WARSAW UNIVERSITY OF TECHNOLOGY Index 351733
FACULTY OF CIVIL ENGINEERING
COMMITTEE FOR CIVIL AND WATER ENGINEERING
POLISH ACADEMY OF SCIENCES ISSN 1230-2945

DOI: 10.24425/ace.2021.138045

ARCHIVES OF CIVIL ENGINEERING

Vol. LXVII ISSUE 3 2021

s. 93–108

Research paper

Assessment of large-panel prefabricated buildings in the social aspect of sustainable construction

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Abstract: A comprehensive assessment of buildings in accordance with the concept of sustainable development requires their analysis in three economic, environmental and social aspects. J It is a multi-criteria assessment, which takes into account many factors and their significance for the purpose of this assessment. Due to the complexity of this assessment, it can be performed due to a particular aspect, and the result obtained is a component of the global quality indicator as an additive function. The article presents the results of research conducted in large-panel buildings (LPB) enabling their assessment due to the social aspect. It is particularly important in the assessment of residential buildings, and the existing large resources of LPB are the basis for choosing them for such assessment According to the PN-EN 16309 + A1: 2014-12 standard, during conducting a social assessment of buildings, six main categories should be taken into account, which include: accessibility, adaptability, health and comfort, impact on the neighborhood, maintenance and maintainability, safety and security. The presented data was obtained as a result of the analysis of the features of selected buildings from the "large panel" located in housing estates in Cracow and Jędrzejów using a computer application. It is based on a mathematical model that was developed as part of a doctoral dissertation.

Keywords: sustainable construction, social assessment, large-panel prefabricated buildings, operation

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1. Introduction

In housing resources in Poland, it is estimated that about 50% are buildings made in the technology of the so-called "large panel". They were implemented in the form of various systems, such as OW-T, W-70, WUF-T, "Domino", "Rataje", "Szczeciński", "Winogrady" and others. The flourishing of residential construction implemented in large panel technology falls in the seventies and eighties. According to the original assumptions of the projected life of large-panel buildings was set at 50 years, and despite the already designed age, they are still successfully used. However, the question remains whether the buildings meet the current requirements of their users and whether their technical condition is satisfactory that they will be able to serve the residents for many years.

For years, many scientific and research centers, including the Building Research Institute (ITB), conduct research on the technical condition of large-panel buildings. The obtained results indicate that the safety of the supporting structure of these buildings is not currently threatened. Joints of load-bearing and structural elements are usually made correctly. There is a problem with the connections of texture layers of walls with structural layers of panels, also important from the point of view of building insulation [1], [2], [3], [4]. In the ITB research report on the assessment of the safety and durability of buildings the following conclusions were presented [5]:

„Large-panel buildings constructed in 1960–1990 are characterized by low functional and utility quality of flats, excessive heat permeability of external partitions, insufficient condition of building installations and equipment as well as low aesthetics of the facade. Continued use of buildings made of a large panels is therefore associated with the need to carry out specialist periodic inspections and assessments of technical condition and testing the suitability for use of buildings, including cost optimization for maintenance, ongoing repairs and possible modernization of buildings".

On the other hand, undoubtedly, large-panel buildings do not generally meet the functional and utility needs of residents. The report also includes the reasons for this [5]:

- functional and utility solutions of buildings and flats, resulting from the so-called communist times "design standard",
- the use of materials and products (especially finishing and installation) of insufficient quality,
- low quality assembly works and workmanship defects,
- misunderstanding the concept of "design service life".

They do not take into account the social context that is required in the current requirements for the design of sustainable construction. Therefore, there is a need to examine and determine the degree of meeting the needs of residents in terms of functionality of apartments and common parts of the building, building logistics, the possibility of raising standards in the field of service (supply of media), friendliness of the building's surroundings.

In the article, the authors present the results of direct surveys carried out in 2019 to determine the degree of satisfaction of the social needs of residents of large-block buildings. Identifying the social needs of residents during the operation of the building, i.e. its use and maintenance, and the method of assessing their satisfaction were developed as part of a doctoral dissertation [6]. This method takes into account assessment criteria, covering many different aspects of building use, also taking into account the immediate surroundings of the building. The method takes into account the changing needs and requirements of apartment users as well as compliance with current socio-economic concepts.

Conducting surveys among residents and persons managing residential buildings and analysis of obtained results allowed for the assessment of both: the functional and operational condition of the buildings examined, and the degree of meeting the current needs of their users in the social context. As the final result of the research, a comprehensive assessment of the performance of large-panel buildings was obtained due to social needs, referring to the principles of sustainable construction and integrated design [7].

2. Evaluation of buildings

Construction works are evaluated in the investment and construction process at every stage of its cycle. Starting from the evaluation of the idea, through the concept of the object, design and repeatedly at the stage of operation.. Traditionally, these assessments cover different aspects of investment and different criteria as to type and number. This sometimes leads to conflicts. An interesting architectural and construction project, e.g. not analyzed at the concept stage in terms of its technologicity, created difficulties, and in extreme cases the impossibility of constructing structures or finishing elements. In turn, the long life of buildings, in which the needs of their residents change as to the functionality of the building, did not provide for the possibility of their easy reconstruction during the design to adapt to the needs of the elderly and / or disabled people.

As it knows, changes made to a building facility are most conveniently introduced in the preparatory and design phases. Therefore, evaluation and acceptance of solutions must be multilateral and take into account various aspects.

