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The multifunctionality of infill buildings as an answer to rational and economical land development

Multifunkcjonalność zabudowy plombowej sposobem na racjonalne i ekonomiczne wykorzystanie przestrzeni

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Abstract. Infill buildings incorporated into the existing urban structure of cities can, under certain conditions, become the places of social-building initiatives and improve the living standards of cities. Cost-effective and efficient utilisation of a land plot's potential can make a building immune to changing economic and social conditions and represents an important citybuilding factor. Moreover rational use of a land plot's potential represents an excellent opportunity for the return to modern, fully functional architecture and consequently to improve the quality of life in often neglected centres of Polish cities.
Keywords: infill; complementary development; multifunctionality; building's multifunctionality; sustainable design; city centre

Streszczenie. Budynki w zabudowie plombowej dogęszczające śródmiejską strukturę miast, przy spełnieniu określonych kryteriów, mogą stać się miejscem społecznotwórczych inicjatyw oraz wzrostu standardu życia w mieście. Ekonomiczne i efektywne wykorzystanie potencjału działki uodparnia obiekt względem zmiennych warunków gospodarczo-społecznych, co może stanowić istotny czynnik miastotwórczy. Racjonalne wykorzystanie potencjału działki jest doskonałą szansą na powrót nowoczesnej, w pełni funkcjonalnej architektury, a w konsekwencji na poprawę jakości życia w często zapomnianych centrach polskich miast.
Słowa kluczowe: plomba, zabudowa uzupełniająca, multifunkcjonalność, wielofunkcyjność budynku, projektowanie zrównoważone, śródmieście.

The urban fabric of cities is formed in a continuous and individual way. It depends on different spatial, economic, political, social and cultural factors. The city center is an area that stands out in the city space, e.g. by greater development intensity, developed infrastructure and offering many functions. As a consequence of many years of urban changes and the increase in the area of cities, their centers remained somewhat forgotten. During the period of modernism, especially between the 1960s and 1970s, the traditional model of forming the urban fabric was gradually discarded [1]. For the mass influx of people from rural areas, cities offered complexes of detached residential buildings, located in green surroundings with the necessary communication and recreational networks. The process of expansion of the urban structure has already absorbed scattered detached buildings, which in the 1970s in many Polish cities marked the boundaries of urban development, because it is now part of it.

In recent years, the urban tissue has been increasing in city centers, which is related to the processes of reurbanization [2]. Many revitalization projects are undertaken primarily to give a new function to this part of the city and to ensure good quality living space. A flagship example of a city centre revitalisation project is Łódź [3], but many other cities in Poland are taking similar actions [4]. Despite the increasing number of investments undertaken in the city centers of Polish cities, many of them face the problem of depopulation of these areas, which is an additional factor motivating to take action to improve the standard of living in the city.

The problem of the urban environment has been analysed by numerous scientists, which has resulted in scientific papers dealing with issues such as residential [5], commercial [6], cultural [7], religious [8] functions, ecology [9] or revitalisation [10]. The urban structure is being supplemented with new structures, infills [11], built in place of old buildings in close quarters, often destroyed, abandoned, subject to demolition, but also fill vacant plots on the frontage of downtown buildings. Thanks to this, these plots have a chance to become part of the city's structure by placing new buildings within them with functions tailored to current needs. In some cases, non-functional buildings, despite having a solid structure, are extensively rebuilt or torn down in order to be replaced by new buildings that offer the required functionality, and such buildings more and more frequently have a high standard of use and an attractive design.

Of fundamental importance in this context is an economical approach to the development of strict inner city areas. The rational utilisation of a land plot's potential is an opportunity to return to modern, fully functional architecture, which consequently leads to the improvement of the quality of life in the city centre. In the age of sustainable

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design, the ongoing congestion of the urban fabric with buildings adapted to the current and future needs is inevitable. Therefore, the process of designing and consequently the construction of a building in a densely-developed environment requires a detailed analysis and research of the existing condition of the adjacent buildings in each case. The designer is obliged to adapt the proposed solutions with the consideration of the existing adjacent buildings.

Land plots situated in densely-developed inner city environments have a specific appearance. Each one is different and has an individual story. The vast majority of adjacent buildings demonstrate a wide range of different facades, which constitutes an interesting challenge when designing the facade of the planned building. Modern forms and dimensional variability is possible, under the condition of maintaining visual harmony with the neighbouring architecture. In such cases, the individual and original character of a new building gives freshness to a street frontage. These plots, due to the possibility of construction of new buildings with attractive architecture and a multitude of functionalities, have a big potential in terms of the fulfilment of social needs and the rational and economical use of the urban space. They can also become a major city-forming, social-forming factor and can significantly improve the quality of life in cities.

