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Research paper

Problems and challenges of the built environment and the potential of prefabricated architecture

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Abstract: A contemporary European city faces various challenges, and it remains in a permanent state of crisis. The components that create such a situation are subject to change over time. In addition to the existing problems, the inhabitants, authorities, and people involved in designing and transforming the city, including architects, face new challenges. In recent years, the old problem of a shortage of affordable housing has been coupled with new challenges, including a sudden influx of refugees, climate change and its consequences, and the pandemic. Solutions to these issues are complex and multi-dimensional, and the actions to be taken are of interdisciplinary nature. Prefabricated architecture can be part of these solutions. Prefabricated building technologies, including prefabricated large-panel buildings, modular buildings and mobile structures, can, under appropriate conditions, modernize the process of building new housing. These solutions fit into the idea of sustainable development and can respond to unexpected and dynamically changing circumstances over time (emergency buildings). This paper examines the contemporary urban crisis and possible steps to be taken through the prism of the possibilities offered by the design of prefabricated buildings. The question is what criteria and design strategies should be adopted for prefabricated architecture to meet the demands of a city in crisis? The conducted analyses are universal. Nevertheless, they consider the application of prefabricated solutions in architecture in Poland and the potential for its further development. Therefore, the discussed implementations from the author's country are given an important role in the text and are shown first against the background of European design practice. Omission of solutions from other continents is a deliberate delimitation.

Keywords: container architecture, crisis of the city, modular architecture, offsite architecture, parasitic architecture, prefabricated architecture

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1. Introduction

Shaping the built environment in contemporary cities is a difficult, interdisciplinary and complex task that obliges its designers to solve existing and emerging problems. Designers of various specialties, including architects, are charged with the responsibility for the present and future shape of cities and are obliged to search for tools that can solve current and potential urban crises. The following text sees a chance to provide solutions to at least some of them through applying the principles of modern building technology and is written from the perspective of a professional architect. The article defines contemporary urban problems and considers how they can be solved using prefabricated technologies.

The starting point for further consideration is the crisis of the city. While, currently, the majority of the world's population lives in cities, it is predicted in various research and forecasts that the percentage share of city dwellers will continue to increase in the years to come [1–3]. The multitude of inhabitants-users and their various needs make the city a stage where "eternal" problems (e.g., housing) and ever-newer issues (e.g., urban sprawl, automotive domination, climate change, pandemics) emerge, together with related conflicts and challenges. The emergence of challenges, adaptation to them, and mitigation of their adverse effects can be described as an enduring crisis. [2–5].

The present paper focuses on shaping the built environment and on architectural tools that can be applied to remedy some aspects of the contemporary city crisis. The article provides the reader with a discussion on prefabricated architecture, its characteristics, and applications (examples of implementation) in the context of current urban challenges.

Some diagnoses of city conditions and desired development directions are of a global nature. Examples include the tasks of the 11th U.N. Sustainable Development Goals ("Make cities and human settlements inclusive, safe, resilient and sustainable" [5]), or the attempt to define various city types, e.g., sustainable, smart, eco, green, livable, resilient, low carbon, etc. [6–13], which is, in fact, a response to the challenges that cities face.

The considerations presented are based primarily on examples of European buildings, especially Polish ones, whose specificity and challenges they face are best known to the author [14–16].

The analysis of the problems faced by a modern city and an attempt to find at least partial solutions to them in the form of prefabricated architecture is inspired by the history of prefabrication [17–23]. The approach also follows a certain tradition of seeking prefabricated architecture as a hope to solve the problems of the built environment, which was initiated in Europe by such architects as Walter Gropius and Le Corbusier [24, 25]. The continuation of the hopes finds supporters today [17–20, 22, 26–29].

The article attempts to answer the questions: what are the urban problems directly related to the design of the built environment; how do we define prefabrication in architecture; can prefabrication be one of the technological and design tools available to architects today to solve pressing urban problems; what urban problems are solvable by utilizing the architectural tools related to prefabrication technology; what are the benefits of applying prefabricated solutions in architecture and is prefabrication in architecture in countries such as Poland worth reviving?