This requires an evolution of the approach to designing buildings [8]. The traditional approach only takes into account the achievement of the required performance and quality assessments of the object during construction or several years of the warranty period.

The current approach known as integrated design is multi-faceted design (including aspects: functional and construction, including durability, safety and usability; environmental; economic and socio-cultural, and all phases of the life cycle of the building, i.e. programming, design, execution, operation (maintenance and maintainability), demolition and management of construction waste [7]). This multi-criteria approach is also used in the assessment of a building, in particular in relation to existing buildings that have already been used for many years, which is the subject of this article.

Each building structure is subject to varying degrees of degradation over time. **The degree of wear** reflects the impairment of a building, which results from **technical, functional and environmental wear**. The building degradation process is associated with two types of processes that take place throughout its entire life cycle:

- permanent decrease in technical efficiency and performance of the building,
- permanent increase in building users' requirements (including regulatory requirements).

Knowledge of the course of these processes is important during operation, i.e. the maintenance and maintainability of the object and in the process of managing it [6].

The condition of the object is evidenced by its technical efficiency and performance, which determine the facility's ability to operate.

Among the commonly used methods of assessing the technical condition, two basic methods are most often distinguished: **temporal** (initial estimation) and **visual** (accurate). Described e.g. in [9], [10], [11], [12] they have many supporters and often form the basis for analyzing the examined object and making decisions.

Many scientists are involved in analyzing the impact of individual structural elements on the technical condition of the object [13], [14], [15], [9], [16], [17], [18], [19]. It is important that these methods are often extended with additional factors that should be taken into account in the assessment, e.g. building type, basement method, type of attic and its covering, etc. Technical direction assessment using mathematical tools such as artificial neural networks is another direction [20], [15] or fuzzy logic [16].

In the light of currently applicable regulations and requirements [21], [22], [23], [24] and others) the assessment of technical condition only does not constitute a reliable assessment of the so-called facility serviceability for its user. Currently, an equally important element of the assessment of suitability for use is the functional wear of the building, which is strongly emphasized in new standards and ordinances. This aspect of the evaluation of buildings has appeared in many works, e.g. [25], [26], [27], [28], [29], [30], [31], [32], [33]. The authors of these works combine, among others functional wear with technical wear estimating the value of the building based on the degree of adaptation of its function to current market requirements.

In turn, in the works [34], [35] were included technical, functional, social and economic aspects in the assessment of buildings. Based on the assessment of the technical condition and conducting surveys among users, the author proposes in her works an algorithm for the preparation of revitalization programs for prefabricated housing complexes. The next study was presented in a dissertation by Robert Bucoń [36]. The author presents determining the value in use of a building by determining the value of four features (operational requirements): technical, energy, visual and functional. In his work, the author presented a decision model (and computer program) that is designed to support the decision-maker during the selection of activities and the scope of renovation of buildings.

In addition, there are many studies in the literature that present proposals for methods for assessing building structures in the aspect of sustainable development. The first of them, commonly used, are certification systems such as: LEED, BREEAM, DGNB, CASBEE, etc. Each of these methods is characterized by a holistic approach to the assessment of buildings both at the design stage and during their use. However, in most of them, the most attention is paid to one of the three main aspects of sustainable construction – the environmental aspect. On the other hand, there is a lack of methods for assessing buildings due to the social aspect of sustainable construction. This aspect is important especially for both residential and public buildings (e.g. office buildings), in which ensuring comfort and safety as well as other features important in the buildings operation phase and is of particular importance to its users.

Therefore, the authors using the original method of social assessment of residential buildings, developed by A. Radziejowska as part of the dissertation [6], in the article present the social assessment of buildings made in large – panel technology, massively built in the second half of the 20th century. They mostly meet the requirements of technical assessment and the results of the assessment in the social aspect may be the basis for increasing their value in use.

3. Research methodology

The problem undertaken for research results from the need to identify factors affecting the use of residential buildings, primarily from the point of view of residents. In addition, it is important to determine the social quality of existing buildings, which, to a large extent, are still objects made in large-panel technology. The determination of important features and their importance of comprehensively describing the social aspect in a comprehensive way was based on standards for sustainable construction, as well as extensive surveys among apartment users and experts in the field of construction.

The social aspect of a building is a measure of ensuring adequate comfort and quality of life for residents throughout the entire life cycle of the object. It consists of, among others: acoustic comfort, visual comfort, adequate microclimate in rooms, access to public goods, and adaptation possibilities. Elements affecting the functionality of the building have been described, among others in the [37] standard. The guidelines from the standard and the method developed by A. Radziejowska (2018) are a methodology that was used in the study and assessment of LPB in the social aspect. Its stages are as follows:

1. Defining the problem and determining the purpose of research: ***assessment of social performance of the building***
2. The development of the model, based on the analysis of the social condition of the building or part of it (selected residential premises) and the features of building components, using a system approach include the following stages:
   a. Defining the structure of the model
   b. Formulation of the initial set of criteria (ISC) and processing it into the final set of criteria (FSC) through: literature research, application of the ordering algorithm to reduce ISC, direct surveys among users, expert research, statistical analysis, reliability indicators of conducted tests.
   c. Development of a method for assessing the criteria taken into account in the constructed model (FSC), using techniques and tools such as: literature studies, direct surveys among users, questionnaire surveys among experts, interviews and expert consultations, fuzzy logic, statistical analysis.
   d. Determining the weight of criteria taken into account in the social assessment of the building through: direct surveys among users and experts, statistical analysis.