The subject of the research is the functional analysis of selected objects that are examples of modern seals located in an urban environment. Due to the analytical nature of the research conducted, a mixed research method was used, which includes a qualitative method and a case study [12]. The qualitative criterion concerns the examination of functionality, and the case study method takes on a comparative nature of selected objects.

The multifunctionality of infill buildings

The function of an object plays an important role, giving meaning and defining the architecture of the building. The existing buildings in densely-developed central areas of Polish cities offer different functionalities. There is a decreasing number of facilities being built nowadays in city centers with one function, e.g. residential. Most often, they are multifunctional. This effect is the result of the variability of economic and social factors, while city centres are subject to constant changes in terms of the intensity, quality and aesthetics of the architecture. Moreover, it should be emphasized that streets within the city are characterized by varying popularity among residents, investors and tourists. Many cities are trying to tackle the problem of 'depopulated' streets. The undertaken attempts to revitalise them are based on bringing them back to life through the introduction of functions that are currently in demand, and by encouraging the local community to participate in various initiatives, such as cultural ones [4].

Currently there is demand for new buildings that respond to various social needs, not only those of today, but also in the future. In most cases, their functionality depends on the individual character and the demands of a given urban environment, but also significantly on economic and ecological factors. This problem will be demonstrated on the basis of a study of examples of infill buildings located in the centres of Polish cities with different population density levels. In urbanized space, where every fragment is valuable, individual solutions aimed at sustainable construction are sought. The examples selected for the study and the comparison of the values they bring in terms of functional programs inside, but also in the impact on the surroundings, constitute only a sample in the article and cannot be used to draw universal conclusions regarding the shaping of infill development regardless of its location. The facilities selected for analysis are examples of interesting architectural solutions, and each of them is characterized by individual solutions that respond to the problems and needs in a given location.

Selected examples of urban infill projects carried out during the recent decade of the 21st century. They reflect the current design and functional programme trends. They offer various functionalities in the fields of culture, education, commerce or gastronomy.

Małopolska Garden of Art (photo 1) is located in Krakow (population approx. 800,000), opened in October 2012, designed by Ingarden & Ewý. The design took into account the structure of the old horse riding hall, which served as the back-up facility for the J. Słowacki theatre, by exposing the old facade as one of its parts. Currently the building has the form of the letter 'T' and occupies the area of the plot in an interesting and maximally effective way, opening up in the direction of Rajska and J. Szujskiego streets. The form of the building fully utilises the natural characteristics of the plot and respectfully blends in with the adjacent buildings in a very modern way. This is a multifunctional building, which incorporates many different art-related functions. It houses the auditoriums of the J. Słowacki theatre and the media-art libraries of the Voivodeship Public Library. The building accomodates shows, concerts, conferences and different performances. It also contains a cafe and education rooms. This infill, despite having a very modern form, has blended in, in terms of its size and multifunctionality, with the old town character of the district and acts as a social-building element and as a centre of many initiatives designed to activate the residents[13].

Radio and Television Department of the Silesian University (photo 2) The facility is located in Katowice (population approx. 300,000). It was designed by 3 design studios BAAS, Grupa 5 Architekci, Małeccy Biuro Projektowe, opened in 2017.

This building was originally designed as an unconventional addition to the city structure. The designers' main goal was to construct a new building, while maintaining the two-story structure of the building that existed on the plot at that time. In terms of its dimensions, the facade blends in with the adjacent buildings and the materials used imitate the traditional materials seen on the adjacent facades. The form of the building opens up onto the street thanks to clear access routes leading to the patio

a) b)