2. Materials and methods

The research process leading to the answers to the above questions is presented in Fig. 1.

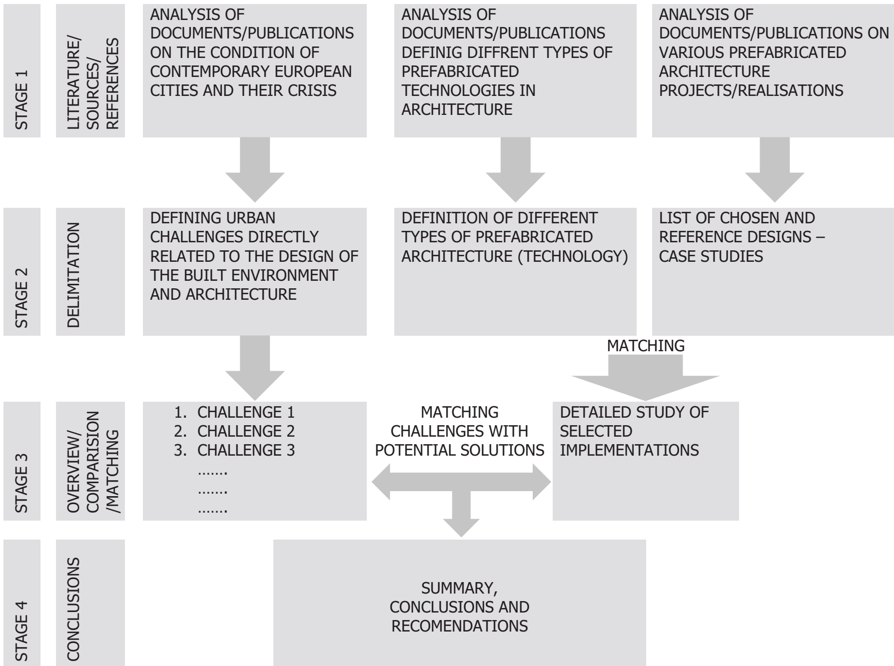


Fig. 1. The research process

The present paper offers a review of selected implementations of prefabricated architecture in relation to contemporary city needs. Firstly, based on the available resources, prefabricated architecture was defined and characterized, while its various types were specified. Furthermore, the challenges related to shaping the built environment in contemporary cities were defined. Then, selected case studies were presented, and an attempt was made to assign prefabricated solutions to the challenges they may respond to. This research stage was based on the analysis of the source literature and the author's case studies on implemented buildings. The final section of the text contains conclusions and their discussion.

As a starting point for the analyses of the modern city's condition and its built environment, the Sustainable Development Goals listed in [5] were used. These define general, but also local challenges. In the architectural context of European cities, goal number 11 (Sustainable Cities and Communities) is particularly relevant. It can be directly related to how architects shape the designed buildings and their surrounding open spaces. Various documents and reports relating to the urban context of European cities and their built environment, published primarily by the United Nations [1–3, 15] and the European Commission [4, 14], have also been studied for in-depth analysis. Publications on sustainable development and sustainable cities were also helpful in highlighting urban problems and crises e.g. [6–8, 10, 11].

In turn, the selection of literature on prefabricated architecture was dictated by the need for a comprehensive look at this phenomenon in both historical and contemporary contexts. Publications describing diverse types of prefabricated architecture, its different applications and background were selected [17–29]. Polish sources identify prefabrication in architecture mainly with the great housing estates of the 20th century [34–36, 43, 51].

2.1. Prefabricated architecture – definition and characteristics

The very concept of erecting buildings made of repetitive components is as old as construction itself. However, the industrial revolution, followed by mass production, opened up a wide range of possibilities for designers while confronting architects with new challenges.

Prefabricated architecture, prefab architecture, offsite architecture, modular architecture – despite slightly different definitions in various sources [17–21, 27–29], all these terms refer to the technology based on the production of building components in controlled factory conditions and then their subsequent assembly on the construction site. Building components usually comprise elements of considerable sizes, such as ceilings, walls, as well as larger fragments, i.e., modules, or sometimes the entire building. Prefabrication transfers a large part of the work needed to erect an object from the construction site to the industrial plant.

