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ARCHITECTURE IN TIMES OF CLIMATE CRISIS – SELECTED ASPECTS

Abstract: Growing crises and social challenges, as well as environmental threats have catalysed the search for new solutions and rethinking of priority issues in relation to the contemporary architectural design process. Taking into account that, according to the UN, world's population living in urban areas will grow to almost 70 per cent by 2050, it is essential to seek solutions that will lessen negative environmental impacts in order to reduce growing threats, ensure living comfort and preserve biodiversity. Cities are a key contributor to global greenhouse gas emissions, waste production, energy and raw material consumption. Buildings play a prominent role in this process, with significant adverse environmental impacts present at every stage of their life cycle. This paper will examine activities based on the triad: recycle, repair and re-use, which, by changing the way of thinking about the building process, will contribute directly to softening its negative impact on the environment.

Keywords: circular design, adaptive reuse, recycle, sustainable design, climate change, buildings and the climate crisis, refurbishment architecture

Climate change is one of the biggest challenges of our times and at the same time a crisis-related experience and threat. Additionally, it is a very complex phenomenon, affecting many different areas of production, operation, politics and society. Therefore, efforts to reduce carbon dioxide emissions, the main cause of global warming, require multidimensional and long-term measures to minimise the negative impact on both human well-being and the biosphere.

In reports prepared regularly by the Intergovernmental Panel on Climate Change (IPCC)[1], scientists emphasise that human activity is the main cause of global changes, including, above all, increasing temperature of the atmosphere, land, oceans and the cryosphere. This activity has brought about undesirable changes that are unprecedented throughout history and have destabilised the climate system[2]. Their direct consequences are extreme weather and climate phenomena, such as heat waves, droughts, torrential downpours, floods and hurricanes, which have greatly intensified in recent decades since the 1950s[3]. The type of threats and their magnitude is partly related to local conditions, which makes it impossible to produce detailed universal solutions. However, due to the global nature of the problem, major trends, hazards and countermeasure options can be identified.

Although cities cover only 2 per cent[4] of the world's land surface, it is estimated that they use between 67 and 76 per cent of energy and are responsible for 71-76 per cent of global carbon emissions[5]. At the same time, as cities are highly complex and multifaceted structures, they need continuous and uninterrupted availability of energy to function properly. As set out, among other things, in the 2024 report by the UN Environment Programme (UNEP) and the Global Alliance for Buildings and Construction (GlobalABC), the building and construction sector alone accounts for approximately 37 per cent of global operational energy and CO_2 emissions[6]. Significant energy demand and greenhouse gas emissions, as well as pollution generation are characteristic for every stage of a building life cycle: from construction material manufacturing,

1 The IPCC was established in 1988 by the United Nations, specifically the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO).

2 IPCC, *Climate Change 2021: The Physical Science Basis, Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge-New York 2021, pp. 4-11.

3 Ibid., p. 5.

4 United Nations, *Generating power*, https://www.un.org/en/climatechange/climate-solutions/cities-pollution#:~:text=According%20to%20UN%20Habitat%2C%20cities,cent%20of%20greenhouse%20gas%20emissions.&text=An%20added%20challenge%20is%20the,cities%20in%20Asia%20and%20Africa [accessed: 4.06.2024].

5 K. Seto et.al, *Human settlements, infrastructure and spatial planning*, in: IPCC, *Climate Change 2014: Mitigation of Climate Change, Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge-New York 2015, p. 927. Interestingly, it is estimated that about 20-30 per cent of total CO_2 emissions are produced by residents of urban centres. Cf. UN Habitat, *Urban Energy*, https://unhabitat.org/topic/urban-energy [accessed: 4.06.2024].