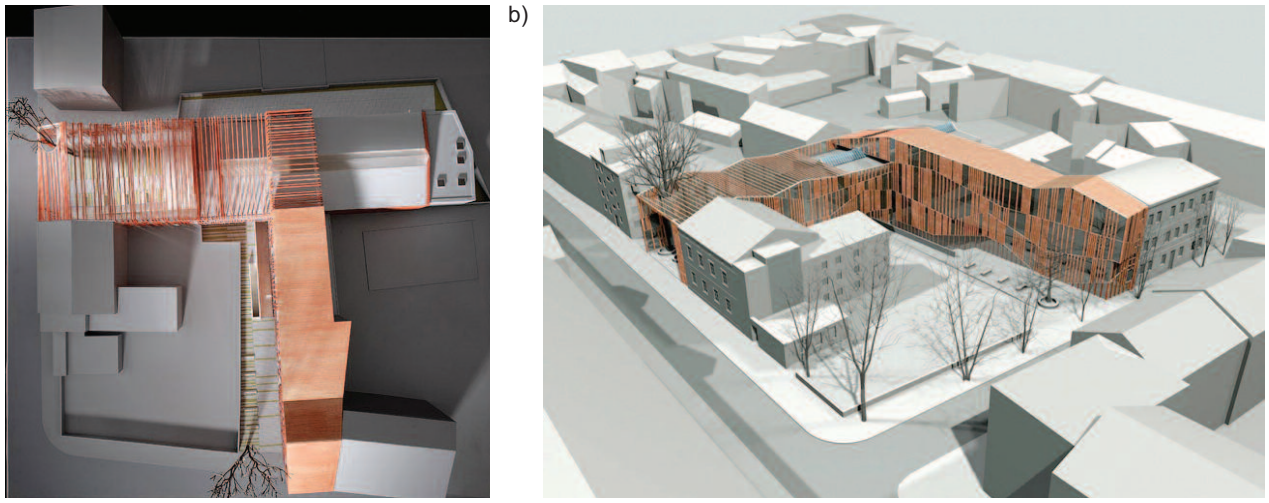

Photo 1. Model of the Malopolska Garden of Art: a) top view showing the shape of the building; b) perspective in the context of the adjacent building *Source: [12]*

Fot. 1. Makieta Małopolskiego Ogrodu Sztuki: a) widok z góry ukazujący kształt budynku; b) perspektywa w kontekście sąsiadującej zabudowy Źródło: [12]

that underline its public, open nature. The facility serves mainly educational functions, but there is also a library, a student club, and an underground parking lot. This is an infill that improves the quality of the urban landscape in this district [14].

Nova Commercial and Retail Building (photo 3) is located in Limanowa (population approx. 15,000). It was opened in April 2021 and was designed by architects Monika Nalewajk, Maciej Sajdak and Adam Dziedzicki.

An infill building erected in the place of existing buildings along one of the streets leading to the main square. Extends across the entire plot, connecting two mutually parallel streets: Józefa Marka street and ks. Kazimierza Łazarskiego street. The facility houses service, retail and office functions with a parking lot located on the ground floor. The difference in ground levels between the street on the side of the main entrance to the gallery and the parallel street on the side of the entrance to the car park, allowed the designers to create a parking/technical area without the need to design an underground level. The building is divided into two zones. The first – the retail part – is situated on the side of the street with the main entrance to the gallery, while the second – the office part – is accessible from the other side of the building. The inclusion of a playground for children in the building means that it offers functionality for residents of all ages. Clear communication routes play an important role in the building and enable efficient movement inside the building. The multifunctionality of the erected infill responds to the various demands of the city centre. The form of the facade is highly distinctive and stands out from the traditional buildings of the street frontage and is an example of bold and original architecture [15].

Education Station (photo 4) location of the facility: Wieleń (population approx. 6,000); opening date: July 2022; designers: Neostudio Architekci. The Education Station' is an unusual infill

a) b)

