Revitalization of Twentieth-Century Prefabricated Housing Estates as Interdisciplinary Issue

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Abstract. The prefabricated construction of housing estates in Poland was very common in times of centrally planned investments. It is estimated that 60% of housing developments created in Polish cities between 1966 and 95 are large-panel buildings. Currently, about 10 million Poles live in these types of blocks (over ¼ of the country’s population). Hence, large-panel housing estates are an important part of Polish housing resources, and the problems associated with them affect the everyday life of a large part of society. The number of problems is significant and diverse, it’s related to many areas - including urban planning, architecture, social and technical issues. This paper attempts to describe those multi-dimensional issues, indicate the directions of changes and evaluate the revitalization potential of prefabricated housing estates. The article concentrates on interdisciplinary and comprehensive nature of the revitalization that can improve the quality of the residents’ life. Authors attempt to enter the issue of large-scale housing estates into the functioning and possibilities offered by the new revitalization act (2015). The article based on research and analyzes of over 18 housing estates. 110 buildings have been analyzed in terms of technical condition, construction, and internal installations. Inspections of buildings were carried out in 2005-06 and 2016-17 with employees of the cooperative, and residents (interviews). Documentation of buildings was found and analyzed.

1. „Large-plate“ – introduction

Walter Gropius in his essay (collection from 1943-55) so anticipated the principles of prefabrication in housing: „Reduction of cost of dwelling construction is of decisive importance for the national budget. Attempts to reduce the cost of conventional handicraft methods of construction by introducing more rigorous organizational techniques have brought only slight progress. The problem was not attacked at its root. The new aim, on the other hand, would be the manufacture by mass production methods of stock dwellings which are no longer constructed at the site but are produced in special factories in the form of component parts or units suitable for assembly. The advantages of this method of production would be increasingly greater in the extent to which it becomes possible to assemble such prefabricated component parts of houses at the building site just like machines. This dry assembly method, to be discussed in detail below, would eliminate not only the troublesome twisting and warping of building parts due to moisture but also the loss of time required for the drying out of houses built by conventional construction methods of masonry, mortar and plaster. This would at once ensure independence of weather and season.” [1]

In these few sentences, the leading creator of Bauhaus described the main reasons for the development and implementation of „large-size prefabricated systems“ (large-panel/large-plate buildings) for residential construction. From the mid-1950s until the end of the 1980s, they were the...
basic ways of solving the problem of post-war housing hunger in many European countries, including Poland. According to the noble assumptions, they were to be relatively economical, quick to erect, and their construction could take place in variable weather conditions. At the beginning, they seemed progressive and modern, in accordance with the idea of modernism.

Unfortunately, a number of issues related to the design, construction and aging of these settlements have contributed to the cessation of their construction and to the critical assessment currently expressed by the residents themselves and by specialists in various fields. Both the scientific authorities and the measures implemented to improve the quality of life of the inhabitants indicate the need for comprehensive revitalization of areas of large-plate housing estates.

In the times of centrally planned investments, the use of prefabricated solutions became common - it is estimated that 60% of housing developments built in Polish cities in 1966-95 were large-panel buildings. [2]. Currently, in this type of blocks live around 10 million Poles (i.e. over ¼ of the country's population) [3]. Therefore, large-plate housing estates are an important part of Poland's housing stock and the problems associated with them affect the daily life of a large part of society.

The number of these problems is large and diverse and covers a wide range of areas, including urban planning, architecture, related social issues and technical issues. This article attempts to characterize these multifaceted problems, to indicate the directions of changes and to evaluate the revitalization potential of large-plate housing estates. The article indicates a wide and interdisciplinary character of the desirable revitalization activities, which may improve the quality of inhabitants’ life. At the same time, the authors attempt to examine the issue of large-plate housing estates in the light of possibilities offered by the new Revitalization Act in force since 2015.

The basis for the formulated problems and directions of large-plate housing estates revitalization were studies and analyses of over 18 housing estates carried out in 2005-06 and 2016-17. A detailed analysis of the technical condition of the structures and internal installations were carried out in 110 buildings. The buildings were inspected with the participation of the building cooperative's employees. Employees and residents were interviewed, information on inspections and renovations was found in the building documentation.