Previous research and the sources cited above propose various categorizations of prefabricated solutions. However, a similar systematic scheme is observed. The classification, along with definitions and a graphic diagram, is presented in Table 1.

Table 1. Classification of prefabricated solutions

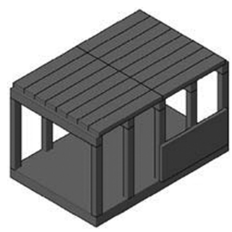
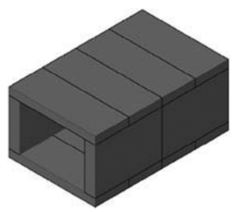
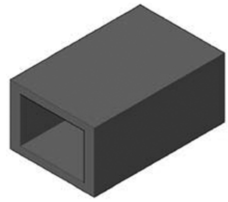
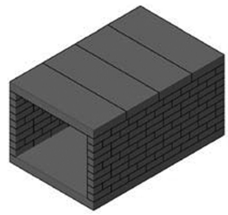
Type of prefabricated solution	Definition	Scheme of the building or its repetitive component
Repetitive buildings/ “kit-homes” – usually in the frame structure – wooden or steel; also made of concrete, or CLT panels	sets of factory-produced parts of various sizes and materials, to enable assembling a complete, typical building (also possible to be erected in a different location); an example of such a solution are “kit homes” – ready-made houses, delivered “in packages”, mainly single-family buildings	
Panel buildings – concrete wall and ceiling panels; CLT panels; panels made of skeleton structure	buildings erected of panel elements (walls and ceilings) manufactured in the factory and assembled on the construction site	

Table 1 – *Continued from previous page*

Type of prefabricated solution	Definition	Scheme of the building or its repetitive component
Modular buildings – (volumetric structure) concrete modules; modules based on steel or wooden frame structures; containers	buildings based on spatial elements produced in factories (volumetric structures), which are three-dimensional modular units – entire small buildings or their repeatable parts transported to the construction site	
Other solutions	hybrid technologies that combine panel and spatial elements, enabling various combinations and architecturally diverse solutions; combined solutions are based on prefabricated elements supplemented with traditional technologies	

2.2. The city in crisis-problem areas

The list of challenges faced by modern cities is long. They have been described in the 11th Sustainable Development Goal, as well as in other documents. The analysis of these documents allows for the identification of four problem areas related to the built environment design. They are presented and defined in Table 2.

Table 2. Problem areas, their characteristics and potential architectural solutions

Challenges	Characteristics
Deficiency of available affordable and good quality housing	"Some of Europe's most in-demand cities have seen sharp increases in housing prices over the past ten years. This threatens housing affordability, as prices are recovering faster than earnings and the availability of housing is low" [4] (p. 30) "(. . .) in many cities, spatial segregation process – as an effect of social polarisation – make it increasingly difficult for people with low incomes or from marginalized groups to find decent housing at affordable prices." [14] (p. 24) "Lack of housing affordability is increasingly affecting large sections of the population (. . .). Although there are considerable differences between the nature and expression of the housing need across the region, there are also shared points of concern, such as a general need for social housing, a rise in homelessness, and a lack of housing affordability due to housing cost overburdens." [3] (p. 38)