6 The data relate to 2022. UNEP, *Not yet built for purpose: Global building sector emissions still high and rising*, Nairobi 2024, https://www.unep.org/news-and-stories/press-release/not-yet-built-purpose-global-building-sector-emissions-still-high [accessed: 4.06.2024].

through transportation, the construction process, usage, to demolition and storage or disposal of debris. Rethinking the architectural approach to design and implementing best sustainable practices is therefore highly relevant in contemporary times. All the more so, because, as analyses indicate, more than half of the world's population (55 per cent, to be exact) live in cities, and this proportion is expected to increase to 68 per cent (two-thirds of the world's population) by 2050[7]. It means that cities will have to accommodate 2.5 billion additional inhabitants[8]. As data show, around 5.5 billion m2 of buildings are erected worldwide every year, which is equivalent to the size of Paris every single week[9]. A critical moment came relatively recently, in 2007, when the urban population outnumbered the rural population[10]. As the UNEP Executive Director, Inger Andersen, said, 'there is no credible path to address climate change without a fundamental shift in the building and construction sector'[11].

From the European perspective, the process of diagnosing risks and seeking solutions that would help to counteract crisis deepening led to the adoption of a strategy aimed at achieving climate neutrality by 2050. If these targets were met, Europe would become the world's first climate-neutral continent[12]. The Directive on the energy performance of buildings and the objectives contained in the European Green Deal also set ambitious targets for the building and construction sector[13]. While the issues of renewable energy generation and low-carbon construction projects are becoming central, the pursuit of making

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7 United Nations, *World Urbanisations Prospects. The 2018 Revision*, New York 2019, p. XIX.

8 In highly developed countries, this number will reach around 88%. In contrast, the highest percentage of the population will live in Asian and African cities. Apparently, these figures reflect a trend perceived from a global perspective and may vary from region to region.

9 M. Smith et al., *Built for the environment report*, RIBA Publishing, London 2021, p. 3.

10 United Nations, *World Urbanisations Prospects*... p. 9.

11 United Nations, *Not yet built for purpose: Global building sector emissions still high and rising*, https://www.unep.org/news-and-stories/press-release/not-yet-built-purpose-global-building-sector-emissions-still-high [accessed: 4.06.2024].

12 *Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law')*, "Official Journal of the European Union", L 243/1, 9.07.2021. An important act paving the way for further arrangements was the *Council Decision (EU) 2016/1841 of 5 October 2016 on the conclusion, on behalf of the European Union, of the Paris Agreement adopted under the United Nations Framework Convention on Climate Change (Paris Agreement)*,"Official Journal of the European Union", 19.10.2016, L 282, p. 4.

13 *Directive (EU) 2024/1275 of the European Parliament and of the Council of 24 April 2024 on the energy performance of buildings*, "Official Journal of the European Union", 8.5.2024, L. European Commission, *Communication from the Commission to the European Parliament, the European Council, the European Economic and SocialCommittee and the Committee of the Regions, The European Green Deal*, Brussels 11 December 2019.

the built environment more sustainable goes far beyond undertaking activities related to technical building infrastructure.

Basically, the interaction between climate change and architectural design is bi-directional. On the one hand, measures are taken to reduce the negative environmental impact of both the construction process and the use of architectural structures, and on the other hand solutions are sought to ensure comfortable living in changing climatic conditions. Mitigation of the effects of climate change and adaptation are identified as the main elements of all actions taken to halt, or rather relieve, the catastrophic processes and growing threats that have already begun, and to get used to living in new conditions[14].

In this context, architectural design attaches importance to, among other things, the pursuit of reducing the scale of manufacture of building materials and thus diminishing negative environmental impacts at an early stage of the construction process. Norwegian studies have shown that the carbon dioxide emissions from domestic extraction, manufacture and transport of building materials are approximately twice as high as those from the subsequent use of the buildings[15]. These are significant parameters.

The markedly increasing role of recycling and architects' interest in reusing both building materials and other types of waste is therefore not surprising. These issues are important not only due to reducing CO_2 emissions and the consequent energy consumption, but also due to the significant challenge that the modern world is facing in terms of overproduction of waste, its disposal and a negative impact on the environment.

The concept of recycling was introduced in the 20th century. Although the idea of reusing building materials and objects deprived of their original function has accompanied the humankind since the earliest times, it was not based on ecological considerations (as it is today), but primarily on economic and sometimes cultural or historical benefits that made the incorporation of fragments of old buildings a symbolic act. The concept and practice of recycling developed strongly in the 21st century, along with the growing awareness

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14 IPCC, *Summary for Policymakers. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge-New York, p. 4. Cf.: United Nations, United Nations Framework Convention on Climate Change, 1992.