Figure 1. Ubiquitous large-panel housing estates in Polish cities (fot. P. Knyziak, A. Tofiluk)

2. Revitalization – an interdisciplinary process

According to the new Act, revitalization is a process of "taking degraded areas out of the crisis, carried out in a comprehensive manner, through integrated actions for the benefit of the local community, space and economy, territorially concentrated, carried out by revitalization stakeholders on the basis of a communal revitalization programme". The stakeholders mentioned in the Act are primarily residents of the revitalization area and owners, users and managers of properties located within the area, including housing associations, building cooperatives and social housing communities.

The revitalization process is the municipality's own task, which determines the degraded territory and the revitalization areas, develops and accepts the revitalization programme and implements the revitalization projects. The Act focuses primarily on the social aspects of revitalization and improving the quality of inhabitants’ life. Public participation is an important component of the whole revitalization process.
A degraded zone is an area in crisis because of the concentration of negative social phenomena (unemployment, poverty, crime, low levels of education or social capital, as well as insufficient participation in public and cultural life). It can be determined in case of occurrence of at least one of the negative economic, environmental, spatial-functional and technical phenomena. The revitalization area includes all or part of the degraded area characterized by a particular concentration of negative phenomena. Therefore, the act may be a tool for revitalizing also the areas of prefabricated housing development. These negative phenomena (which are the prerequisites for the designation of revitalization areas), in particular environmental, spatial, functional and technical ones, are present in many of these settlements. The Act defines them as, inter alia:

- insufficient equipment in technical and social infrastructure, its poor technical condition;
- lack of access to basic services or their poor quality;
- inadequacy of urban solutions to the changing functions of the area;
- low level of communication support;
- shortage or poor quality of public land;
- degradation of the technical condition of buildings, including those used for residential purposes;
- the technical solutions enabling the efficient use of construction works, especially in terms of energy efficiency and environmental protection, are not working.

Processes and phenomena listed above are often caused by various types of negligence, the nature of which is multi-faceted. As a result, corrective actions need to have a wide range of activities and be interdisciplinary.

When designing and implementing revitalization projects in the discussed housing estates, it is worth taking advantage of European experience [Table 1], bearing in mind that domestic problems have their specific character resulting mainly from the ownership right to housing. In Western European countries (mainly France and Germany), where the revitalization of large-plate housing estates has been a success, most of the establishments are social and therefore have the same owner who, if he has the appropriate resources, can decide to revitalize them or make minor improvements. Poland is dominated by a fragmented housing ownership system, which makes it difficult both to define the most important revitalization needs and to finance them.

3. Large-plate estates and urban, social and architectural aspects of their revitalization.

Analyzing the condition of large-plate housing estates, it should be stated that the relations between social, urban and architectural issues are inseparable. The life quality of the inhabitants, including the comfort of living and the creation of neighborhood relations, depend on urban and architectural solutions, therefore they will be discussed together.

The most visible and common problems of large housing estates related to their urban planning and architecture, which have an impact on social relations, are as follows:

- A large range of assumptions - from a few to even several dozen buildings, often high (buildings erected in the "big slab" technology usually had a standard number of storeys - 5 or 11, in some systems also 13 and 16) "scattered" among better or worse maintained greenery, which do not define urban interiors or these interiors are extensive and not sufficiently private. Thus, the social and public spaces are not defined.
- Large-panel buildings often have many storeys and a large number of apartments this results in a sense of anonymity, lack of social control, as a result, a reduces sense of safety.
- Low level of identification of residents with their place of residence - large-panel housing estates are often settlements, "(...) in which a huge scale of blocks and empty, ownerless spaces creates neither opportunities for contacts nor the possibility of diversified use. The area of the estate is only a transition from the means of transport to the apartment and is overcome quickly without stopping. The huge housing complex, therefore, for its inhabitants, is a space that is foreign and poorly assimilated"[6].
• Lack of "human scale" in the inter-block areas - high buildings, extensive spaces, insufficiently "furnished" in objects of small architecture and other elements of open communal areas.
• Architecture of buildings - many large-panel buildings are tall, overwhelming, with a repetitive, monotonous form, without individual features, without details.
• Failure to fully implement the planned service and cultural program during the construction of housing estates, what later resulted in the accidental location of commercial pavilions with low architectural value.
• Intense colours of thermal insulation influencing negative impact on the aesthetics of housing estates.
• Inadequate buildings to the needs of people with disabilities.
• Lack of complexity in modernization activities – e.g. insulation of buildings one by one, which brings with it incoherent colours of neighbouring buildings. Also, individual blocks are superstructured or expanded without care for the overall image of the estate, the superstructures themselves are also unmatched to the character of the large panel object.
• Unergonomically designed flats - inflexible arrangement of small apartments (very limited reconstruction possibilities).
• Peripheral location of many large-panel housing estates in relation to city centres.