3. Carrying out building assessment using multi-criteria analysis and determining the social quality indicator through:
   - reference to the reference building,
   - selection of assessment aggregation method – application of corrected summation index,
   - calculating the social quality index using a computer application developed by the author.
4. Conducting calculations and analysis of results.

Surveys, according to a prepared questionnaire, were conducted in over 100 residential buildings. Expert interviews were also conducted to obtain partial assessments for all criteria taken into account in the research. The obtained results were compiled in the form of graphs, which allowed for a clear illustration of the results of the assessment of large-panel buildings, subjecting them to analysis, and then determining their social quality index.

4. Description of research and analysis of results

4.1. Characteristics of examined objects

The research was carried out in 2019 in 109 completed buildings in large-panel technology, which were created in 1958–1992 in Jedrzejow (Świętokrzyskie Voivodeship – Fig. *1*) and Cracow (Lesser Poland Voivodeship). In addition to conducting direct surveys among residents, thanks to the courtesy of the cooperative employees, it was also possible to reach the technical documentation of the examined facilities and consult the maintenance and operation policy with technical employees.

Based on the technical data of the buildings, it was established that the tested objects were made in different technologies, i.e.: OWT – 75, W- 70, W-70 MK, WK- 70, WUFT – 67, WUFT – 68, WUFT – 69, PGS Skawina, Żerań, Świętokrzyska, Kielecko- Szczecińska. Large variations can also be seen in the volume. The smallest buildings have approximately 3660 m3, and the largest has a volume of 106 477 m3. Similarly, blocks with the smallest volume, have 20 apartments, the largest (the longest residential block in Krakow) has 474 apartments (Fig. *2*). The number of residents was not possible to specify, because the number of people enrolled in the documents of a given housing association differs from reality, especially due to the numerous migrations and rental of housing. According to the data recorded in housing cooperatives, the number of inhabitants exceeds the standards set out in the Journal of Laws No. 75, 2002 concerning housing categories.

Fig. 1. Residential building (Kielce-Szczecin technology) Jędrzejów, st. B. Krzywoustego 8, 22.09.2019

Fig. 2. The longest residential building located in Cracow at the Kościuszko 6 estate, 22.09.2019

In the examined residential premises there was a kitchen, bathroom or bathroom with toilet and from one to three rooms. Some apartment owners have modernized the rooms on their initiative over the years. Most often, the number of rooms was increased by transforming the kitchen into a bedroom, while adapting part of the living room space to a kitchenette.

Studies and observations have shown that construction projects have been replicated within the given housing estates, which indicates their typing. In the examined districts there were downtown buildings, the buildings were well connected with other parts of the city.

4.2. Results and analysis

The completed evaluation form consisted of 55 closed questions in which the respondents assessed individual social features on a five-degree discrete scale (details can be found in the paper [6]). The research was conducted in March and April 2019 in 109 buildings in two cities: in Jędrzejów and Cracow [37].

The researched residential buildings were erected from 1958 to 1992, which covers practically the entire period of construction of housing estates in the technology of large slab. Most buildings were built in 1976 and 1980 (Fig. 3).

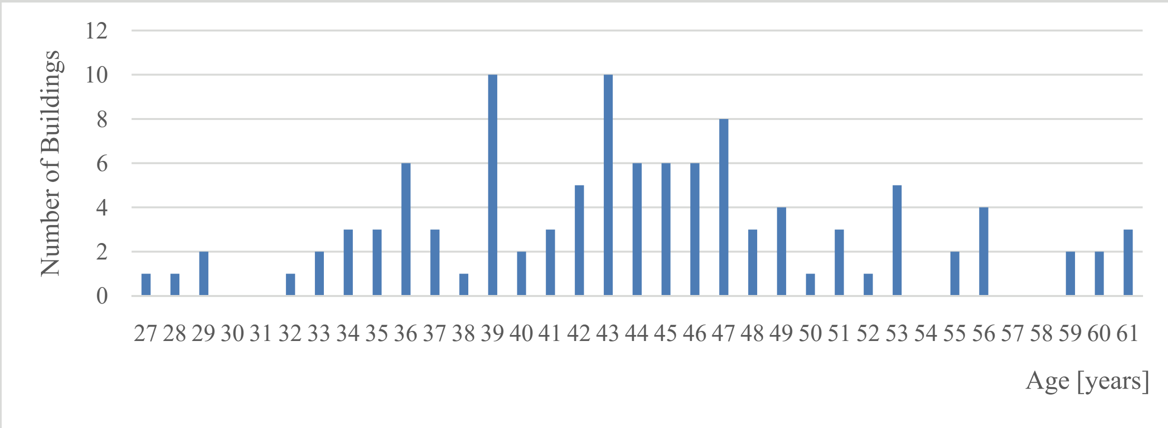


Fig. 3. Age of analyzed buildings

The application developed in the doctoral dissertation [6] allowed to collect data and present them in the form of spider web charts of both the general social assessment of buildings and individual categories, e.g. accessibility, adaptability, etc.

Using a unified discrete 5-point scale (analogous to hotel stars), the degree to which the building meets social properties called the social quality index was determined (δ [%]).During analyzing the examined features of buildings, it is assumed to be compared to a reference object, which reflects the currently fulfilled regulations (it is not an ideal building). Therefore, the reference building is treated as a hypothetical object designed in accordance with applicable standards and common practice and with the same technological, construction and functional parameters as the building being assessed [6].

The building is assessed in accordance with the guidelines contained in Table 1.

