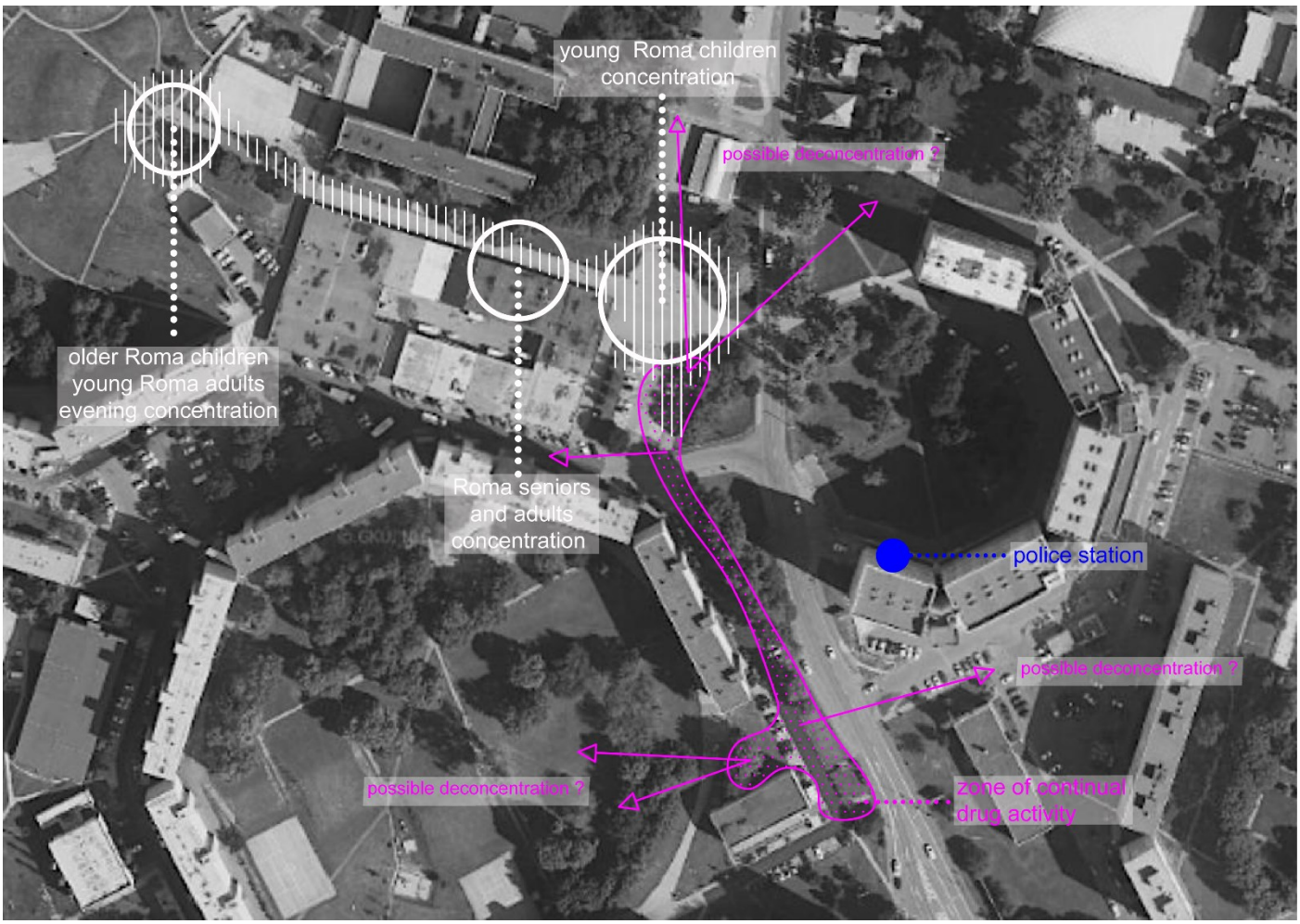


**Fig. 7.** The movement of drug activity during the third observation phase and possible directions of the de-concentration of drug activity. (Source: Authors, 2023)

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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

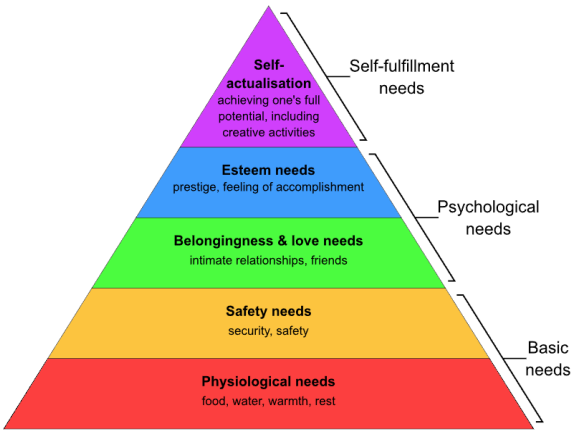



**Fig. 1.** Maslow's hierarchy of needs. (Source: Androidmarsexpress, 2020; CC BY-SA 4.0)

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).