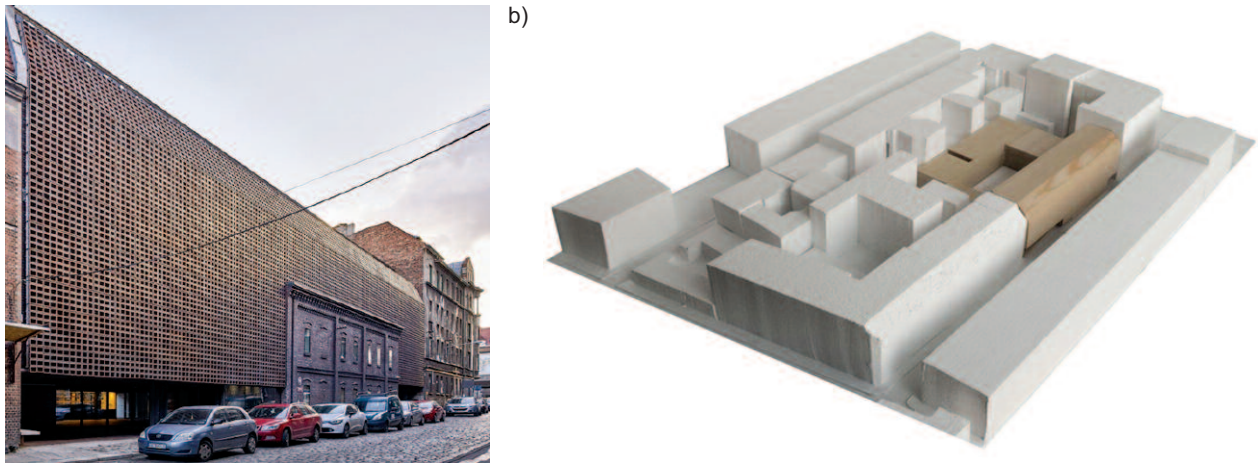

Photo 2. Radio and Television Department of the Silesian University in Katowice: a) facade of building; b) model demonstrating the compatibility of the building's size with adjacent buildings *Source: [14]*

Fot. 2. Wydział Radia i Telewizji Uniwersytetu Śląskiego w Katowicach: a) elewacja budynku; b) makieta ukazująca dopasowanie obiektu gabarytami do sąsiadującej zabudowy Źródło: [14]

a) b)

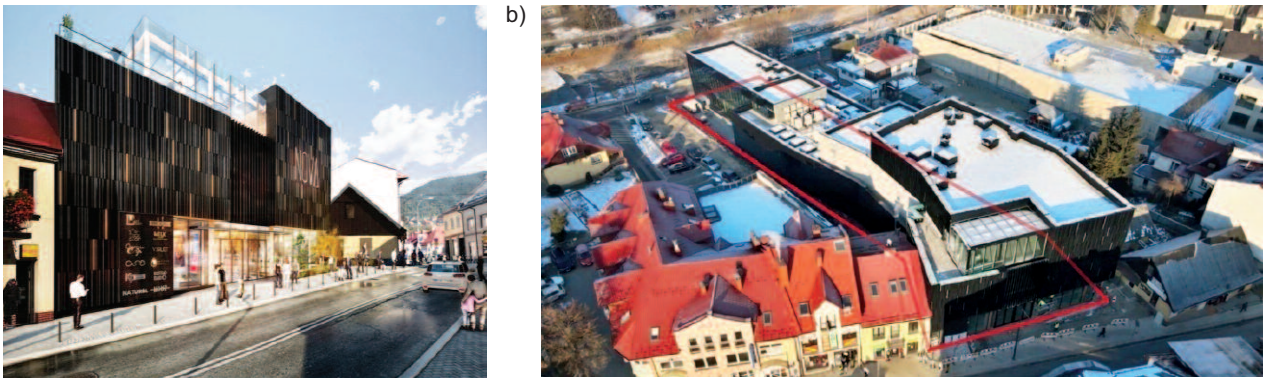

Photo 3. NOVA commercial and retail building: a) visualisation of the front facade [15]; b) view of the gallery demonstrating the utilisation of plot area
By author, on the basis of [16]
Fot. 3. Budynek usługowo-handlowy NOVA: a) wizualizacja elewacji frontowej [15]; b) widok na galerię przedstawiający wykorzystanie działki
Opracowanie własne na podstawie [16]

project at Kościuszki street as a response to the revitalization activities undertaken in the city. This small--volume building is a part of the designed cultural square. It blends in with the existing low-rise buildings in an interesting way via an arcade reinforced concrete wall, which is situated close the interior of the building. The facade wall covers a glass cafe pavillon. This is a low-budget project, appropriate for a small town, which 'invites' the local community to participate in the social life. The building also houses an information centre. It is accompanied by a square, which serves as a meeting place, hosts cultural events and an outdoor cinema. This project represents an unconventional example of how to economically revive a neglected area by offering the residents a multifunctional facility that can act as a social-building element [17].

Analysis of seals according to the adopted criteria

The analysis of buildings was based on the author's own criteria, to which the modern infill in the city center was assessed in the context of:

- the impact of the object on the outside, in relation to the surrounding urban structure and the plot on which it was located (Figure 1);
- the interior of the object, its functionality and accessibility for users (Figure 2).

A complex analysis of multifunctional urban infills in the context of selected problems, with the consideration of various scales of the selected examples, will allow us to answer whether a given infill responds to the current social demands and whether the inner city space has been utilised in a rational and economic way.