Table 1. Classification of a building / apartment according to the degree of fulfillment of social properties

Building rating (stars)	Degree of compliance with social performance $\delta = \frac{\Delta_{R+D}(t)}{O_R(t)} \cdot 100\%$
5	[1] $\Delta_{R+D}(t) < 0$
4	$0{,}0\% \leq \delta < 20\%$
3	$20\% \leq \delta < 40\%$
2	$40\% \leq \delta < 60\%$
1	$\delta \geq 60\%$

[1] is expressed by the formula $\Delta_{R+D}(t) = O_R(t) - O_D(t)$
where:
$O_R(t)$ – the social utility value of the reference building during t,
$O_D(t)$ – social value in use of the analyzed building during t,
Source: based on [6].

In addition to the rating according to the table, the application generates charts in the form of a spider's web illustrating the ratings of individual categories and subcategories against the background of the maximum and reference rating. An exemplary list of grades and a graph are presented in Fig. 4.

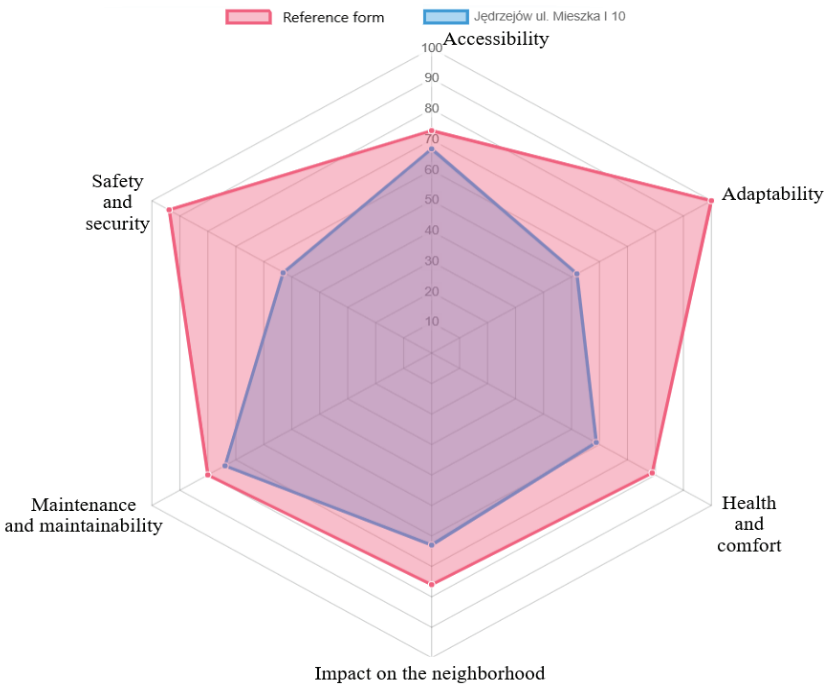


Fig. 4. Graph in the form of a spider's web of a building located at street Mieszka I 10 in Jędrzejów

By compiling detailed assessment results, it is possible to determine the weakest points of the examined object. Partial data on the object's compliance with social properties may help in the later planning of a rational renovation and modernization policy of the examined buildings.

The results collected in the application forms were analyzed. In the K_1 **Accessibility** category, most buildings obtained an average rating of 3,4 – 50 buildings. 44 buildings achieved a higher average than 3,4, and only 15 residential buildings received a lower than 3.4 (Fig. 5).

In category K_2 **Adaptability**, only two values of average building ratings were obtained: 2,7 and 3,4. These results depend on the height of the buildings, which is associated with the then regulations for the installation of elevators in buildings over 5 floors. 81 low buildings (5 floors and below) were tested – average 2,77 and 28 high buildings – average rating 3,4 (Fig. 6).

Ratings of individual buildings in the category K_3 **Health and comfort** oscillate within limits 2,9 – 3,1. Most residential reached a score of 3,1 – 57 buildings, the average of 3 was for 46, and only 6 residential buildings reached 2,9 (Fig. 7).

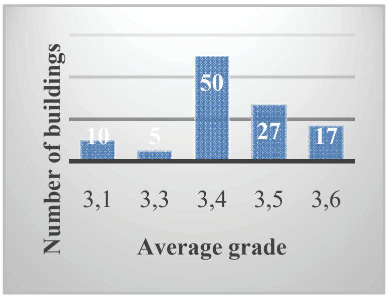


Fig. 5. Ratings obtained in the availability category

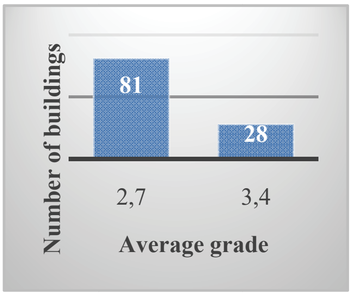


Fig. 6. Ratings obtained in the adaptability category

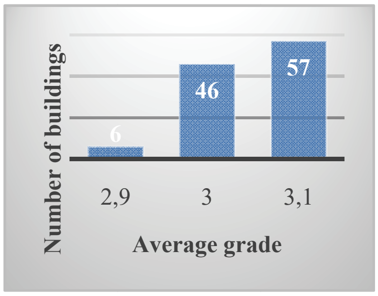


Fig. 7. Ratings obtained in the health and comfort category

In the case of category K_4 **Impact on the neighborhood**, the average rating of individual buildings is the same for all residential buildings. It amounts to 3,2.