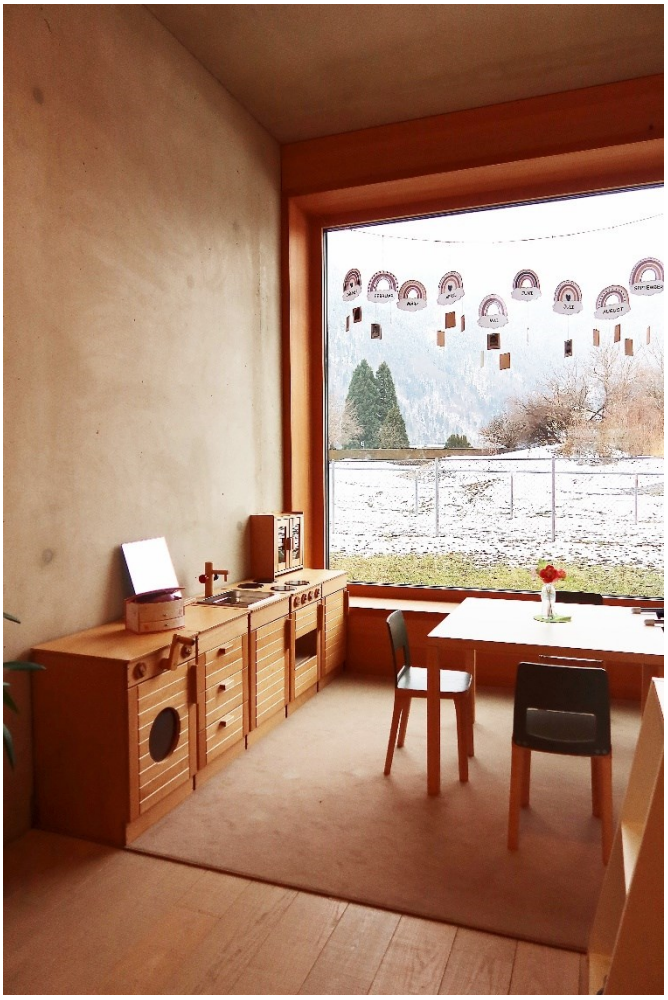


**Fig. 16.** Teachers have complained of headaches due to inadequate air supply. It would help to have a more efficient air exchange or more adjustable windows in all rooms. (Photo: Jakub Hanták, 2023)

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.