Continued on next page

Table 3. Table 2 – *Continued from previous page*

Challenges	Characteristics
Environmental protection, mitigation issues, and adaptation to climate change	“While being responsible for a high level of energy consumption and, therefore, generating about 70% of global GHG emissions, cities are particularly vulnerable to the impacts of climate change.” [4] (p. 82) “By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and other waste management.” [5] (p. 22) “In many member countries, cities are already leading the transition towards a green economy and low-carbon development. Due to their compact form and high population density, urban areas are natural testing grounds for achieving resource-efficient and green economic growth. (. . .) The building sector is one of the priority energy end-use areas in relation to climate neutrality.” [3] (p. 51)
Urban sprawl	“Urban sprawl (. . .) is one of the main threats to sustainable territorial development; public services are more costly and difficult to provide, natural resources are overexploited, public transport networks are insufficient, and car reliance and congestion in and around cities are heavy.” [14] (p. IV) “Urban sprawl and the inefficient use of land remains a problem, with varying impacts in different contexts.” [4] (p. 93) “Secondly, the current state of the economy and the urban lifestyle prevalent in the region are moving towards integrated environmental sustainability, but phenomena such as urban sprawl contribute not only to soil sealing and increasing traffic, they also increase air pollution, climate change, and local heat islands in urban agglomerations. These developments can significantly reduce the quality of life in the cities (. . .)” [3] (pp. 54–55)
Crises, as well as sudden and periodic/ emergency needs	“Today, cities and city inhabitants are facing increasing challenges as a result of uncontrolled urbanization, climate change, and political instability (. . .)” [4] (p. 122) “In the last few years, international migration flows have risen to levels unprecedented since the Second World War. (. . .) In 2014, over 50 million foreigners resided in the European Union, of which 33.5 million were born outside of the European Union, and 17.9 million were born in a different European Union member State from the one where they were resident. These trends are projected to persist and increase. The total net immigration for the region is estimated to increase by 20 million in the period 2010–2030” [3] (p. 17)

3. Prefabricated architecture as an answer to the urban crisis

3.1. Shortage of affordable and good-quality housing

Prefabricated solutions have constituted a technology considered and used in constructing multi-family housing in Europe since the first half of the 20th century. Initial attempts to use prefabrication in Europe are evidenced by the Praunheim estate (New Frankfurt) designed by E. May and built in 1926–1930 [23] or the Berlin Splanemann-Siedlung from the same period (Fig. 2) designed by J. Göttel and W. Primke, erected with the participation of M. Wagner [30, 31]. The specificity of multi-family housing, characterized by the repetition of flat plans, types of stories, or their fragments, seemed to predispose prefabricated technologies to be used in this type of buildings. This assumption is also shared today by supporters of prefabricated solutions.

Fig. 2. Splanemann-Siedlung, 1926–1930, the first housing estate built with panel technology in Berlin, September 2021, photo. A. Tofiluk

In Poland, an exceptionally high need to build a large number of flats quickly and relatively cheaply emerged following World War II. It is estimated that the destruction of urban properties amounted to 50% of the pre-war stock. The war damage made the housing situation more complex than ever before. The demand for promptly erected available flats also remained constant in the following post-war decades due to industrial development and influx of inhabitants from villages to cities, and high birth rate [32, 33].

The interest in the prefabrication of building elements among the architects was a natural consequence of the search for optimal technologies to solve the housing problem. For decades since the first post-war years, residential buildings, housing estates, and even significant parts of cities with a residential function were designed based on various prefabricated technologies [34–37]. However, at the end of the 1980s, the use of the so-called "large-panel" (prefabricated concrete walls and ceilings) was gradually discontinued. As the political system changed, many large production plants, including "house factories", ceased to exist.

Although various attitudes to the Polish large-panel of the 20th century are observed today, it cannot be denied that the technology contributed, at least partially, to improving the housing situation in Polish cities. It is estimated that about 10 million people (over a quarter of the population) now live in large-panel estates erected prior to the 1990s. These figures are to be found in the media [38, 39], but remain difficult to verify. However, based on other data (e.g., the estimated number of objects [40–42]), they seem realistic. Currently, large-panel technology in residential building construction is rare in Poland, while no other prefabricated technologies are applied on a large scale. Paradoxical though it may seem, the lack of current large panel implementations does not result from the lack of production potential. In Poland, some production plants and design offices do provide solutions to foreign markets [43–45].

Nevertheless, in recent years, a renaissance of prefabricated construction in multi-family architecture can be observed. In order to popularize this way of building, exhibitions, architectural competitions, conferences and public discussions are held. Public institutions, producers of building materials, and designers act as promoters of the return to prefabrication in Polish residential architecture. After a long pause, the first Polish large-panel project was erected in Warsaw, at Sprzeczna Street, designed by the B.B.G.K. Architekci studio (Fig. 3), and constructed in 2016 [46]. The investor, a manufacturer of concrete elements, implanted the facility to draw attention to a slightly forgotten and unpopular technology. The building gained recognition from the architectural community and proves that a creative interpretation of large-panel technology is possible. Although of exhibitive and advertising nature, the facility was not conceived as an affordable and cost-optimized building.