Table 1. Summary of trends of revitalization in European countries [5]

| Directions of revitalization programs | Country |
|--------------------------------------|---------|
| Revitalization                        |         |
| ● without taking into account the social factor | England | France | Netherlands | Germany | Czech Republic | Denmark | Sweden | Norway | Finland |
| ○ including the social factor, especially after 1980 | ● ● ○ ○ ○ ○ ○ ○ |
| Demolition                           | ○ ● ○ |
| Partial demolition                   | ● ● ○ ○ |
| Repairs - these are actions preventing the technical deterioration of the building | ○ ● ○ |
| Modernization - mainly: the standard of equipment, residential functions and the building's body, i.e. actions preventing the moral obsolescence of the building | ○ ○ ○ ○ ○ ○ ○ ○ |
| Technical improvement of buildings   | ● ● ○ ○ ○ ○ ○ ○ |
| Rehabilitation - this is a modernization taking into account the improvement of the building's environment | ○ ○ ○ ○ ○ ○ ○ ○ |
| Protection of the housing estate structure including cultural activities | ○ ○ ○ ○ ○ ○ ○ ○ |
| Restoration of area of the housing estate | ○ ○ ○ ○ ○ ○ ○ ○ |
| Extending the range of services on the estate | ● ○ |||
The superstructure of the building in Warsaw clearly separates from the older tissue and the rest of the buildings on the estate (fot. P. Knyziak) [9, 10].

The above problems should be solved comprehensively, in relation to the whole housing estate, not individual buildings. Possible revitalization activities are:

- Introduction the "human scale" to the housing estate space through the new arranging of common areas, furnishing with small architecture, greenery supplementation. These activities should result in a better use of open areas by residents, and thus have a positive impact on the creation of neighbourhood bonds and the comfort of life.
- Densification of existing buildings (if there is a reserve of land), the development of which is raised, not lowered standard of living in the housing estate. Thanks to the new buildings, it is possible to change the proportions of open spaces, spatial definition of social and public areas, and the closure of urban interiors. New buildings with a commercial and cultural function supplement the existing offer, residential buildings generate profit for the estate, thanks to which new investments or modernizations are possible.
- Thermal insulation of buildings, which, beside the energy-saving function, also play an aesthetic role, if they are carefully designed and planned for the whole housing estate (a coherent graphic form and colours of facades).
- Superstructures and rebuilding’s that increase the standard of housing and generate profits (new residential or service areas) carried out with a view to the urban composition and the architectural expression of the whole housing estate.
- The addition of balconies, creating front gardens for flats on the ground floors of buildings - raising the standard of flats.
- Modernization changes in the area of the building entrance areas, such as extension (vestibule function), roofing - raising the aesthetics and standard of use, giving individual features.
- Construction of infrastructure facilitating the mobility of disabled people - lifts in buildings up to 4 floors, driveways to staircases, removal of thresholds.
- Planning of new parking places in the estate without loss for public and neighbourhood area, possible construction of multi-storey car parks.
- New communication solutions - good service of the estate through the public transport network, which will help reduce the inconvenience resulting from the location away from the centre and balance parking spaces in the housing estate.

4. Technical aspects of revitalization of prefabricated housing estates

Correlated, extensive work must be carried out to allow safe use for a long time of the buildings made in the large-panel technologies. This is the only solution if we want these buildings to be sufficient for the changed and constantly changing social demand. For residents and owners of apartments, the revitalization in the context of technical aspects means in practice significant reductions in energy consumption both for heating flats and hot tap water, and thus lowering energy bills. In addition,
comprehensive works should eliminate the risk of unpredictable, expensive failures, and reducing current charges for the repair fund. As a result, the service life of the building should be extended by at least 50 years, and upgrading the building's standard should not only improve the resident’s life quality, but also increase the real value of housing.

