

Renovation and modernization issues of residential development in Kazakhstan

Abstract. Mass urban development in Kazakhstan has been the subject of discussions and scientific research for many years. Unsatisfactory housing conditions, unhealthy urban environment require specific proposals for housing renovation. This study reveals the specifics of mass housing in Kazakhstan and determines the feasibility of residential buildings' renovation. Despite the fact that specialists from the economic, social and architectural fields of sciences have studied the topic, there is still ambiguity in solving the following issues: renovation strategy in the country; the possibility of residential buildings' renovation; types of residential buildings to be renovated. As a result of a comparative analysis of design materials, literary sources and statistical data, the authors determined the classification of multi-apartment residential buildings of mass series in the Republic of Kazakhstan. This classification combines the chronological order of construction, the type of structural scheme of buildings and the name of the series of residential buildings. The systematization of statistical data of the housing stock by various parameters made it possible to identify, with a small error, the proportion of multi-apartment housing subject to renovation. In addition, this work generally reveals the problem of renovation in the country related to the structure of the housing stock, the peculiarity of housing and communal services and the process of architectural and urban planning design.

Keywords: renovation, mass housing, residential development, architecture of housing, urban renewal

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1. Introduction

The city as a complex multi-component organism includes many subsystems and structures. Degradation of one of the elements is accompanied by a general regression of the urban environment. One of the main components of the city affecting its appearance, integrity and sustainability is residential development. Considering housing as a structural element of the city, it is possible to distinguish its inherent parameters: the type of houses, the age of buildings, the connection with the urban environment, physical and moral deterioration of buildings. Each of the parameters is an indicator of the object condition and the discrepancy of one of them with the modern requirements of physical and psychological comfort affects the entire housing as a whole. When identifying negative characteristics in a dwelling, the question arises about the reconstruction and modernization of the building, which is a natural process associated with the life cycle of buildings [1].

The development and formation of cities in the Republic of Kazakhstan began mainly in the second half of the XIX century and is associated with the entry into the Russian Empire. The absence of preserved older urban structures is due to the nomadic culture of the local population and prolonged wars in Central Asia. Thus, ancient cities on the territory of Kazakhstan are represented either by ruins (Otyrar, Sauran, Sygnak), or have been preserved in fragments (Turkestan, Taraz) [2, 3]. The evolution of residential development in modern cities of the republic can be divided into three stages: the pre-revolutionary-tsarist period; the Soviet period; the period of independence. For the first time, the issues of housing modernization in the country were taken up in the 80s of the XX century, as evidenced by the

appearance of a block-complete construction method [4]. For the most popular five-storey series of standard projects built in the USSR, in 1986 the CRIED of Housing (Central Research Institute of Experimental Design) developed recommendations for modernization, where solutions are considered both for individual buildings and for development as a whole [5].

The economic feasibility of renovation of the housing stock in the country was studied in the work of A.A. Turlybaev [6], with the proposal of a model for evaluating the effectiveness of modernization of specific residential buildings. Separately, it is worth noting the result of the renovation of housing for the population, identified by the author in the study: the result of improving the quality of housing as economic well-being is a social result; the result of increasing the cost of housing as a commodity; the result of increasing the profitability of housing in the case of rent; the result of reducing current housing maintenance costs; the result of a reduction in one-time costs for capital repairs of housing.

Currently, Kazakhstan has different programs for the development of the housing sector [7, 8]. Existing programs highlight the key problems of the country's housing stock and ways to solve them, however, renovation tasks are not included in the list of necessary tasks [9]. It should be noted that there is no developed renovation strategy in the country that combines economic, architectural, urban planning, social and legal aspects [10]. Studies on the typology of housing in Kazakhstan, the transformation of housing and communal services (housing and communal services) and the use of BIM technologies in the process of housing reconstruction demonstrate the interest of the scientific community in this issue [11, 12, 13]. To develop a competent renovation strategy and its implementation, the housing and communal services of the country and the features of the housing stock should be considered separately.

2. Materials and methods

This study is aimed at identifying the features of the housing stock of Kazakhstan, namely the specifics of mass housing in the country. To collect primary data, an analysis of statistical collections on housing and its further systematization was carried out. On the basis of the studied literature sources, a correlation was made between statistical data and information about the typical series of multi-apartment residential buildings built on the territory of Kazakhstan. For the reliability of the data obtained, the authors systematized multi-apartment housing by the year of construction of houses and by the number of rooms in apartments. The resulting classifications of mass housing in Kazakhstan were determined using the method of synthesis and interpretation of data.