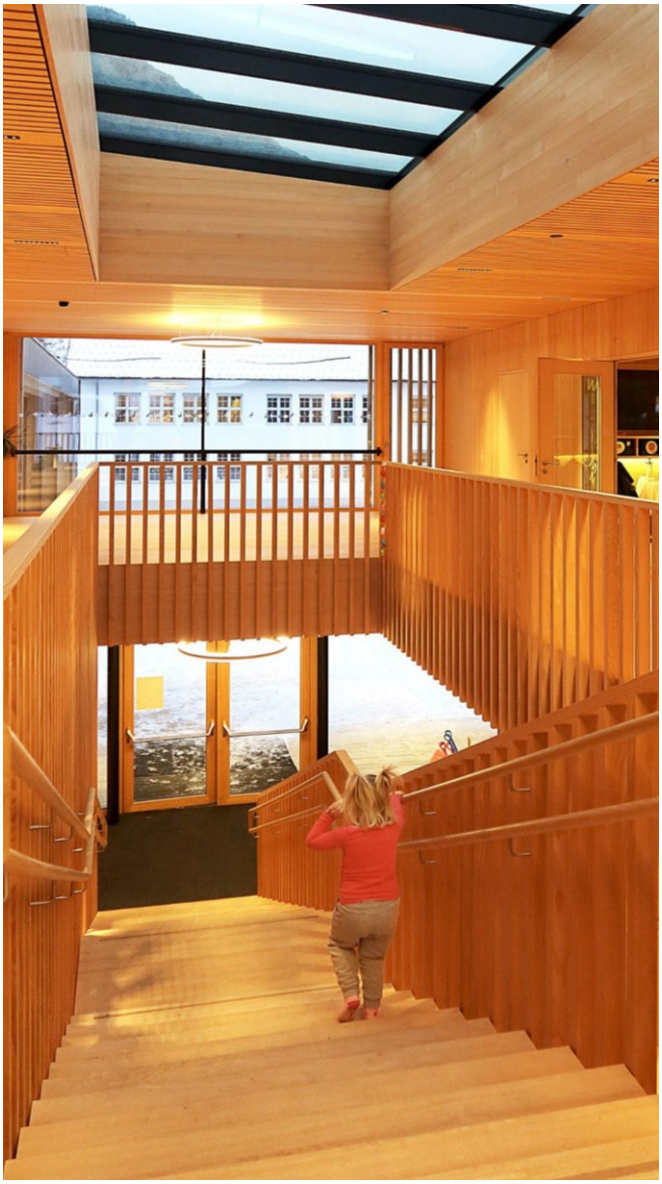


**Fig. 19.** Central space of the gallery with a skylight and a linear staircase. (Photo: Jakub Hanták, 2023)

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."*

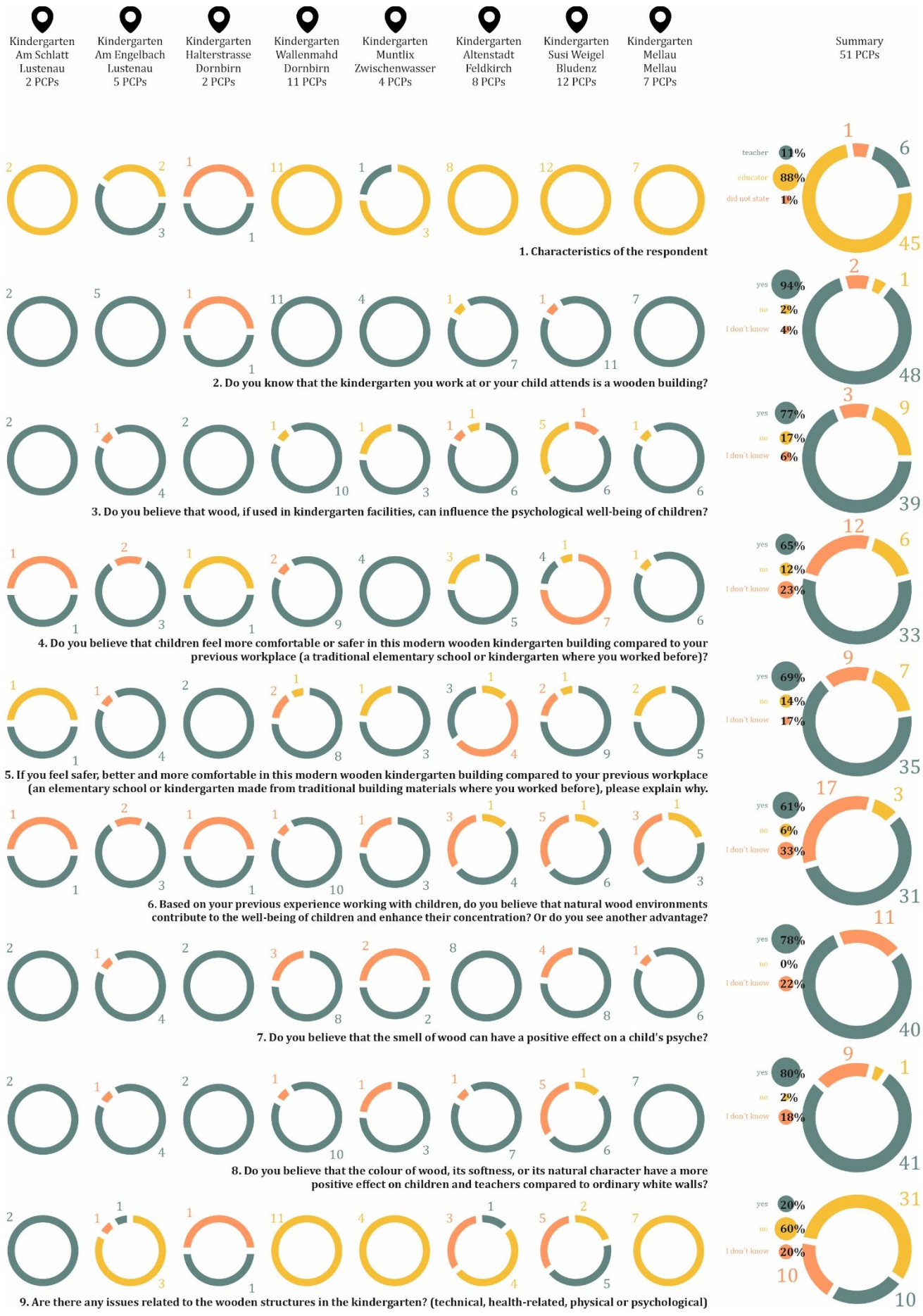
Partial results from the survey indicate that as many as 78% of respondents believe that the smell of wood has a positive impact on the psyche. The aroma can stimulate the senses, and a pleasant and natural wood scent can help reduce anxiety and stress, creating a sense of relaxation and peace. Children 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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# Summaries



## USING A DIGITAL PARTICIPATORY APPROACH TO FACILITATE INCLUSIVITY IN JORDANIAN HERITAGE SITES: STAKEHOLDERS' REQUIREMENTS AND A PROPOSED SYSTEM

**Aseel Aljaafreh, Vanja Garaj, Youngok Choi**

*Keywords: participatory approach, inclusive design, immersive technology, community engagement, built heritage sites*