Analysing the technical deterioration of buildings, it is possible to indicate factors that affecting gradually (the passage of time affects the value), sudden (e.g. failures), important, insignificant, irrelevant. The technical deterioration affects the value in use of the building (PN-ISO 15686-1) [7]. Factors leading to the degradation of the building affect individual elements differently. In a building that has not been renovated in a relatively short time, the users' or building's structure may be in danger.

On the technical deterioration of buildings various factors have influence:
- natural environment - corrosion and erosion of materials, moisture, freezing, leaching, soil settlement, vibrations, shocks, chemical and biological pollution,
- defective workmanship - exceeding the limit deviations assembly, the use of inappropriate materials, careless execution of detail solutions,
- improper operation - lack of current maintenance, devastation,
- other - this group includes mainly random accidents (fires, floods, explosions).

Technical deterioration [8] of large-panel buildings also causes:
- initial state of the object elements (e.g. the quality of materials, design defects, defective workmanship, etc.), durability of elements,
- the length of use, natural deterioration,
- environmental conditions of exploitation, biological factors (fungi, molds, worms),
- policy of operation of the building, improvement of use values through repairs and maintenance.

A residential building is used for a limited period of time, which is defined as the total service life of the building. This is the period of time from the day of construction to the day of demolition. Demolition does not have to be a result of achieve the emergency condition, many buildings achieve the end of use due to other criteria. The length of the service life depends on the rate of technical deterioration of the building and moral obsolescence.

Technical wear can be prevented or even reversed by repairing or replacing damaged structural, equipment or finishing elements. One of the factors determining the technical usefulness of a building for major overhaul and modernization is the deterioration degree of foundations and load-bearing walls.

The same objects may have different durability, because it depends on many factors:
- the type of materials from which they were made,
- quality of elements, assembly, durability of joints and nodes,
- type of construction solutions,
- the impact of environmental conditions,
- the manner and conditions of use of the facilities,
- frequency and quality of maintenance and repair work.

The environmental and operational conditions play a very important role. As part of a proper repair policy, it should be carried out:
- repairs in the field of warranty or guarantee,
- continuous maintenance,
- planned and preventive repairs,
- emergency repairs,
- major repairs with possible modernization.
It is usually assumed that the greatest danger to the safety of the structure will be the technical deterioration of the main load-bearing elements, and the estimation of their load capacity is treated as a priority issue in determining the degree of deterioration of the whole building.

Based on our own research and the experience of other researchers, we have created an author's list of typical necessary works to perform in all (and at least in most) large-panel buildings (previously not upgraded or modernized incompletely), which includes:

- Strengthening of hangers fixing façade panels (in a large number of buildings, reinforcements were not made despite the installation thermal insulation, so far there are no failures).
- Improvement of inefficient ventilation.
- Thermal insulation in order to save energy for heating and adaptation to the existing requirements of thermal insulation.
- Improvement of acoustic insulation by reducing communication noise (planting high greenery), noise reduction from the installation (acoustic insulation in combination with thermal insulation), reduction of living noise (setting hours to carry out loud works, renovations), establishing the time of night silence.
- Comprehensive work to obtain a sufficiently low level of demand for non-renewable primary energy for heating, ventilation, cooling, lighting, and accordingly low unit heat demand for heating hot water. It is necessary to apply or replace insulation of cable ducts along the entire length (including passages through partitions) and to insulate the accessories of the ducts.
- Replacement or upgrading old ironwork of balconies, handrails originally made of at a height of 90 cm. In some buildings after renovation and insulation, the correct height has been reduced and requires adjustment to the level of 110 cm (required by the technical standard).
- Replacement of dry risers, after years of stealing and devastation, on irrigated risers. It is a relatively expensive modernization, it also requires performing inspections and testing the efficiency of the installation twice a year.
- Replacement of the electrical installation together with appropriate electrical protection accessories in electrical risers, regular checks on the security performance.
- Polymerisation of the gas installation or replacement of the installation with a new one.
- Remounting of the main gas valve outside the building.
- Installation of the main fire protection switch at the entrance to the building.
- Disassembly of old non thermo-weldable roofing paper and laying of new thermo-weldable roofing membranes or continuous coating (it was made in practically all buildings, in some buildings new layers were laid on old ones),
- Revitalization of the gable walls consisting in the replacement of insulation made with the dry method on ETICS insulation.