The average rating of individual buildings in the K_5 **Maintenance and maintainability** category turned out to be the most diverse. The results are in the range 3,4 – 4,2. Most buildings (31) received a rating – 3,6. Slightly fewer buildings – 28 and 27 were rated 4,2 and 4 respectively (Fig. 8)

The results of building assessments in category K_6 **Safety and security** range 2,8 – 3,3. Most residential obtained value of 2.9, up to 51 buildings (Fig. 9).

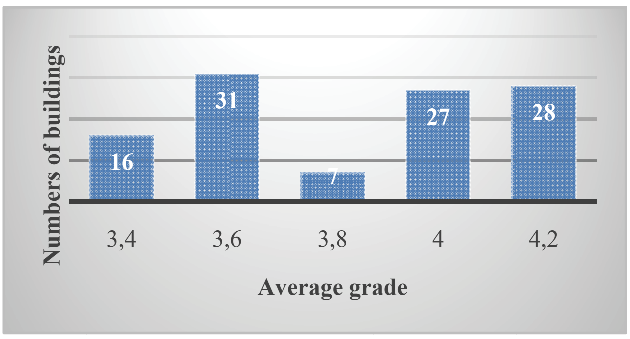


Fig. 8. Ratings obtained in the maintenance and maintainability category

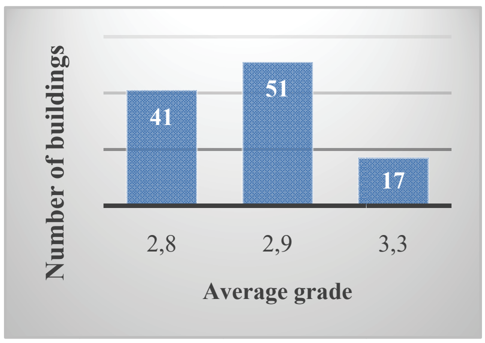


Fig. 9. Obtained ratings in the safety and security category

To sum up, the percentage values of the social quality index were obtained: 58% in 4 buildings, 60% in 27 buildings, 62% in 50 buildings, 64% in 4 buildings, 66% in 7 buildings and 68% in 17 residential buildings (Fig. 10).

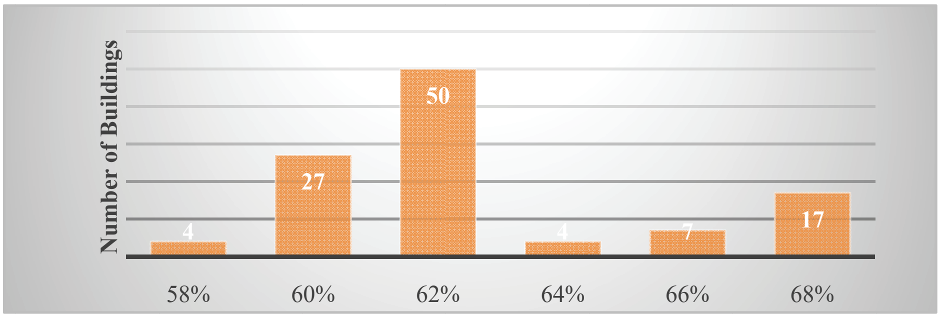


Fig. 10. Percentage values of the social quality index of all examined buildings

Due to the received quality indicators, it can be seen that most of the buildings finally obtained a grade 3 on a 5-point scale (an example of the result of the assessment of one of the buildings studied is shown in Figure 11).

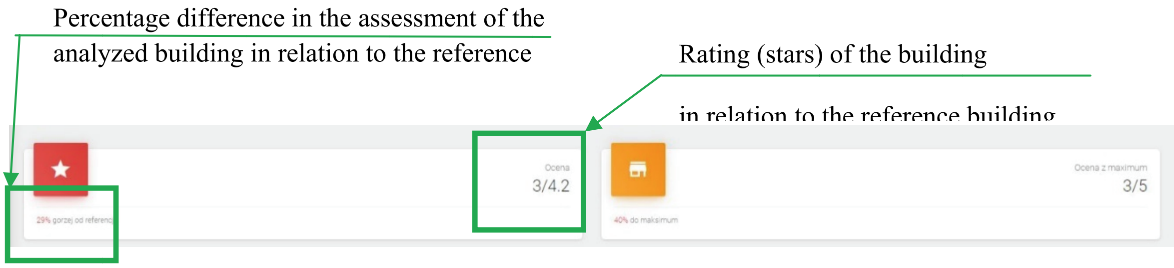


Fig. 11. The final assessment of the building in the form of hotel stars, which is located at st. Mieszka I 10 in Jędrzejów

In the general assessment, the lowest in the adaptability category, which may be due to the difficulty or inability to modify the room layout. Despite this, the overall rating of the buildings is quite good, especially thanks to the highly rated assets, which include categories availability and maintenance & maintainability.

5. Summary and conclusions

Large-panel construction is characterized by the so-called good localization. The housing estates are equipped with commercial and service outlets, basic medical care, as well as educational institutions, because the main goal in their implementation was to create independent units, for small towns. The green areas were also taken care of, and playgrounds and places for recreation and sporting activities were created.

In modern housing projects, parking spaces are often overlooked or very limited. This is related to the implementation of residential buildings in increasingly dense urban development. In the case of large-panel housing estates, the availability of a large number of parking spaces nearby is an extraordinary advantage.