This paper explores the barriers and factors affecting inclusivity in historical sites, focusing on the "Accessible Tourism" national project in Jordan. The paper discusses the importance of inclusive design in built heritage and the positive outcomes it can promote, such as social cohesion, cultural understanding, equal opportunities, empowerment, representation, and economic benefits. The use of digital technologies in cultural heritage projects is highlighted as a significant development, revolutionizing the way people experience and interact with the past. Various applications of digital technologies, including 3D photogrammetry, immersive techniques, virtual reality, and big data analytics, are discussed in the context of architectural and urban environments, archaeological sites, building and site monitoring, mapping, and model making. The paper emphasizes the need for collaborative methodologies and the integration of digital technologies in preserving and promoting cultural heritage. It discusses how digital technologies facilitate digital preservation, interactive display functionalities, virtual restoration and reconstruction methods, and community involvement. Additionally, the paper explores the role of participatory design approaches in enhancing audience engagement and fostering conversations with visitors, as well as the use of technology solutions like Linked Data, crowdsourcing, exergaming, wikis, and virtual reality in community-led cultural heritage initiatives. The research methodology employed in the paper involves interviews with 23 participants involved in the "Accessible Tourism" project. These participants include accessibility consultants, architects, planners, project managers, legal affairs actors, and heritage site staff. The interviews focused on understanding the challenges and requirements faced by these stakeholders in designing and planning inclusive and accessible tourism. The data collected from the interviews were synthesized, coded, and analysed using NVivo software. The findings and discussion section of the paper consists of two parts: Session 1 focuses on understanding user design and planning challenges, while Session 2 discusses participants' views on using digital technologies in the design and development process. Session 1 highlights the common challenges faced in facilitating accessibility and inclusivity at cultural and historical sites. Effective interdepartmental communication is crucial to ensure a shared understanding of goals and requirements. Historic preservation constraints and comprehension of accessibility codes pose challenges. Additionally, difficulties in engaging users with disabilities or from marginalized communities and limited user research hinder the development of inclusive facilities. To address these challenges, the paper suggests allocating adequate time and resources for user research and engagement. Inclusivity can be enhanced by involving end-users from the early stages of the project, conducting focus groups, interviews, surveys, and

usability testing, and prioritizing effective communication methods. Session 1 also identifies role-specific challenges for legal affairs actors, architects, planners, heritage site staff, project managers, and accessibility consultants. These challenges include navigating complex legal frameworks, finding architectural solutions that preserve historical value, balancing competing objectives for planners, training heritage staff members, and lacking comprehensive guidelines for project managers and accessibility consultants. Session 2 discusses participants' perspectives on using digital technologies in the design and development process. The benefits of digital tools include enhanced design visualization, improved remote communication and collaboration, cost and time efficiency, accessible design testing, and preservation of historical integrity. However, there are also concerns raised about integrating technology with historical preservation regulations, technological barriers, learning curves, and the digital divide. The paper concludes by proposing an initial system design diagram to address the challenges discussed. It emphasizes the importance of a user-centred approach, comprehensive user research, and user engagement in achieving true accessibility and inclusivity in historical sites. It integrates 3D capturing technology with interactive crowdsourcing platforms with a particular emphasis on engaging the local community. In conclusion, this research paper provides insights into the barriers and factors affecting inclusivity in historical sites, focusing on the "Accessible Tourism" national project in Jordan. It highlights the role of digital technologies in cultural heritage projects and the importance of collaborative and participatory design approaches. The findings contribute to the understanding of the challenges and requirements in implementing inclusive design principles in built heritage sites.

## UNIVERSAL DESIGN AND SOCIAL CARE: ASSISTIVE ROBOTS AS OTHER USERS OF THE BUILT ENVIRONMENT?

**Lea Rollová, Peter Hubinský, Natália Bošková Filová**

*Keywords: architecture, built-environment, universal design, assistive robot, butler robot, social care*

Population ageing is a serious problem, as confirmed by the results of all known national and international population projections. The negative impact of population ageing is manifested in almost all areas, especially threatening the sustainability of social and economic systems. Therefore, solutions are being sought to help people in need of care while also relieving the burden on care staff through technological innovations, including robots. When investigating the relationship between robots and the built environment, it is necessary to analyse the robots' ability to move in the environment, and also the possible ways of handling various objects, studying the robots' possible actions in the environment in which social services are provided. It is also important to create an infrastructure for locating robots in the indoor environment, recharging them, and ensuring the appropriate type of wireless communication between the robot and the building's infrastructure. A big challenge for the robot is mounting or descending stairs or overcoming other vertical obstacles. Therefore, for the use of a robot as a human assistant in a social services building, it is optimal to ensure a completely barrier-free environment. Another condition for the undisturbed work of assistive mobile robots is the existence of a charging infrastructure. The following research question was hypothesised: Can a building that is designed according to Universal Design principles be suitable for Assistive Robots? For the purposes of the investigation, a building known as supported housing was selected, in which the social service is to be provided. The selected model building, Type B – Family type house, is an adaptable house with a capacity of 4 to 12 inhabitants, depending on the needs of the service provider, location or size of the plot. This building consists of specialised residential placements that provide ongoing assistance and access to as-needed specialised therapies or treatments. In the premises of the selected model project Type B, size "L", the movement and functioning of assistive and butler robots was simulated. Our research investigated the functioning of robots in the selected model building, which, together with digital assistants of other kinds, could also provide people with some forms of social care support. Two selected robot models were researched, whose dimensions and the method of movement were taken into consideration during the investigation: (1) Assistive Robot "RIBA II", and (2) Butler Robot "RELAY+S". The premises of the model building were analysed for the requirements and