Fig. 3. Building on Sprzeczna Street in Warsaw, June 2017, photo. A. Tofiluk

Another residential housing estate made with concrete panel technology was a one in Poznań, on Jasielska Street, erected in 2019 according to a design by Adam Mikulicz Architekci studio. Here, too, the investor was a manufacturer of prefabricated elements.

The next example is an investment in a housing estate in Okólna Street, Toruń. The facility is designed by S.A.M.I. Architekci studio [48]. The investor, a state-owned entity (P.F.R. Nieruchomości), implements a program of affordable apartments. Under architectural competitions organized by this institution, prefabrication is indicated as the preferred technological solution.The new housing estate includes eight three-story buildings with a total of 320 apartments. The project is a pilot program for the use of prefabrication in affordable housing.

In Germany, where numerous large-panel housing estates were built since the 1950s, this technology is also being revived today in order to ensure affordable and social housing. Old buildings in this technology are being revitalized.

To solve the issue of housing for refugees [48], the Berlin authorities began to make real the MUF building program [49–51]. The abbreviation MUF stands for Modulare Unterkünfte für Flüchtlinge, i.e. Modular Accommodation for Refugees. It is also planned to use the flats in the future, after interior reconstruction, for social facilities and for students. MUF buildings are erected as the second stage of providing housing for refugees, who arrived in Germany in 2015–2016. The first stage, the container housing estates, are described further in the text.

In 2016, a new modular system (concrete slabs and panels) for MUFs was developed. The planned time for building construction is less than a year, whereas its life expectancy is 50 years.

A residential module that can be assembled in rows and added up to 6 stories constitutes the fundamental element of the residential building. An additional bungalow building houses general and communal functions. The urban layout of the development complex can be adapted to a given location. Initially, 10 locations were designated, followed by new sites in which buildings were to be erected according to this system (Fig. 4).

Fig. 4. Modulare Unterkünfte für Flüchtlinge, Wittenberger Straße, Berlin, photo. A.Tofiluk

There are three 4-person flats (42 m^2) and one adapted for the disabled (32 m^2) on the ground level in one residential module. The upper floors are open; there are eight twin rooms, a kitchen and shared rooms, sanitary and storage facilities. In the future, the floors can be rebuilt and divided into independent apartments, elevators and balconies can be added.

3.2. Environmental protection, mitigation issues and adaptation to climate change

The selection of technologies, including structural and material solutions, which will exert the most negligible negative impact on the environment due to its degradation and climate changes [8,52–54] provides an aspect of sustainable architectural design. To shape a building in a climate-responsible manner, an architect should strive to apply solutions aimed at reducing the use of natural resources and energy consumption throughout the building's life cycle. The design trend that combines prefabrication with high energy-saving requirements seems the easiest to assess, as represented by the following two implementations. In both panel technology (skeleton structure with heat-insulating material) is used and both feature better energy characteristics than those required by the regulations and are equipped with additional pro-environmental solutions – e.g. photovoltaic installations, mechanical ventilation system with recuperation, shading devices.

The first example is the passive kindergarten in Podkowa Leśna, garden city near Warsaw [55], by Bjerg Arkitektur, built in 2021 (Fig. 5). The building consists of a simple block with an atrium. The façade is made of vertically-arranged wooden boards, which, apart from their aesthetic value, regulate sunlight access. Photovoltaic panels are installed on the roof. Low carbon footprint materials, particularly the ubiquitous wood, were used for construction. The use of a prefabricated structure was supposed to shorten the construction time to a minimum so that the newly-built kindergarten could promptly replace the old, demolished one and commence its operation as soon as possible.

Fig. 5. Passive kindergarten in a panel structure, Podkowa Leśna, photo. M. Płoszaj-Mazurek

A small housing estate Wawer district, Warsaw [56], offers the second example of the skeleton panel technology. Designed and built by Ecologiq, it consists of eight premises. The buildings were equipped with a photovoltaic installation and a mechanical ventilation system with recuperation. To prevent room overheating in the summer, the buildings on the southern side were protected with special covers (Fig. 6). The construction of an energy-efficient municipal building complex has been positively verified by KAPE [National Energy Conservation Agency] [60].