Unfortunately, large-panel buildings, which is one of their biggest disadvantages, do not have too many adaptive values. There are no elevators in five-story buildings. This results in quite large restrictions, especially for people with disabilities. The building designs do not provide for the possibility of installing passenger lifts or even stair chairs. High buildings, although they are equipped with elevators, but their geometry does not meet current requirements. In large-panel buildings, there are often no escape routes, which means fire safety is not guaranteed. Unfortunately, due to the narrow staircases it is not possible to use emergency exits in them. It seems that the only reasonable solution would be to install external fire stairs.

Construction objects erected in the large slab technology are, however, structurally safe. Foundations, horizontal and vertical elements meet current requirements. These buildings are also resistant to wind or snow.

All examined buildings have been thermo modernized, which results in very good assessments regarding the risk of mold and fungus development. These buildings were also highly rated for their acoustic comfort. It is worth noting that each housing cooperative took care of enclosed space for waste storage. This not only helps to keep the housing estates clean, but also helps to protect the environment.

None of the residential buildings surveyed had spare equipment for heating and electricity production. Power generators not difficult to install would allow to improve the social rating of each building. Access road lighting is also an important issue in the assessment, therefore energy-saving LED lighting was installed in Jędrzejów.

In the conducted surveys, opinions among residents were rather unanimous. The main disadvantage of large panel systems was access restrictions for people with disabilities, the lack of lifts and difficulties in adapting the rooms. However, overall research shows that residents live very well in large panel housing estates, primarily due to the available infrastructure and green areas. The residents themselves do not pay attention to some issues – e.g. the type of access lighting.

To sum up, despite the many disadvantages that occur in residential buildings constructed in the technology of large slab, these buildings have obtained a satisfactory social rating and can certainly serve their residents well for many years.

References

[1] L. Runkiewicz, B. Szudrowicz, H. Prejzner, R. Geryło, J. Szulc and J. Sieczkowski, "Diagnostics and modernization of large-panel buildings". Vol. 1 and Part 2, *Przegląd budowlany,* 7–8, 9 2014.

[2] J. Sieczkowski and J. Szulc, "Three-layer walls in large-panel buildings," *Inżynier budownictwa,* 10 2019.

[3] M. Wójtowicz, "Possibility of failure of the outer walls of multi-panel buildings – a real problem or a media sensation," in *XXV Konferencja Naukowo-Techniczna „Awarie Budowlane"*, Szczecin-Międzyzdroje, 2011.

[4] M. Wójtowicz, "Durability of large-panel buildings in the light of research," in *XIII Konferencja naukowo-techniczna. Warsztat Pracy rzeczoznawcy budowlanego*, Cedzyna, 2014.

[5] J. Szulc, "General technical condition of large-panel buildings in the aspect of historical systemic irregularities," *IZOLACJE,* http://www.izolacje.com.pl/artykul/id2763,ogolny-stan-techniczny-budynkow-wielkoplytowych-w-aspekcie-historycznych-nieprawidlowosci-systemowych?p=4, 08.04.2019.

[6] A. Radziejowska, *A method of assessing the social performance of residential buildings in the aspect of sustainable construction,* Cracow, 2018.

[7] D. Walach, J. Sagan and M. Gicala, "Assessment of Material Solutions of Multi-level Garage Structure Within Integrated Life Cycle Design Process," *IOP Conference Series-Materials Science and Engineering. Volume: 245,* 2017.

[8] A. Ajdukiewicz, "Aspects of durability and impact on environment in design of concrete structures," *Przeglad budowlany,* pp. 20–29, 2 2011.

[9] A. Wodyński, Technical wear of buildings in mining areas, Kraków: Uczelniane Wydaw. Nauk.-Dydakt. AGH im. S. Staszica, 2007.

[10] J. Arendalski, Durability and reliability of residential buildings, Warszawa: Arkady, 1978.

[11] Knyziak, "A proposal for a new method for determining the technical wear of buildings," in *Problemy naukowo-badawcze budownictwa*, Białystok, 2008.

[12] W. Drozd, "Methods of evaluation of technical condition of buildings in the aspect of their practical use," *Przegląd budowlany,* pp. 43–47, 4 2017.

[13] E. Marcinkowska and P. Urbański, "Assessment of the technical degree of wear of residential buildings using artificial neural networks," *Ekologia w inżynierii procesów budowlanych. Konferencja naukowa, Lublin-Kazimierz Dolny,* pp. 319–325, 21–24 5 1998.

[14] L. Miks, M. Radim, V. Mencl and J. Kosulic, "Assessment of the technical condition of older urban buildings as a base for recontruction proposal," *Slovac Journal of Civil Engineering,* pp. 30–34, 2004.

[15] P. Knyziak, *Analysis of the technical condition of prefabricated residential buildings using artificial neural networks,* Warszawa, 2007.

[16] J. Rusek, *Modeling the degree of technical wear of buildings in mining areas using selected methods of artificial intelligence,* Kraków, 2010.

[17] P. E. O. PEO, "Structural Condition Assessments of Existing Buidlings and Designated Structures Guideline," 11 2016 . [Online]. Available: http://www.peo.on.ca/index.php/ci_id/31399/la_id/1.htm

[18] J. Jaskowska-Lemańska, D. Wałach and J. Sagan, "Technical condition assessment of historical buildings – flowchart development," *INFRASTRUCTURE AND ECOLOGY OF RURAL AREAS,* http://dx.doi.org/10.14597/infraeco.2016.4.4.132

[19] B. Nowogońska, "Method for predicting the technical condition of a residential building," *Materiały budowlane,* 8 2017. http://dx.doi.org/10.2478/ace-2019-0020

[20] P. Urbański, "Assessment of the degree of technical wear of a selected group of residential buildings using artificial neural networks," in *Zastosowania metod statystycznych w badaniach naukowych II*, Kraków, 2003.