15 P. Bernhard, P. F. Jørgensen, *Byggenæringens CO_2 utslipp. Notat for Byggemiljø - ByggenæringensMiljøsekretæriat*, KanEnergi, Oslo 2006, as cited in: A. S. Nordby, *Salvageability of building materials: Reasons, criteria and consequences regarding architectural design that facilitate reuse and recycling*, Doktoravhandlingerved NTNU, Trondheim 2009 [doctoral thesis]. For the analysis of the environmental impact of a building throughout its life cycle, see, inter alia: S. Junnila, *The environmental impact of an office building throughout its life cycle*, "Helsinki University of Technology Construction Economics and Management research reports A 2", 2005. http://hdl.handle.net/11250/231092 [accessed: 4.06.2024].

of the environmental crisis. Recycling in architecture can be present on various levels, with plastic being a good example. It is a very popular material, with global production rising to 400 million tonnes per year. In 2022, China reached over 30 percent of global plastic materials production, making it the top plastic manufacturer. At the same time, Europe, which ranked second in 2017, is in the third place in 2021[16]. Europe alone emits around 13.4 million tonnes of CO_2 annually, which is about 20 per cent of the chemicals industry's emissions. Plastic is also hard to recycle and, its durability means that discarded items will remain in the environment for generations to come. Based on data, only around 9 percent of all the plastic waste generated globally is recycled. According to the report prepared by the World Economic Forum and the Ellen MacArthur Foundation, if nothing is done to counteract the current trends, by 2050 oceans are expected to contain more plastics than fish[17]. Microplastics are linked to serious health issues, and studies undoubtedly show that more and more plastic microparticles are found not only in the environment, but also in human blood and internal organs, such as lungs, kidneys and liver[18].

Due to their properties (e.g. good insulation, durability, corrosion resistance, high plasticity, etc.), recycled plastic materials can be used in various ways in the building and construction industry, e.g. in insulation, window frames, piping, interior fittings, etc. However, plastic waste is also increasingly becoming the basis for architectural concepts, influencing not only the environmental friendliness of a building, but also its aesthetics in a way that does not reveal the origin of the recycled materials or objects, or creating a distinct architectural expression. An interesting example is the Taman Bima Microlibrary in Bandung (Indonesia), completed in 2016 according to a concept of the SHAU architecture and urbanism firm. The library was built as part of a pilot project for developing low-cost and environmentally-friendly small reading facilities, which create valuable public places for small local communities and help to combat illiteracy. The reading facility was placed on an optically-light metal structure above a pre-existing open-air stage used for community gatherings and events. The façade was made out of two thousand bright, one-colour ice-cream buckets. (Fig. 1) Some of the closed boxes were arranged in a subtly distinctive inscription: 'buku adalah jendela dunia' (books are a window to the world). The use of

16 Plastic Europe, *Plastics – the Facts 2022* [report], Brussels 2022.

17 European Environment Agency, *Plastic*, European Union, 19.06.2024, https://www.eea.europa.eu/en/topics/in-depth/plastics?activeTab=07e50b68-8bf2-4641-ba6b-eda1afd544be [accessed: 4.06.2024].

18 G. Kutralam-Muniasamy et al., *Microplastic diagnostics in humans: "The 3Ps" Progress, problems, and prospects*, "Science of the Total Environment", 2023, vol. 856, doi.org/10.1016/j.scitotenv.2022.159164.