functioning of these robots. The analysis is carried out sequentially according to a defined route that passes through all rooms. In each room, the role of the robot is defined, and its space requirements and the required hardware are examined. The location for contact charger spaces in the model home was also investigated. We compare the space requirements in terms of accessibility for people using wheelchairs and accessibility for robots. The major problems associated with the robot operation in the model project are summarised. In the selected model project, the requirements for bed mobility were taken into account in the design of spaces and doors. The manoeuvring space of a person in a mechanical wheelchair has a diameter (Ø) of 150 cm, which is significantly more than the assessed robots need. This circle must be planned around objects which are being handled for example in front of a door, a table, a cupboard, or by a bed. The Assistive Robot RIBA II can rotate in around a point, so the manoeuvring circle is Ø 110 cm and the Butler Robot RELAY+S rotates around a point, so the manoeuvring circle is only Ø 51 cm. The model building project, i.e. Type B – Family type house, is largely suitable or adoptable for the purposes of robot movement and operation. We proposed several modifications to it to enable robots to manoeuvre and be used in all spaces as required. More fundamental modifications had to be made in the bathrooms. We took into account the requirements of people with the greatest need for assistance, for example people with muscular dystrophy who need assistance to be transferred from a wheelchair to a toilet or to a shower chair. Adjustments were necessary because the robot needs more space next to a toilet or a shower than a human assistant does when "operating". We design the charging spots separately for each type of robot to avoid collisions. Catering to all the unique needs of older people can be a difficult task for those providing personal care, especially as they have many other important responsibilities. Many older adults who are cared for feel boredom, illness, sadness, pain, and loneliness. Current research is looking at the extent to which robots could improve the quality of care. The environment also plays an important role in wellbeing. We see interdisciplinary research as crucial because assistive systems that can help people “age in place” in their own homes can increase the wellbeing and independence of older adults and people with disabilities, reduce the societal cost of care, and at the same time solve the problem of workforce shortages in the health and social care sector.

## ARCHITECTURE OF HEALTHCARE AND SOCIAL INCLUSION IN INTERWAR CZECHOSLOVAKIA: PEZINOK PSYCHIATRIC INSTITUTE AND THE MASARYK INSTITUTE FOR YOUNG PEOPLE WITH INTELLECTUAL AND PHYSICAL DISABILITIES IN BRATISLAVA

**Matúš Kiaček**

*Keywords: health, social care, social inclusion, disabilities, psychiatric institute, interwar Czechoslovakia, Frič, Harminc*

The formation of an independent Czechoslovak Republic created a space for the institutionalisation of health and social care and the institution of a new legacy as a reflection on the state’s social policy. In addition to social and medical work in the field, as well as improvements in housing and hygiene conditions in both cities and the countryside, it became crucial to modernise and expand the network of healthcare and social facilities, including those for the people with disabilities. Although there were medical advancements in institutional care for people with mental and physical disabilities, such as rehabilitation, hydrotherapy, hippotherapy, electroconvulsive therapy, or therapy at work, attempts at social inclusion were rare and the care only improved slightly. There were only a few innovative institutions that pioneered social inclusion of patients, through proper education and adaptable architecture. The paper focusses on the subject of healthcare and social inclusion of young people with intellectual and physical disabilities in interwar Czechoslovakia, presented in the architecture of the Institute for People with Nervous and Mental Health Disorders in Pezinok (1930s–1940s) and the Masaryk Institute for Young people with Intellectual and Physical disabilities in Bratislava (1935). The aim is to identify crucial problems, confront visions and reality, and to prove that, despite difficulties and minor results, even then there were innovative architectural and medical reflections on the needs of people with disabilities. The Pezinok Institute was the first clinic in central Europe to offer treatment of children with epilepsy and mental disabilities. The institute was owned

by the joint-stock company Pezinské železité kúpele (Pezinok Ferrous Spa), established by the construction entrepreneur Rudolf Frič (1887–1975), who redesigned and rebuilt the clinic and added new functionalist buildings (1930s–1940s). In an expert capacity, the project was professionally overseen by Professor Karol Matulay (1906–1998). For chronic child patients with epilepsy and intellectual disability, work therapy and hippotherapy were particularly effective, so that the facilities established workshops, ovens, and greenhouses where patients learnt practical craft skills. The institute believed that elementary education and practical skills would socialise patients, adapt them to general society, and decrease their dependence on the government and their relatives. The early phase of the institution's construction consisted of rebuilding a ferrous iron spa in the early 1930s and its adaptation to a men's ward. In 1940 the campus was expanded by absorbing the neighbouring plot of land with the former antimony factory, the buildings of which were provisionally adapted to a women's ward and the gardens of the two sites were connected. The campus was enlarged in stages by the construction of other ward pavilions, private patient pavilions, an office building, workshops, complementary facilities and others, including landscape redesign and new outdoor facilities such as horse riding. The further planned expansion of the facility, based on the pavilion plan, including the construction of new wards and a school, was halted by the worsening war situation and the increasing social hate and feeling of superiority to any minority, including the one with disabilities, as claimed by the Nazi ideology. The Masaryk Institute, as the first of its kind in Slovakia, aimed not only to establish institutional health and social care, but also to integrate its patients into the society. According to its initiator, professor Karol Koch, it was requisite to adapt the architecture to the needs of the people with disabilities, while not allowing them to feel that their environment differed from that of the others. Therefore, the facilities would include ateliers, workshops, aulas and studies, a theatre hall and library, to educate and socialise the patients. The innovative nature of the institute's program was imprinted in its progressive functionalist design by Milan Anton Pavol Harminc (1905–1974), with a pavilion for people with physical disabilities, another pavilion for people with mental deviations, and one central social and educational pavilion with a hospital ward. The cascading structure of buildings located on a hill made it possible to arrange the buildings in a more concentrated manner, ensuring sufficient ventilation and sunlight, as well as the separation and segregation of patients and facilities. Unfortunately, due to financial shortages, and strategic change in the institutionalisation of government healthcare, the Masaryk Institute for Young People with Intellectual and Physical Disabilities has never been built. It proved that as opposed to the society, the government was not prepared for the ambitious vision of inclusion of people with disabilities. The paper has tried to verify that, despite obstacles and partial achievements, the Czechoslovak interwar architecture managed to reflect the actual demands of health and social care of people with both intellectual and physical disabilities. However, both examples prove only partial fulfilment of the medical and social goals of Czechoslovak interwar health and social care of the people with disabilities.