[21] No. 305 UE, *Regulation No. 305/2011,* 2011.

[22] Dz. U. Nr 75, *Regulation of the Minister of Infrastructure on technical conditions to be met by buildings and their location,* 2002, p. 6.

[23] EN 15643-1, *Sustainability of buildings – Assessment of building sustainability – Part 1: General principles,* 2011.

[24] ISO 15392, *Sustainability in building construction — General principles,* 2008.
[25] J. Konior, *The impact of housing maintenance on the degree of wear of elements,* 1997.
[26] D. Caccavelli and G. H., "TOBUS – an European diagnosis and decision making tool for Office building upgrading Energy and Building," 2002. [Online]. https://doi.org/10.1016/S0378-7788(01)00100-1.
[27] B. Nowogońska, *Selected factors determining the programming of renovation activities of buildings made in traditional technology,* Zielonagóra, 2003.
[28] A. Kaklauskas, E. Zavadskas and S. Raslanas, "Mulivariant design and multiple criteria analysis of building refurbishemnt," *Energy and Buildings,* pp. 361–372, 2005. http://dx.doi.org/10.1016/j.enbuild.2004.07.005.
[29] T. Kasprowicz, "Identification analysis of the exploitation of building objects," in *Polish construction a year after joining the European Union. Selected technological and organizational problems*, Gdańsk, 2005.
[30] T. Truchanowicz, "The concept of methods for identifying the state of use of a building," *Prace Naukowe Instytutu Budownictwa Politechniki Wrocławskiej. Studia i Materiały Vol. 87, nr 18,* pp. 353–360, 2006.
[31] M. Starzec, "Programming the operation of residential buildings. Problems of preparation and implementation of construction investments," Puławy, 2008.
[32] M. Prystupa, "Hierarchy of legal and methodological conditions in the real estate valuation process," *Rzeczoznawca majątkowy,* pp. 8–12, marzec 2013.
[33] Z. Orłowski and A. Radziejowska, "Model for assessing the utility properties of a building," in *Conference: People, Buildings And Environment*, Kromeriz, 2014.
[34] A. Ostańska, "Revitalization programs of settlements with prefabricated buildings in Europe, a contribution to the development of Polish programs," *Przegląd budowlany,* 3 2010.
[35] A. Ostańska, „Social research as a contribution to improving the built environment," in *Badania Interdyscyplinarne w Architekturze 1", tom 1 „Problemy jakości środowiska w kontekście zrównoważonego rozwoju"*, Gliwice, Wydział Architektury Politechniki Śląskiej, 2015, pp. 227–237.
[36] R. Bucoń, Decision model for the selection of variants for renovation or reconstruction of residential buildings, Lublin, 2017.
[37] E. Bolewińska, *Engineering thesis: Social assessment of buildings from a large slab,* 2019.
[38] K. Firek and J. Dębowski, "Influence of the mining effects on the technical state of the panel housing," *Czasopismo Techniczne. Architektura,* pp. 275–280, 2007.

Ocena budynków z wielkiej płyty w aspekcie socjalnym zrównoważonego budownictwa

Słowa kluczowe: zrównoważone budownictwo, ocena socjalna , budynki z wielkiej płyty, użytkowanie

Streszczenie:

Szacuje się, że w zasobach mieszkaniowych Polski około 50% budynków wykonanych jest w technologii tzw. *wielkiej płyty* (WP), masowo budowanych w drugiej połowie XX wieku. Badania wykazały, że w większości spełniają one wymagania przydatności do użytkowania ze względów technicznych, natomiast nie spełniają one innych wymagań np. dotyczących budownictwa zrównoważonego (ZB). Obecne podejście do projektowania obiektów budowlanych, jak też konsekwentnie do ich oceny, w szczególności przez wiele lat eksploatowanych, uwzględnia trzy grupy wymagań i kryteriów oceny – środowiskowych, ekonomicznych i socjalnych oraz wszystkie fazy cyklu życia obiektu budowlanego. Należy podkreślić, że rozwijane są metody projektowania zintegrowanego na użytkowanie, oceny budynków w zakresie wymagań środowiskowych, są odpowiednie normy, natomiast brak ich jest dla aspektu socjalnego. W związku z tym autorki, wykorzystując oryginalną metodę oceny socjalnej budynków mieszkalnych opracowaną przez A. Radziejowską w ramach rozprawy doktorskiej [6] przedstawiają ocenę socjalną budynków wykonanych w technologii WP, a wyniki tej oceny stanowić mogą podstawę do podniesienia ich wartości użytkowej.

Zastosowana metoda badań szczegółowo opisana ww. doktoracie, opiera się na ocenie budynku poprzez porównanie go z budynkiem wzorcowym (referencyjnym). Ocena następuje przez obliczenie ocen cząstkowych, a następnie oceny agregacyjnej dla obu obiektów: badanego i referencyjnego. Porównanie otrzymanych wyników następuje poprze obliczenie ilorazu różnicy (wzór (1)) i nazywane jest **wskaźnikiem jakości socjalnej**.