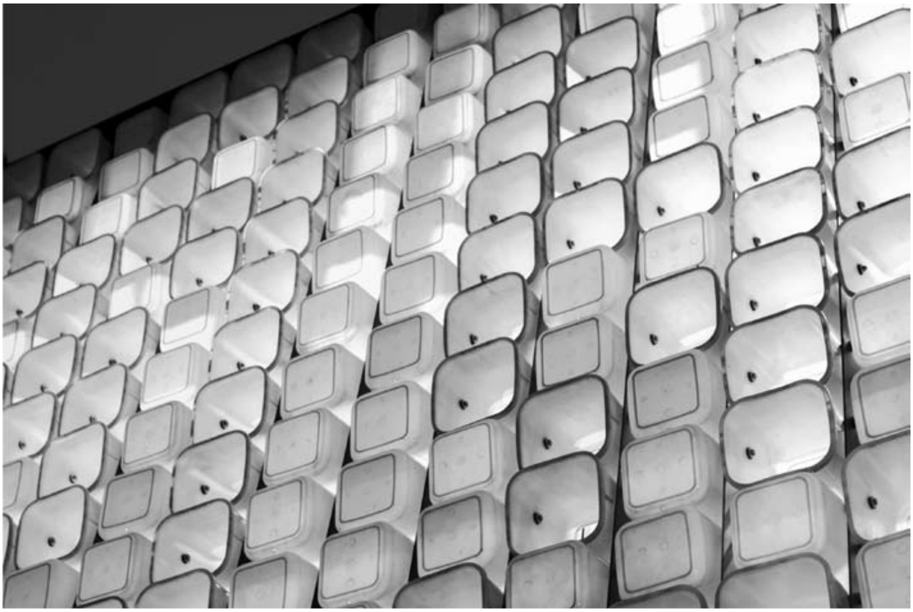

Fig. 1. Bucket façade of the Microlibrary -Taman Bima, Bandung (Indonesia), design by SHAU, photo by Sanrok Studio

partially transparent materials, as well as a decision to open some of the boxes, provided adequate natural lighting and ventilation of the room without the use of air conditioning (which would generate costs, boost energy consumption and affect the environment). Thanks to the architects who skilfully used the properties of plastic boxes, the Microlibrary is both functional and well-thought-out with aesthetics achieved through the simplest and environmentally neutral means. Sunlight penetrating through the light-coloured plastic walls of the boxes illuminates them with soft diffused light, creating a welcoming atmosphere inside and a conducive library environment. (Fig. 2) The reprocessed alternative materials used in the project did not undergo a higher degree of recycling, and the aesthetics of the building is devised in a way that does not dazzle with the original purpose of the materials used (which improves the comfort of the users who have been given a new aesthetic space), nor tries to hide it. The adopted solutions have also allowed the local community to get involved in the construction of the Microlibrary. The project therefore combines the ideas of recycling and wider environmental and pro-social activities.

Fig. 2. Bucket façade seen from inside the Microlibrary, design by SHAU, photo by Sanrok Studio

It does not mean that reclaimed plastic is not used in ultra-modern and luxury projects. One example is the visually appealing façade of the Tiffany & Co. shop at Singapore's Changi Airport designed by the MVRDV architectural practice. A delicate blue mesh covering the transparent walls is inspired by the local oceanic environment, including motifs resembling a coral reef[19]. At the same time, its form has been linked to the history and origin of the material used in the design, namely plastic obtained, among other things, from recycled fishing nets. The plastic objects were processed and then used for 3D printed transparent screens foreseen by the project. Thus, in this case, the architects used both advanced techniques and innovative solutions.

Undoubtedly, reusing plastic materials results in reducing the amount of plastic waste generated globally so far. It therefore helps to alleviate the existing problem, but from a long-term perspective, we need to reduce the global production of plastic. All the more so that some polymers can only be recycled once.

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19 Cf. MVRDV, *Tiffany Facade Singapore Changi*, https://www.mvrdv.com/projects/879/tiffany-facade-singapore-changi [accessed: 4.06.2024].