Fig. 6. Housing estates in Warsaw at ul. Bambusowa [Bambusowa Street], photo. A. Tofiluk

3.3. Urban sprawl

Counteracting urban sprawl is a task of a comprehensive nature. One of the proposed solutions is the compact city concept implementation, including the increase in the existing urban density [57–59]. This, in turn, may take the form of superstructures upon existing buildings – so-called "parasitic architecture". Parasitic architecture is structurally supported by the host building, accessible via it, and often complements or extends the existing function of the object. The parasitic architecture has been present in discussions for many years now as a response to urgent urban problems [60–62].

The Loftcube, a residential module designed by W. Aisslinger, is a concept that was implemented in 2003 [63, 64]. It consists of a minimalist prefabricated apartment designed as an independent unit (Fig. 7). It can be installed on the ground or upon the roofs of existing buildings. It can easily be transported. In 2017, it was installed on the roof of the Hotel Daniel in Graz, Austria. Loftcube proves that prefabricated parasitic architecture is possible and that the idea itself is worth developing on a larger and more accessible scale.

Fig. 7. Loftcube, Graz, August 2019, photo. A. Tofiluk

4. Crises and sudden and periodic needs

The essential feature of prefabricated architecture, namely its production outside the construction site and prompt assembly of the object on the site, makes it particularly applicable in crisis situations [65–67].

The first of the examples dates back to 1945. Its long history is unique and proves the legitimacy of prefabricated objects being installed in the absence of solutions based on local resources. By 1945, 72 percent of the housing stock in pre-war Warsaw had been demolished. Thus, the housing situation in the Polish capital city was catastrophic [68]. As part of the support for Biuro Odbudowy Stolicy [Capital Reconstruction Bureau], the soviet authorities donated apartments for their employees and shipped 500 prefabricated wooden houses, the so-called "Finnish cottages" to Poland [69, 70]. It was decided that the buildings would function for a maximum of 10 years, so it was necessary to look for a location that would not interfere with newly-planned investments. Several locations were selected, including the Jazdów area, where 27 facilities still exist today. The assembly of 90 buildings in this location began in March and was completed in August of 1945. The buildings comprised the first new housing estate in a city after the war. Although modest by today's standards, the estate was considered luxurious in the post-war reality. The urban-planning layout of the buildings which have survived to this day was entered into the municipal register of monuments, together with the three best-preserved objects. It is worth mentioning that currently, only a few buildings are used for housing purposes, while the remaining ones are used by non-governmental organizations (Fig. 8).

Fig. 8. "Finnish houses", Warsaw, Jazdów, photo. A. Tofiluk

Nowadays, various types of containers offer a solution to sudden disasters, catastrophes and crises. Mobile units can be adapted to immediate needs, and their service can be planned in a given location as a temporary measure. Sometimes it is possible to reuse shipping containers or adopt new ones for housing and other purposes. The Covid-19 pandemic crisis led to the emergence of such objects in public spaces of European cities. The services they house include Covid test sites, outpatient clinics, solitary units, and finally, vaccination points [71, 72].

The migration crisis in Europe in 2015–2016 was and still is a challenge. Attempts to solve it have been made ad hoc, whereas the adopted solutions included housing containers [73, 74]. About 2.45 million refugees arrived in Europe during this time, almost half of whom came to Germany. 72,000 refugees ended up in Berlin [75]. Initially, the refugees were placed in hastily arranged housing, such as the unused premises of the Tempelhof airport, sports halls, schools [76–78]. The Berlin authorities then decided to erect Tempohomes, i.e., container housing estates [79–81]. Tempohomes are designed for a maximum stay of three years. Two residents occupy a room whose area totals about 13 sq. meters, a bathroom and a small kitchenette are shared with the residents of another twin room. Each quadruple unit has a separate entrance. There are also common and functional rooms. Tempohomes were implemented in the one-story and three-story options (Fig. 9). Contrary to the original plans, some of the container estates operated for more than three years, pending the erection of the MUFs. Dwellings in containers are not well assessed by their inhabitants [82].