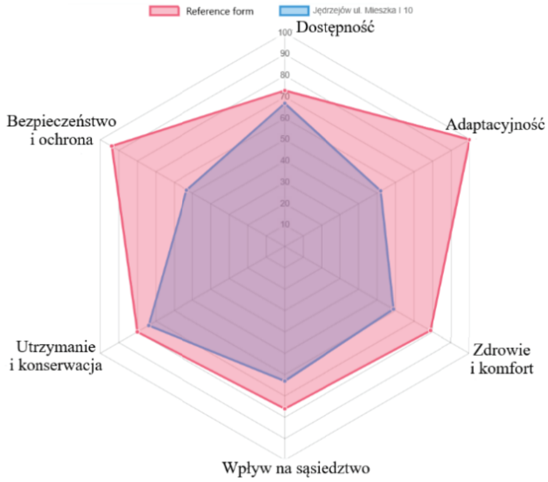
$$\delta = \frac{O_R(t) - O_D(t)}{O_R(t)} \cdot 100\% \qquad (1)$$

gdzie:
$O_R(t)$ – socjalna wartość użytkowa budynku referencyjnego w czasie t,
$O_D(t)$ – socjalna wartość użytkowa analizowanego budynku w czasie t.

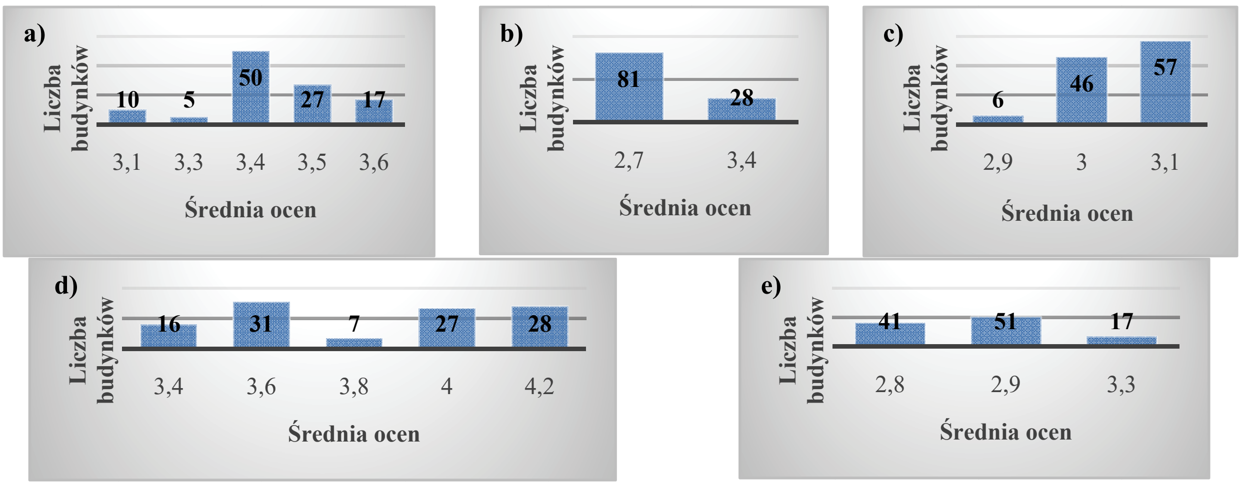
Rozbieżność δ przedstawiona wzorem (1) świadczy o stopniu socjalnej przystosowalności analizowanego obiektu. W pracy doktorskiej zaproponowano graniczne stopnie spełnienia interpretowane w formie gwiazdek hotelowych (świadczących o standardzie i udogodnieniach). Dla wygody przeprowadzania oceny socjalnej opracowano również aplikację komputerową.

Na potrzeby niniejszego artykułu, w oparciu o powyższą metodę zbadano 109 budynków mieszkalnych w wieku od 27 do 61 lat (pytania ankietowe, dokumentację techniczną, wywiady, oceny eksperckie).

Na rys.1 przedstawiono wyniki podstawowych kategorii oceny socjalnej przykładowego badanego budynku, na tle oceny budynku wzorcowego/referencyjnego, a na rys. 2 średnią ocen poszczególnych kategorii dla wszystkich badanych budynków.



Rys. 1. Wyniki oceny socjalnej budynku z WP (Jędrzejów, ul. Mieszka I/10)



Rys. 2. Uzyskane oceny w kategorii: dostępność (a), adaptacyjność (b), zdrowie i komfort (c), utrzymanie i konserwacja (d), ochrona i bezpieczeństwo (e)

Badania wykazały, że większość budynków z WP uzyskała oceny poszczególnych kategorii socjalnych średnio ~ 3 w 5-stopniowej skali. Mimo wielu trudności w likwidacji występujących niedogodności podczas ich użytkowaniu (np. w wyposażeniu w windy, w adaptacji pomieszczeń), dobra lokalizacja osiedli z WP, ich wyposażenie w infrastrukturę społeczną (szkoły, przedszkola, przychodnie, lokale handlowe i usługowe) i rekreacyjną (domy kultury, place zabaw, zieleń) dają zadowalającą łączną ocenę socjalną i przekonanie, że jeszcze przez wiele lat mogą dobrze służyć ich mieszkańcom. Jakkolwiek należy mieć świadomość kosztów, jakie niosą wszelkie zmiany w eksploatowanym już obiekcie. Na podstawie tych badań możliwe jest ustalenie najsłabszych punktów badanego obiektu. Cząstkowe dane dotyczące spełnienia przez obiekt właściwości socjalnych mogą pomóc w planowaniu racjonalnej polityki modernizacyjnej badanych budynków.

Recievied: 2020-11-09, Revised: 2020-12-17