Although mass-produced and difficult-to-recycle plastics present a major problem and contribute significantly to the environmental crisis and deterioration of living conditions on the planet, it is not the only kind of waste material that should be reclaimed. A very wide range of diverse objects and materials can be used in architectural design, from large shipping containers, which are eagerly introduced in small-scale projects, such as the DOKI Gastrobar in Łódź, or larger establishments, such as The Box Office by Distil studio, through aluminium cans (e.g., the Can Cube by Archi-Union Architects in Shanghai), to small and seemingly completely useless cigarette butts. (Fig. 3) The latter, although small, are not biodegradable, thus posing a threat to the environment. This fact encouraged the RMIT University to conduct a study on recycling cigarette butts in order to use them in the construction process. The results showed that incorporation of cigarette butts into clay bricks has beneficial effect on their performance by, among other things, reducing compressive strength and thermal conductivity[20]. However, the use of this type of 'difficult' waste, which also includes used tyres, requires caution and in-depth research into not only the possibility of their secondary use in architectural projects and the resulting environmental benefits, but also a direct impact on the health of residents and users.

A variety of recycling possibilities in architecture are visible, for example, in Villa Welpeloo in Enschede (the Netherlands), a project designed by 2012 Achitecten. This single-family house consists of 60 per cent recycled materials salvaged from the neighbourhood, which also mitigated negative effects associated with transportation. The façade is clad with boards from redundant cable-reels, while the structural beams were sourced from unused machines from a neighbouring factory. Another innovative measure consisted in converting a crane used during the construction into a lift. Most of the windows are made from glass waste, while offcuts obtained from a caravan manufacturer were used for the façade insulation. Elements of the interior were also created from recycled materials. For example, dark walls in the bathroom were made out of recycled coffee cups, and spokes of broken umbrellas were transformed into a fixture of halogen lighting[21]. The materials provoked the architects to take a creative approach to design and to look for new solutions.

In 2017, i.e., eight years after the completion of Villa Welpeloo, another experimental building design was created in the Netherlands, this time in Einhoven. The project used 100 per cent borrowed materials. The People's

20 A. Mohajeran et al., *A Practical Proposal for Solving the World's Cigarette Butt Problem: Recycling in Fred Clay Bricks*, "Waste Management", 2016, vol. 52, pp. 228-244.

21 F. van Andel, *Villa Welpeloo Enschede: 2012Architecten*. "DASH | Delft Architectural Studies on Housing", 2012, vol. 07, pp. 148-155.

Fig. 3. DOKI Gastrobar in Łódź made up of four cargo containers, Łódź (Poland), design by Nastazja Kropidłowska, photo by Julia Sowińska-Heim

Pavilion, designed by Bureau SLA&Overtreders W, was created in conjunction with the Dutch Design Week to demonstrate practical possibilities of introducing the idea of circular design into architecture. It is in line with the concept of circular economy, a model of production and consumption which involves repairing, reusing and recycling, which is a departure from the traditional linear economic model: take, make, consume, throw away[22]. Such a solution helps us to reduce waste and diminish or eliminate the negative environmental impact of the manufacturing of building materials, but also to cut down the consumption of natural resources. Various elements and materials needed to put the People's Pavilion into use were obtained from different sources. For example, the glass façade was saved from a demolished office building, the glass roof was borrowed from a greenhouse supplier and the benches from a church[23]. Thus, apart from having ecological value, the project also involved the local community in the creative process. It was a temporary building, yet its demolition left no construction waste, since all the borrowed materials were returned, and many items reused in other projects. Even colourful shingles recycled from PET bottles donated by Eindhoven residents were returned to their owners, although in this case in a changed, more aesthetic form.

Actions based on the recovery and reuse of construction waste spark growing interest and provoke architects to seek creative solutions. Components that are relatively often recovered include doors or window frames, and materials include brick, wood, concrete or metal. However, architects also use less obvious materials. In the Debris House by Wallmakers (India, 2015), the walls are made of debris from an earlier building and the earth that was dug out within the site. A decision to build the walls from debris with only a small (5 per cent) addition of sand and cement reduced energy consumption and greenhouse gas emissions five and four times, respectively, compared to traditional brick material[24]. This solution has both ecological and economic advantages. At the same time, the house contains modern technologies, such as an innovative roof construction, passive air circulation and a rainwater harvesting system. Recycled objects and materials were also used as decorative elements. An example of original solutions is meter boxes from a local scrapyard placed in the windows to create an intriguing, delicate openwork decoration. The

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22 European Parliament, *Circular Economy: Definitions, Importance and Benefits*, 2023, https://www.europarl.europa.eu/topics/en/article/20151201STO05603/circular-economy-definition-importance-and-benefits [accessed: 4.06.2024].