Fig. 9. Tempohomes in Berlin (left) Closed container village on Blumberger Damm; (right) Still functioning village on Karl-Marx-Straße, photo. A. Tofiluk

In Poland, container facilities are sometimes applied as flats for the citizens who fail to adapt to the social principles. Usually, the authorities declare the solution only as temporary measures. In practice, however, the span of their operation may reach several years. In Józefów near Warsaw, a container building has been operating for over ten years now. According to the residents, the rooms remain underheated in winter, too hot in summer, while mildew appears on the walls due to everyday use and poor ventilation [83, 84].

The two examples presented below may help solve urban problems and lead to the usage of areas that would probably remain idle. The implementations provide a framework for the urban functions and social life activities where it is desired in the absence of traditional architecture.

Lack of space in university buildings, the need for practical construction and the desire to use architecture as a tool and a place in the social integration process, as well as the need for creating an inclusive city were reasons to built the Mobile Stadtlabor (city mobile laboratory). In 2012, as part of a course, students at the Technical University of Vienna designed a facility based on transport containers. The object features an open research platform within T.U., devoted to urban development issues in the Vienna metropolis which is managed by the university's Future.lab. Together with the organization of open seminars, exhibitions, lectures, and other events at the Mobile Stadtlabor, Future.lab has emerged from the university walls into the city space. The facility consists mainly of an auditorium and other working and auxiliary rooms. [85, 86].

The first location of the Stadtlabor was Karlzplatz in front of the university. In 2016, the facility was moved to become the focal point of OPENmarx project. It was established in the former Viennese Central Livestock Market, which in the future was to become the site for new municipal investments. However, until this happens, in 2016–2020, an open spatial concept of a meeting place and mutual interaction was implemented here. OPENmarx was aimed at young people from various social and geographical environments. The new spatial form was to invite the local community and refugees from the nearby camp to build, learn, experiment, discuss, produce, play sports, cook, eat, and spend time together (Fig. 10).

Fig. 10. Openmarx, September 2018, Vienna, photo. A. Tofiluk

5. Discussion and conclusions

The discussion about prefabrication in architecture is still strongly marked in Europe by the experience of the large housing estates of the post-war era. The evaluation of the 20th-century prefabricated housing architecture, mostly erected in large-slab concrete technology, both in Poland and in Europe, consists of many accusations [40–42]. At the same time, much of valid and justified criticism does not concern the building technology as such [41, 87].

The history of architecture shows that prefabricated technology is limiting. Modularity, optimization of structural solutions and repetition of elements restrict the freedom of choice of architectural design options and their flexibility. Additionally, some modernist ideas and assumptions did not turn out to be correct. The shaping of contemporary architecture must be done through the prism of these experiences.

The cases described in this paper present a vast spectrum of implementations that fall within the definition of prefabricated architecture, whose aim is to help solve problems and alleviate urban crises. In order for prefabricated architecture to become a tool for improving the city, several conditions must be met each time. Listed below are the conditions of a general nature:

– Prefabricated architecture, established as a result of a carefully designed construction system and assembly process, may provide a solution to the need to provide high-quality housing quickly and relatively cheaply, although several conditions and requirements must be met for such investment in each case.
– Apartments constructed in prefabricated technology are more justified in the case of relatively small apartments, which is related to both production and assembly technology and affordability. Regardless of the construction material used (wood, steel, reinforced concrete), the modularity of prefabricated construction, optimization of structural solutions and transport considerations limit the spans of the load-bearing elements of the structure.
– Assuming the mass use of a given prefabricated system, the risk of repetition and monotony in the urban space should be borne in mind. However, such an effect can be avoided if the objects are relatively small, as in the case of MUFs, grouped by

3 (two 5-story residential buildings and one-story service facility), or if individual groups are dispersed across the urban fabric. Simultaneously, as other studies also show, prefabrication can be a tool for shaping architecture with high architectural qualities [88].