Repairs are the first, basic way to improve the technical condition of buildings, but they can be the right way, mainly where no newer material and technical solutions have been created. The second method of improving the technical condition, modernizations, may use the latest technical achievements, including much more durable and economical solutions. Only the modernizations allow to increase the value in use of the building above the level of the original building, they allow to advance the value in use to the requirements of the currently projected objects (figure 3). This is particularly important for the impact of the work performed on the satisfaction and acceptance of residents, whose requirements are increasing. In the case of modernization, they see that buildings at least to some extent achieve a technical level such as in new buildings.
Figure 3. Value in use of the building including modernization (own study)

Each building can be operated to a certain extent between an exceptionally good technical condition and a very poor technical condition, on the border of a failure (figure 4). Considering this range in technical terms, values close to the lower limit, i.e. low level of deterioration, mean a good way of operation characterized by low costs of repairs carried out without delay and part of the work carried out in the form of modernization. Values close to the upper limit mean that almost no current repairs carried out, damages are repaired with a long delay. This method of exploitation leads to higher repair costs, because the range of damage not repaired regularly often increases significantly (e.g. local dampness of the roof of the attic is the beginning of leakage, which can lead to intense moisture of the structure, freezing, destruction paint and plaster on a large surface, destruction of roof and walls materials). Postponed renovations delay the necessary expenses only for some time, but their size increases over time. In the opinion of the residents, a good technical condition of the building is usually associated with the satisfaction of living in such a building, a better inter-neighbourhood atmosphere. It is also important that the value of the building and flats is significantly higher, in the case of a sale it is much easier to find a buyer. The maintained building in poor technical condition does not mean low costs, because the poor technical condition of the construction elements and installations leads to unexpected, often expensive failures. Poor technical condition also means higher operating costs, including both winter heating (freezing, leaks) and energy for hot water (old uneconomical devices). In such buildings, devastation is also a common problem.
Figure 4. The impact of policy of operation of the building on the technical condition of the building

5. Conclusions - evaluation of the revitalization potential of prefabricated housing estates

Despite many of their disadvantages, large-plate estates have at the same time a huge revitalisation potential. It should be remembered that many of them have relatively large open areas (in comparison with the housing estates designed and built today), are equipped with basic services (shops, schools, kindergartens, health centres and others), and after years of operation they are usually well connected with the rest of the city.

Small and impossible to rearrange apartments, on the one hand, may not be very attractive, but their standard is similar to modern ones, and their prices are competitive. Polish housing estates do not face such problems as those in France or Germany, which are either depopulated or incubate in many pathologies. This is mainly due to the fact that unlike foreign settlements, the Polish "big plate" is largely a cooperative and proprietary flat, not a social one.

As the article has shown, there are a number of possible changes in the structure of the housing estate and buildings which should be carried out comprehensively, preferably as part of a carefully planned revitalisation. The new law can be an effective tool for multi-faceted revitalization activities in the fields of architecture, urban planning and the technical condition of housing estates, if they are located in the areas of revitalization and are covered by long-term revitalisation plans.

In the era of urban sprawl, revitalisation activities in the already existing urban areas are part of the idea of a sustainable city. A sustainable city is, among other things, a city where modernization of existing buildings, density and use of areas already invested are preferred to construction of new facilities on previously undeveloped areas.

Finally, it is worth noting that although a number of unfavourable opinions adhered to the large-plate housing estates, it is not the technology of erection that owes them but the design assumptions related to the urban planning and architecture of the housing estates, as well as the lack of renovations or their
complexity. Similar - in terms of the scale of assumptions, size of buildings or flats - housing estates, although built in other technologies, face similar problems [11]. At the same time, the technology itself, although improved, is now widely used in many European countries. [12]

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