23 Bureau SLA, *People's Pavilion*, https://bureausla.nl/project/peoples-pavilion/?lang=en [accessed: 4.06.2024].

24 In the case of the rammed earthwalls, both of these parameters were four times lower than in the case of fired brick wall. *Debris House/Wallmakers*, "ArchDaily", https://www.archdaily.com/903691/debris-house-wallmakers [accessed: 4.06.2024].

result is not only a sustainable, climate-friendly house, but also an original and aesthetically interesting project.

In circular architecture, it is important to creatively source and use building materials as well as to think, right from the initial stages of a project, about how to reuse components in other buildings, reclaim used products, or use biodegradable materials. The idea of circular architecture is thus more complex and broader than architectural recycling, which is in fact its important component. Researchers from the Institute of Design Research Vienna, who, having conducted a research project within the framework of the New European Bauhaus[25], developed a set of Circular Design Rules (a practical guideline and tool for designers), emphasize that modularity is a very important concept in circular design[26]. A modular design system allows for replacing or adding independent components, which gives better opportunities for repair, improvement, expansion and, consequently, extends the useful life of a product.

Paying more and more attention to the idea of circular design, architects are searching for optimal solutions to create a sustainable built environment. This has given rise to innovative projects, such as the Urban Mining and Recycling (UMAR) Experimental Unit by Werner Sobek with Dirk E. Hebel and Felix Heisel (Dübendorf, Switzerland). Although this full-fledged building is in no way associated with temporary solutions, it is constructed from components that are completely reusable, recyclable or compostable. In line with the interesting idea of 'borrowing', utilised materials are returned to the biological and technological cycle when their current function is over. From this perspective, the project can also be perceived as a temporary storage facility for materials[27].

The idea of circular architecture is also introduced into public buildings. Interesting examples include Velno City Hall by Kraaijvanger Architects and the Temporary Courthouse Amsterdam by cepezed. Velno City Hall is designed according to the cradle-to-cradle principle, based on a closed cycle of materials, water and energy. The Dutch city and municipality of Venlo was among the first in the world to adopt this principle as a basis for action and development, recognising that it would have a positive impact on both improving the quality of the living environment and stimulating innovation or economic growth[28].

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25 *Communication from the Commission to the Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, New European Bauhaus: Beautiful, Sustainable, Together*, Brussels 15.09.2021.

26 H. Gruendl, R. Grossar, F. Reiterer, *Circular Design Rules – V2.0 Product Design*, Institute of Design Research Vienna, Vienna 2023.

27 *Urban Mining and Recycling*, http://nest-umar.net/portfolio/umar/ [accessed: 4.06.2024].

28 *Cradle to Cradle Innovative Economic Principle in the Venlo Region*, https://c2cvenlo.nl/en/cradle-to-cradle-in-the-venlo-region/ [accessed: 4.06.2024].

According to a study by the Ellen MacArthur Foundation, the new town hall has been a key factor in updating the image of the city, which used to be associated with agriculture and logistics, and now is perceived as innovative and offering many opportunities for economic development. This change proved to be very beneficial, and the project made the city attract both entrepreneurs and young people (18-24 years old), whose proportion among Venlo's residents has visibly increased[29]. The second referenced building, the Temporary Courthouse, served as a courthouse for several years until the final building was erected. From the very beginning, the building was thought as a temporary solution, so its concept was based on easy adaptation to changing functions and reusability at a different location. A large two-floor structure was conceived in such a way that it could easily be dismantled and reassembled. This idea does not negatively impact the courthouse aesthetics and perhaps even had a favourable influence on the precise and careful elaboration of both the details and the whole they created. After performing its role as a courthouse, the building was moved not only to another location, but even to another city (Twente). Later this year (2024), it is going to be put back into use. The building's external appearance will be preserved, but due to its different function (a business meeting place) and thanks to the flexible interior design, it will be laid out differently. The possibility to relocate the structure reduces CO_2 emissions by up to 2,000 tonnes, compared with the construction of a new building[30].