## MENTAL HEALTH AS DETERMINING FACTOR OF URBAN DISTRICT'S CHARACTER: CASE STUDY BRATISLAVA – THE PENTAGON

**Barbora Šimkovičová, Katarína Smatanová**

*Keywords: mental health, urban design, crime prevention, drugs, addiction, segregated urban areas, design for health*

The topic of mental health is on the fringe of the interest of architects and urban planners. But the physical environment in which we live is one of the strongest determinants of our health (United Nations, 2015). Sometimes, we overlook these issues – or they remain unobserved behind more visible phenomena. On a case study of the urban district Medzi Jarkami in Bratislava, Slovakia, particularly a block called the Pentagon, this article argues that drug addiction, as a mental health disorder, determines the character of a whole spatial entity, according to which a locality is hugely stigmatised and segregated. Mental health as a factor defining the architectural characteristics of a building or space is a topic viewed mainly through the lenses of health institutions. Extending the topic to a urban scale to provide guidelines on designing a space that supports good mental health is a relatively new research focus, yet without a robust

base for architectural and urban design approaches. On the other hand, the literature is solid in environmental psychology determining environmental factors affecting mental health, known as environmental stressors. Research suggests that the environment a person lives in can protect from or catalyse the development of a mental disorder. Its direct or indirect influence depends on the exact environmental stressor. These factors, or stressors of a place, affect mental health both at the psychological and physical level. The psychological level is affected by raising or lowering stress levels (Helbich, 2018); while the physical level is demonstrated through changes in brain structure and function (Bick, Nelson, 2016). Based on these theories, the goal of our study is to understand the connection between and the impact of the mental health of residents and the urban structure they live in through the identification of particular physical aspects representing these stressors. The complexity of the situation required continuous data collection. Apart from the literature review, the analysis of the case study of the Pentagon was elaborated at two levels: on-site participant observations in three phases during 2022 and 2023 in parallel with structured interviews. The Medzi Jarkami housing estate lies on the Bratislava's outskirts. The entire locality is deeply rooted in the minds of many Slovaks as a drug ghetto. The infamous reputation is also underlined by the data on the crime rate, which annually show the highest figures within the city in these parts of the capital. The stigmatisation and reputation of the locality has several underlying effects, including notably lower real estate values as compared to any other Bratislava's urban districts and diminished educational opportunities and possible achievements. As an experimental residential complex, Medzi Jarkami was built in the 1970s. The smallest unit of the complex, the Pentagon, comprises five objects connected through vertical cores based on an initial intention to provide temporary housing for employees of large state-owned companies. The social intention led to filling all five objects with only two types of small apartments (a total of 450 flats) with an overall size of an apartment of 38 square meters (Varga, Kvitkovský, 2023). The lack of diversity of the flats predestined the locality to only be interesting to specific social-income groups, mainly with low economic status. After 1989 when the flats became owned by individuals, drug activity gained its place, and the locality started to be seen as problematic. Through complex research, several environmental stressors were detected in the area. The most evident proved to be the acoustics of the Pentagon's inner block. The internal facades of the building's half-circle-like composition reflect all the sounds from the inner block causing acoustic pollution, which is reinforced by other elements (e. g. absence of doorbells). The second environmental stressor present here was characterised by low social control. This is caused by the low utilisation of the parterre floors, but also by the material base of the lower floors, which does not allow visual connections. Other elements lowering the social control are neglected greenery and ruined elements of public spaces. Lastly observed are the dark and "invisible" corners referring mainly to the built-in staircase in the terrain break. All these are supported by the evident need of residents to address these problems through self-help solutions, such as to protect themselves using CCTV cameras or covering spaces or openings with metal sheets. Overall, the research proved that there is a direct correlation between a urban structure and the mental status of its residents. A number of environmental stressors were detected to be still present in the built structure. Furthermore, there is the stigmatisation of whole urban districts caused by high incidence of drug addictions as a mental disorder that, in the bigger terms, influence the "image" of the area. The drug problem in the Pentagon marked the whole urban district of Vrakuňa, reducing the resident's quality of life significantly over the years. Even though many measures to prevent drug activity in the locality have been taken, the situation in the area did not improve radically. In this urban district, behind the high crime rate lies drug addiction as a mental disorder that has its direct connections with the surrounding built environment. So, to propose a sustainable solution, parallel to "soft" interventions (medical, social help), the abovementioned environmental features must also be addressed in an architectural way.