The table was introduced into the body multifunctional infill according to criteria accepting these for research. They concern the external environment of fillings and their impact in space. Selected infill were assessed in the context of: economic use of the plot space, impact on improving the quality of urban space, revitalization of degraded space, but also – whether the form of the facade and dimensions of the infill refer to the neighboring buildings and whether the facility constitutes a social-creative space. In

a) b)

Photo 4. Education Station in Wielen: a) building facade in the context of the adjacent buildings; b) view of building and a fragment of square
Source: [17]
Fot. 4. Przystanek Edukacja w Wieleniu: a) elewacja budynku w kontekście sąsiadującej zabudowy; b) widok na budynek i fragment placu
Źródło: [17]

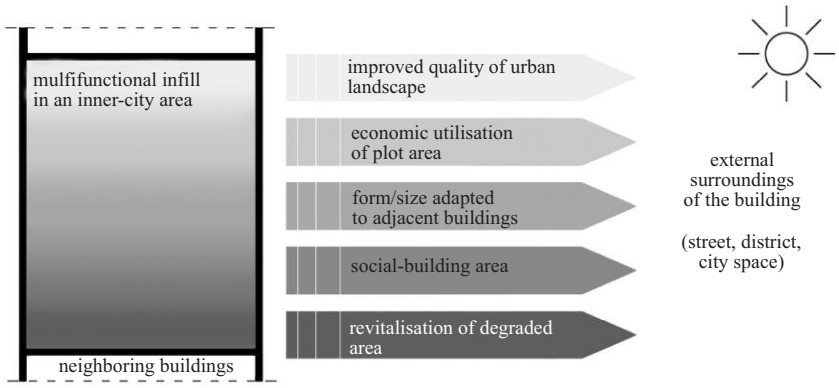

Fig. 1. Features of a multifunctional infill that influences the environment
Rys. 1. Cechy multifunkcjonalnej plomby, którymi oddziałuje na otoczenie

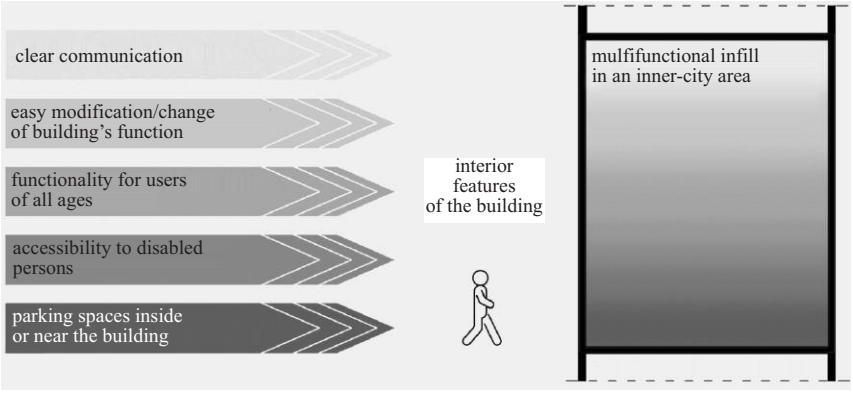

Fig. 2. Internal features of a multifunctional building
Rys. 2. Wewnętrzne cechy multifunkcjonalnego budynku

Analysis of infill objects according to the criteria adopted for testing
Analiza obiektów plombowych wg kryteriów przyjętych do badań

Analysed aspects of multifunctional infill building	Małopolska Garden of Art	Radio and Television Department of the Silesian University	Nova commercial and retail building	Education Station
Economic utilisation of plot area	■	■	■	■
Improved quality of urban landscape	■	■	■	■
Talisation of degraded area	■	■	■	■
Facade form and size adapted to adjacent buildings	■	■	■	■
Social-building area	■	■	■	■
Easy modification/change of building's function	■	■	■	■
Functionality for users of all ages	■	■	■	■
Accessibility to disabled persons	■	■	■	■
Parking spaces inside or near the building	■	■	■	■
Clear communication routes	■	■	■	■
Total	10/10	10/10	8/10	9/10

■ criterion fulfilled ■ criterion not fulfilled

terms of the interior of the tested facilities, the following items were assessed: ease of modification and change of functions, functions offered to users of different ages, clear communication, access for people with disabilities and whether the necessary parking spaces are provided inside or near the building. It should be noted that contemporary trends are aimed at limiting passenger cars in city centers. Multifunctional infill respond to these issues by offering many functions within one object. However, the possibility of parking within or near the building is a great convenience for people with disabilities, pregnant women and the elderly.