As Carl Elefante, Fellow of the American Institute of Architects (FAIA) points out: 'The greenest building is ... one that is already built'[31]. This is because the preservation and retrofitting of existing buildings offers significant opportunities for reducing greenhouse gas emissions and energy consumption, released both during demolition, transport and waste disposal, and during the manufacture of building materials and construction of a new building. Therefore, threats posed by climate change have also led to a desire to limit the demolition of buildings that have lost their original function[32]. The greater percentage of the original architectural fabric is preserved, the more beneficial the effect becomes. However, if it is not possible to reuse the whole, even preserving fragments of, for example, the façade or walls, will cut greenhouse gas emissions.

29 Ellen MacArthur Foundation *Venlo City Hall from Cradle to Cradle*, March 2019 https://emf.thirdlight.com/link/lnut181xxmzn-v0fwu5/@/preview/1?o [accessed: 4.06.2024].

30 Data from the website of the cepezed architectural office.

31 C. Elefante, *Existing Buildings: The Elephant in the Room*, "Architect Magazine", 2018, vol. 10, p. 108.

32 Interesting analysis of the environmental impact of reducing demolition activities: J. Lederer et al., *Raw materials consumption and demolition waste generation of the urban building sector 2016e2050: A scenario-based material flow analysis of Vienna*, "Journal of Cleaner Production", 2021, vol. 288, doi.org/10.1016/j.jclepro.2020.125566.

In order to encourage architects to undertake this type of actions, as well as to draw their attention to the creative nature and importance of such undertakings, prestigious prizes have been founded for refurbishment projects. For example, in 2023, the Royal Institute of British Architects (RIBA) set up the Reinvention Award that recognises achievement in creative reuse and retrofitting of existing buildings that 'improve their environmental, social or economic sustainability'[33]. The first award was given for the Houlton Scholl project in Rugby (van Heyningen & Haward Architects). This environmentally friendly project was also recognised for the skilful combination of thoughtful restoration of the degraded architectural fabric of a historical post-industrial building with new additions made with locally available materials. Another highlighted issue, very important in the case of the adaptive reuse of a historic building, was its role in strengthening the local community and sense of belonging.

Adaptive reuse is an important element of sustainable development, both from an ecological perspective (lessening the environmental impact of the building and construction sector and reducing waste) and a socio-cultural one (preserving heritage that is important for the local community, strengthening connections with the place, etc.)[34]. A lot of post-industrial complexes and sites which have been neglected, degraded or, for example, contaminated, need to be transformed into environmentally friendly places. A good example is the introduction of cultural functions to the site of the former steelworks in Bochum (Jahrhunderthalle, Germany) and the adaptation of the surroundings for recreational purposes. This design concept was based on a symbiosis between industrial artefacts, new buildings and vegetation growing on the site. (Fig. 4)

Extensions, superstructures or additions redirect a building back into its life cycle and allow it to be reused. Skilful adaptive reuse and retrofitting do not mean destroying the character of an existing building or complex. On the contrary, these activities can actually contribute to a better understanding of the structure's original character, even if only fragments of the original architectural fabric are preserved. An interesting example is 2024 finalist for the Mies van der Rohe Award, namely the extension project for a 15th-century convent (Corsica) by Amelia Tavella Architectes. The historic convent, which was previously lying partially in ruins, underwent restoration and gained a copper-clad

33 *RIBA Reinvention Award 2023*, https://www.architecture.com/awards-and-competitions-landing-page/awards/RIBA-Reinvention-Award [accessed: 4.06.2024].

34 For more on these issues, see: J. Sowińska-Heim, *Transformacje i redefinicje. Adaptacja-dziedzictwa architektonicznego do nowej funkcji a zachowanie ciągłości historycznej miejsca*, Wydawnictwo Uniwersytetu Łódzkiego, Łódź 2018; J. Sowińska-Heim, *Adaptive Reuse of Architectural Heritage and Its Role in the Post-Disaster Reconstruction of Urban Identity: Post-Communist Łódź*, "Sustainability" 2020, 12(19), 8054; doi.org/10.3390/su12198054.