## POSITIVE EFFECTS OF WOOD IN VORARLBERG'S (AUSTRIA) TIMBER KINDERGARTENS

**Jakub Hanták, Danica Končeková**

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

The topic of implementing sustainable materials and integrating them into newly constructed, valuable, and cultural architecture is currently often mentioned in connection with the new initiative of the New European Bauhaus. The aim of this article is to highlight the impact of wood as a material used in the interiors of kindergartens on the development of children and inclusivity in education. The use of wooden furniture and wooden structural elements in kindergarten interiors opens up a new area of research and interest in the context of supporting diversity and accessibility for every child, regardless of their abilities or limitations. The article analyses the timber architecture of kindergartens in the Vorarlberg region, which, thanks to the use of natural, local, and especially sustainable material such as solid wood, serves as an excellent reference example for creating new school projects. The partial research focused on existing wooden kindergartens in Austria, as one of the Alpine countries where wooden kindergartens are relatively widespread. The study interprets the results of practical research conducted in eight selected kindergartens (Kindergarten Am Schlatt - Lustenau, Kindergarten Am Engelbach - Lustenau, Kindergarten Hatlerstraße - Dornbirn, Kindergarten Wallenmahd - Dornbirn, Kindergarten Muntlix - Muntlix, Kindergarten Altenstadt - Feldkirch, Kindergarten Susi Weigel - Bludenz, Kindergarten Mellau - Mellau) in the Vorarlberg region. The visual-haptic-olfactory contact with solid wood elements in kindergarten environments undoubtedly affects the emotional and physiological well-being of children. Wood material in kindergarten interiors can improve the educational processes, contribute to inclusive education for children, influence their cognitive abilities, reduce their stress, and ultimately positively influence their overall quality of life. This article aims to emphasize the effect of solid wood material (structural elements, furniture, toys and play elements) on the development of children and inclusivity in education. The presence of solid wood can have an aesthetic and psychological effect in kindergarten interiors and exteriors, providing children with direct contact with nature, which has become increasingly less frequent due to the modern urban lifestyle. The wood material, as characterized in this research, is presented as a visual, solid, interior substance. Its execution is authentic, with little or no surface treatment that could degrade its visual-haptic-olfactory qualities. The authors raise questions as to how such architectural and design thinking can help in providing inclusive education for children and whether it can positively influence children's cognitive abilities, ultimately improving their overall quality of life. The selected analyses and comparisons focused on whether the presence of wood material can positively influence the well-being of children in the physical environment of kindergartens. The article aims to demonstrate that interiors with visible wood can help to improve teaching processes, promote social interaction, and foster playful learning in children. The results of this study can serve as a strong argument for the New European Bauhaus initiative supporting the implementation of renewable materials such as wood in accordance with the principles of biophilic, restorative environmental and salutogenic design in practice. The presented paper is a partial result of doctoral research focused on studying the positive influence of wood on children's psyche and educational processes in general. One of the research goals 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 the recipients, and evaluate to what extent wood as a material has the potential to positively influence the educational process. The obtained results have the ambition to inspire the creation of new recommendations, guidelines, and solutions for the design of kindergarten architecture that would create an inclusive environment for children offering space where could expand their knowledge, gain experiences, thus applying design thinking in practice.

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# Summary of approved PhD theses

**Martin Dubiny**
**Marek Lüley**
**Martin Varga**
**Wanda Borysko**
**Vanda Gábrišová**

## ARCHITECTURE OF RIVER HARBOUR AREAS ON THE SLOVAK SECTION OF THE DANUBE

**Ing. arch. Ing. Martin Dubiny, PhD.**

The harbour infrastructure belongs to the strategic parts of the national economy. Compared to abroad, in Slovakia, harbours are a closed zone, not commonly visited by citizens or tourists. There are three major river harbours on the Slovak section of the Danube in – Bratislava, Komárno and Štúrovo. During the 20th century, they underwent manifold changes, which affected their territorial distribution and the composition of the building stock within the harbours' inner area and the city. In our territory, harbour infrastructure flourished at the turn of the 19th and 20th centuries. Its development was halted by the adversity of World War I. The "golden age" returned with the interwar period and lasted until the beginning of World War II. After World War II, a period of massive damage repairs followed. Afterwards, it had to come to terms with the establishment of the socialist regime and, after 1989, with a period of privatization. At the turn of the "millennium", harbour infrastructure was modernized and in the last decade, a discussion was initiated whether it is possible to list it under industrial heritage while finding new functions for these areas. Research under the dissertation focused on a particular type of industrial heritage, namely the architecture of harbour infrastructure. The identification of the values of this specific type of architecture provides an overview of its potential for further development of harbour areas. The comparison of the contemporary industrial architecture of selected harbours and, at the same time its confrontation with historical, cultural, and social influences, underline the complexity of the research. It transpires that professional discussion in the field of industrial heritage needs to be conducted at the interdisciplinary level not only at national and international conferences, but also in practice. The dissertation brings a set of knowledge about harbour infrastructure issues in Slovakia, which represents a contribution to extend the knowledge, which has not been comprehensively compiled so far. It describes the basic elements of harbour infrastructure from the architectural and urban points of view. The synergic interconnection of urbanism and architecture involving transport, aquatic and industrial infrastructure of the harbour and the city offers a high potential for further utilization.