– Although there is no requirement for prefabricated solutions to be energy-saving or ecological, they have unique potential in this regard. A controlled production process increases the efficiency of material use and results in reducing the amount of waste, both in the production plant and at the construction site. The controlled production process also ensures the high quality of the building components in terms of thermal insulation properties. The disassembly potential prompts the design and implementation of a prefabrication system, as the materials and components could be reused. The prefabricated technology is conducive to planning the entire life cycle of a building.
– Prefabricated parasitic architecture in the era of the necessity to densify cities seems to offer a promising solution to be further researched, analyzed and developed and and attempts to apply it should be evaluated very positively. However, it should be mentioned that parasitic architecture is not applicable everywhere. It is limited, for example, by the structural capacity of existing host buildings, preservation requirements or the technical condition of the buildings. It should be remembered that it also provides relatively little additional space.
– Characteristic features of a container facility include quick assembly, relatively low price, the possibility of their reassembly in various locations, or different use of the containers in the future. Therefore, such a solution seems ideal for the temporary development of areas whose function may likely change in the future, such as in the case of the OPENmarx. Container structures should not be used for residential purposes. If necessary, the time of use should be kept as short as possible.

The above conclusions are important from the perspective of Polish design and construction practice and indicate the importance and possible use of prefabricated technologies. The described contemporary Polish examples are still few, but they indicate an increased interest in prefabrication among designers and investors.

In conclusion, it is worth noting that prefabricated architecture is "everyday architecture", not particularly aesthetically sophisticated and not luxurious, but it has the potential to provide acceptable working, living and educational conditions to a relatively large number of users. It is worth remembering that "Prefab is not an end in itself. It only has value if it can get the results it needs to – if more people end up with well-designed, well-made houses than can currently get them." [27].

Conclusions from the described analyses do not entitle one to say that prefabricated architecture will save the city, but they allow a belief that it can help solve its crises.

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Problemy i wyzwania środowiska zabudowanego a potencjał architektury prefabrykowanej

Słowa kluczowe: architektura prefabrykowana, kryzys miasta, architektura modułowa, architektura pasożytnicza, architektura kontenerowa

Streszczenie:

Współczesne europejskie miasto mierzy się z wieloma problemami i można przyjąć, że pozostaje w permanentnym kryzysie. Składowe ten kryzys tworzące ulegają zmianom w czasie. Do już istniejących problemów dochodzą nowe wyzwania, z którymi zostają skonfrontowani mieszkańcy, zarządcy oraz osoby zaangażowane w projektowanie i przekształcanie miasta, w tym architekci. Do „odwiecznego" problemu jakim jest niedobór dostępnych mieszkań, dołączyły w ostatnich latach nowe wyzwania, w tym m.in. gwałtowany napływ uchodźców, zmiany klimatu i ich konsekwencje oraz pandemia. Rozwiązania tych zagadnień są złożone i wielowątkowe, a podejmowane działania interdyscyplinarne. Architektura prefabrykowana może stanowić część składową tych rozwiązań. Prefabrykowane technologie budowlane, w tym budownictwo wielkopłytowe, modułowe oraz obiekty mobilne pozwalają, przy spełnieniu odpowiednich warunków, usprawnić proces wznoszenia nowych mieszkań, wpisują się w ideę gospodarki cyrkularnej oraz mogą być odpowiedzią na nieoczekiwane i dynamicznie zmieniające się w czasie uwarunkowania (budynki kryzysowe). Niniejszy tekst analizuje współczesny kryzys miasta i możliwe do podjęcia kroki przez pryzmat możliwości jakie daje projektowanie obiektów prefabrykowanych. Stawia pytanie i poszukuje odpowiedzi przy spełnieniu jakich warunków ta architektoniczna „najstarsza nowa idea" może pomóc sprostać wymaganiom współczesności. Przeprowadzone analizy mają charakter uniwersalny, niemniej jednak uwzględniają zastosowanie rozwiązań prefabrykowanych w architekturze w Polsce oraz potencjał jej dalszego rozwoju. Dlatego też omawiane realizacje z kraju autora zajmują istotne miejsce w tekście i są pokazywane w pierwszej kolejności na tle europejskiej praktyki projektowej. Pominięcie rozwiązań z innych kontynentów jest celową delimitacją.

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