Fig. 4. Jahrhunderthalle in Bochum (Germany), post-industrial complex adapted for cultural functions and recreational area, photo by Julia Sowińska-Heim

extension. Although thoroughly modern, it complements and evokes the original character of the building. Combined together, the preserved ruins and the new architectural intervention bring back the history of the site while creating a new whole. In the case of adaptation, extension or reconstruction of socially and culturally 'sensitive' buildings or monuments, a particularly important element is careful interpretation of the context of the place and combining the preserved architectural heritage and the new interventions into a harmonious whole. In sites of lower social, cultural or historical value, architects have more freedom in creating the building's aesthetics, such as in the case of the K.118 project in Winterthur (Switzerland). Three new, brightly red-orange storeys were built on top of the existing ochre red brick warehouse. The project is an example of circular architecture, combining adaptive reuse of the existing building, extension and recycling of building materials. In addition to recycled material, the project also used reclaimed elements from local demolition sites. The architects also sought to make sure that as many components as possible could be re-used in the future. In the implementation phase of the project, the acquired materials were catalogued. Then, their reusability potential was thought out and creatively determined, not always in line with their original purpose. The measures taken significantly reduced CO_2 emissions, cut down the waste and almost eliminated the use of natural resources[35]. As architect Barbara Buser notes, the main value of the project was a change in the way of thinking about architectural design and construction[36]. She has consistently pursued this idea for a long time. Back in the 1990s, she and Klara Kläusler founded the first-ever building parts exchange.

In the face of the growing climate crisis and, consequently, increase in the number of weather anomalies and rising temperatures that, according to health-care specialists, pose a direct threat to people's health and lives, it is necessary to take measures aimed at reducing CO_2 emissions from the building and construction sector. Although innovative projects show interesting possibilities and are paving the path for environmentally friendly solutions, still only 12 per cent of materials and resources end up being recycled[37]. Circular design, rooted in sustainability and based on the triad: repair, re-use and recycle, requires not only creative architects, but also a change in societal behavioural patterns and mindsets. An important element in this process is involving local communities in the undertaken activities and creating space for bottom-up initiatives. Unconventional projects affect a broader perception of possibilities to bring about change, providing the impetus to modify the way of thinking and go beyond the patterns.

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ARCHITEKTURA W CZASACH KRYZYSU KLIMATYCZNEGO – WYBRANE ASPEKTY (streszczenie)

Narastające kryzysy i wyzwania społeczne, a także zagrożenia ekologiczne stały się katalizatorem dla poszukiwań nowych rozwiązań i przemyślenia priorytetowych kwestii w odniesieniu do współczesnego projektowania architektonicznego. Biorąc pod uwagę, że według przewidywań ONZ, w 2050 roku, niemal 70% obywateli całego świata mieszkać będzie w miastach, niezbędne stało się stworzenie rozwiązań, które przyczynią się do ograniczenia negatywnych skutków środowiskowych, a w konsekwencji zmniejszenia narastającego zagrożenia, zapewnienia komfortu życia i zachowania bioróżnorodności. Miasta w znaczący sposób uczestniczą w globalnej emisji gazów cieplarnianych, produkcji odpadów, zużycia energii i surowców. W procesie tym kluczową rolę odgrywają budynki. Przy czym znaczący niekorzystny wpływ na środowisko odbywa się na każdym etapie ich życia. W artykule tym przeanalizowane zostaną działania oparte na triadzie: recycling – naprawa – ponowne użycie, które poprzez zmianę myślenia o procesie budowlanym, w sposób bezpośredni przyczynić mają się do zmniejszenia jego negatywnego wpływu na środowisko i stanowić kontrpropozycję dla modelu linearnego: weź – wyprodukuj – zużyj –wyrzuć.

Słowa kluczowe: architektura cyrkularna, adaptacja do nowej funkcji, recykling, projektowanie zrównoważone, kryzys klimatyczny, architektura i kryzys klimatyczny

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