*PhD thesis approved at the Faculty of Architecture and Design STU in Bratislava, Slovakia, in the study programme Architecture*

## STRATEGIES FOR ADAPTABLE ARCHITECTURE

**MArch Marek Lüley, PhD.**

When dealing with the daily demands of a sustainable approach in architecture and the rapid development of society, we must accept change and time as an integral part of the building system. The dissertation deals with adaptability in architecture as a strategy for achieving long life of buildings and resistance to change. The main argument for adaptability is its sustainable approach, incorporation of embodied

energy, its resilience, and the elimination of impacts on the environment and climate change. Architecture that is unable to adapt to the constantly changing demands of society is doomed. An adaptable approach understands architecture as a process which enables a dynamic response to changing environmental and social conditions with the aim to extend the life of a building. The application of adaptability is as ambivalent as the concept itself. Therefore, the dissertation opens a discussion on the different perceptions of adaptability in architecture. Adaptability cannot be only understood as movable partitions or a vast open space. There are several different principles leading to adaptability that can demonstrate their versatility of use – from the basic understanding of flexibility to intricate polyvalence. The application of adaptability to the design process is elaborated on from several aspects, whether it is the beginnings of the architect's journey using an educational method, evaluating decisions using a life cycle analysis, or forming a strategy using scenarios, feedback, and interpretation.

*PhD thesis approved at the Faculty of Architecture and Design STU in Bratislava, Slovakia, in the study programme Architecture*

**"VIRTUAL ARCHITECTURAL HERITAGE" AND ITS USE IN PRESENTING CULTURAL AND HISTORICAL VALUES OF THE MONUMENTS FUND**

**Mgr. art. Martin Varga, PhD.**

This dissertation addresses virtual architectural heritage and its use in presenting cultural and historical values of the monuments fund. The main objective was to define a legislative framework that is a prerequisite for creating digital databases in the context of the monuments fund of the Slovak Republic. The findings were evaluated using the research by design method in selected castles during the long-term periods of their ongoing reconstructions. The results of the study defined the legislative framework allowing the acquisition of digital material for the development of existing databases as well as the means and forms of digital presentation methods in the castles and their environment. The conclusions can be used in long-term castle reconstructions and their presentations. They can also help improve the collection and dissemination of digital information through the Monuments Board of Slovak Republic to the professional public.

*PhD thesis approved at the Faculty of Architecture and Design STU in Bratislava, Slovakia, in the study programme Architecture*

**INTERACTIONS OF HUMANS AND WOOD: CONCEPT OF MATERIALS, EXPERIMENTAL PRODUCTS AND SPACE**

**Mgr. art. Wanda Borysko, ArtD.**

The presented dissertation thesis explores, in its theoretical and practical parts, the possibilities for the utilisation of wood in experimental products of info-educational infrastructure and small architecture used for observing nature. The thesis focuses on the broad issue of the interaction between humans and wood, as a natural material with unique properties that is both renewable and environmentally friendly. Furthermore, the text highlights the possibilities of shaping sensory experience through wood, using the example of the wooden experimental bird watching platform Duna and the complementary educational infrastructure located by the Danube River. The dissertation includes an analysis of the design of small-scale architecture and educational facilities in nature. These not only respect the unique specifics of the territory in which they are located, but are also able to adapt to the given natural conditions and stand as self-sufficient, pro-ecological creations with minimal impact on the environment.

*PhD thesis approved at the Faculty of Architecture and Design STU in Bratislava, Slovakia, in the study programme Design*

**DESIGN AS A UNIQUE FORM OF THE REPRESENTATION OF THE COUNTRY. USE OF A STORY AND MULTISENSORY EXPERIENCE IN THE PRESENTATION OF THE DESIGN**

**Mgr. art. Vanda Gábrišová, ArtD.**

Design is a unique tool that can comprehensively represent and express the creative potential of a country. Slovakia has constantly been searching for its place in the world and trying to shape its unique identity. Design, as a multidisciplinary cultural commodity, is capable of presenting the rich culture of a country and its potential abroad. This paper focuses on the use of storytelling and multisensory design to present Slovak design, and their significance in product design. A multisensory approach in design can substantially improve the user experience and create stronger and more lasting impressions. The proper use of multisensory elements can establish a better connection between users and products and can be applied in various design fields. The methodology for evaluating multisensory product properties is a valuable benefit for designers in improving product quality and the design process itself. Multisensory design represents an important approach to product design and considering multisensory experiences in the design process has a positive impact not only on product appearance, but also on the functionality of products and overall experience of using them.

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