Based on the analysis of the results contained in the table, general conclusions were drawn about the quality of contemporary designs filling objects. Result of the work is also a summary of issues related to functional solutions affecting the quality of the building and its surroundings. The list has an ordered structure – from general features in the scale of the city surroundings, streets, to the interior of the building. It turns out that modern designed multifunctional infill have many common features. All objects meet most of the adopted criteria. Among other things, the following were not met: no reference to the dimensions of the neighboring buildings (NOVA building), lack of socio-creative space, or uneconomical use of the plot area (Przystanek Edukacja). The implemented analysis criteria, which were used to determine the effect of infill buildings on the environment as well as the internal attributes of the multifunctional buildings, were determined cannot constitute universal parameters for designing infill buildings in a densely-developed urban area. The presented table can support the development of guidelines for programming design assumptions and research work, provided that the generally formulated criteria should each time be specified with specific values to constitute the basis for planning functional programs for facilities of this type. It should be emphasized that the described research is partial and shows the complexity of the problem and the multi-threaded nature of infill development in the city centers of Polish cities. In the article, we attempted to present the features that should be present in a multifunctional infill in downtown buildings that responds to contemporary and future social needs (Figure 3).

Conclusions

The development of city centers is dynamically and constantly developing. This process is inseparably linked with

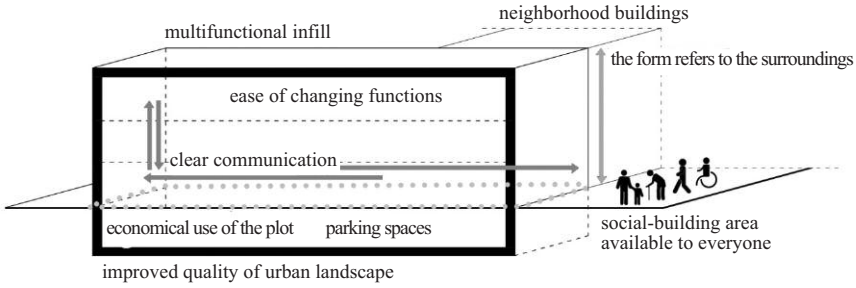

Fig. 3. Features of a modern urban infill
Rys. 3. Cechy współczesnej plomby miejskiej

the development of unoccupied areas in urban centres. This results in the need to select the basic values and characteristic features of such new buildings. The list of many positive criteria that should be met by a multifunctional infill building shows that the economic and social factors play an important role. The ability to design this type of building with the consideration of changing economic and social condition demonstrates an economic and rational approach to design. In the article, the economic aspect was interpreted both as efficient (intensive) use of space and in the economic context.

Undoubtedly, the economic use of a plot located in the center of the city is a complex project due to many requirements, such as the analysis of the foundation conditions of the neighboring buildings, the need to design several floors, and the need to provide parking facilities. Nevertheless, city center has that are able to compensate for the financial outlays incurred. City development, its prestige, or fashionable districts often attract potential investors. The provision of a multifunctional and flexible area in a building makes it attractive to a wide range of consumers, which consequently translates into the profitability of a project and a better image of the area. The overall form of the building, meanwhile, should take into consideration its changing functionality in time and the possibility of adapting the building to these changes as highly as possible. Only then the designed space will be sufficiently effective to adapt to changes taking place not only within the urban fabric, but also in changeable economic and social conditions. A rationally-designed building should also take into consideration the functional, spatial, economic, ecological and user safety aspects [18]. Buildings situated in inner-city areas combine their main and auxiliary functions in a way that allows them to adapt to the functional spatial context of a given location in the most effective manner. Moreover, the individual functions assigned to such buildings do not affect each other.

Summary

The performed analyses of multifunctional, modern infill buildings located in the centres of Polish cities demonstrate that the functional, as well as dimensional variability of such buildings that the evaluation criteria indicated in the study constitute initial parameters which, after being expanded and specified with specific values, taking into account the individual attributes of a given location, can be used in the design of modern multifunctional infill facilities. Apart from fulfilling modern social, cultural, territorial, economic or even symbolic demands, such buildings provide new quality to the urban fabric and respond to the problem of the depopulation of streets and neglected city centres. They also inspire new social-building initiatives and the improvement of living standards in cities. The most-effective utilisation of a plot's potential and the adaptation of the functional programme to the local needs facilitates the integration of the building with its environment, and makes the facility resistant to changing economic and social conditions, which is an important city-forming factor. The presented issue can be also helpful in the process of programming the design assumptions for new infill buildings, or their modernisation.

Analysis of all aspects of the discussed problems, apart from the participation of architects, requires the interdisciplinary cooperation and involvement in the research of experts from different fields.

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