2.1 Housing and communal services in Kazakhstan

Housing and communal services in Kazakhstan consists of the communal sector (water, heat, gas, electricity) and the housing sector (apartment buildings and individual housing) [14]. Analysis of the existing housing and communal services system in the country revealed a number of problems affecting its effective functioning [15, 9]. First of all, it is worth noting the imperfection of legislation in the field of housing management and maintenance. The legal documents and programs being developed should be focused on increasing the responsibility of apartment owners and management bodies of condominium facilities in the proper maintenance and operation of apartment buildings. Over the past ten years, steps have been taken in the country to develop the legislative framework, as evidenced by the adoption of the Law "On Energy Conservation and Energy Efficiency", the introduction of the programs "Modernization of Housing and communal services" and "Development of regions until 2020".

Despite the introduction of housing and communal services modernization programs, the situation regarding apartment owners and their participation in housing maintenance remains the same. Homeowners do not seek to create homeowners' associations in their homes that could improve the condition of housing through their influence [7]. The active participation of residents in the

modernization process is the most important condition for its implementation. A good example is the large-scale rehabilitation of panel residential buildings in Germany, implemented due to the following factors: legislative and legal conditions allowing the joint work of homeowners, tenants, architects and the state; the participation of residents in the process of renovation of residential buildings; developed programs for regeneration and modernization of buildings [16].

2.2 Housing stock in Kazakhstan

As it was noted earlier, the formation of the housing stock in Kazakhstan can be divided into three main stages related to the development of the country's territory and the formation of cities. Each historical stage is characterized by the use of specific types of housing, building materials and technologies, as well as the volume of construction. By 2020, the country's housing stock totaled 364.3 million sq.m, of which 231.4 million sq.m. in urban settlements and 132.8 million sq.m. in rural areas (Figure 1) [17]. The provision of housing per inhabitant is 22.2 sq.m., which is significantly lower than similar indicators in the USA and the UK [18].

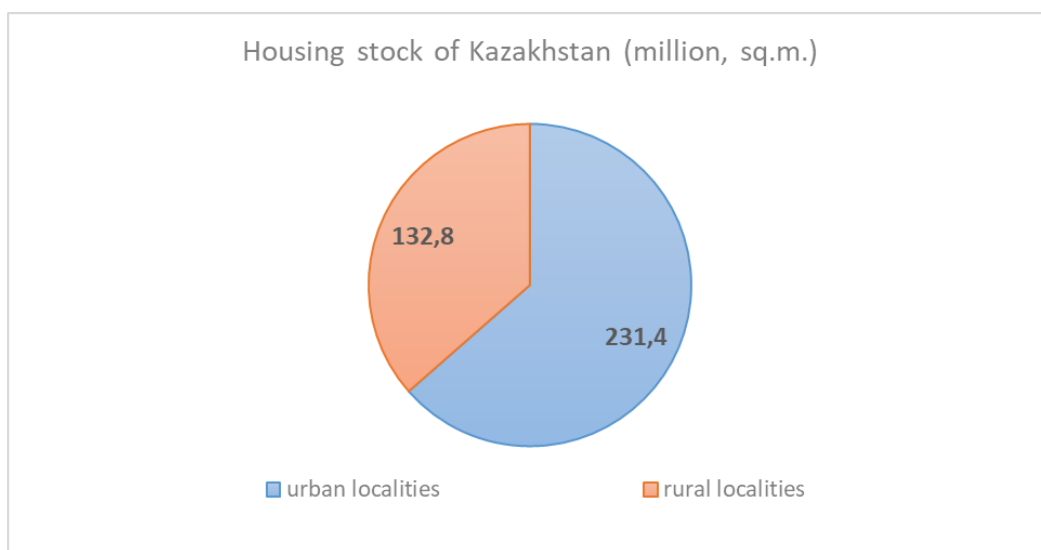


Figure 1. Housing stock of Kazakhstan (Source: authors)

In total, the housing stock includes 2 363 618 residential buildings, of which 2 049 446 are individual and 314 172 are multi-apartment. Multi-apartment residential buildings are evenly represented in all localities: 131 613 in urban and 182 559 in rural, respectively. The typology of multi-apartment residential buildings includes five types of buildings: 213 687 two-apartment, 21 180 three-apartment, 14 328 four-apartment, 3 412 five-apartment, 61 565 six or more (Figure 2) [17].

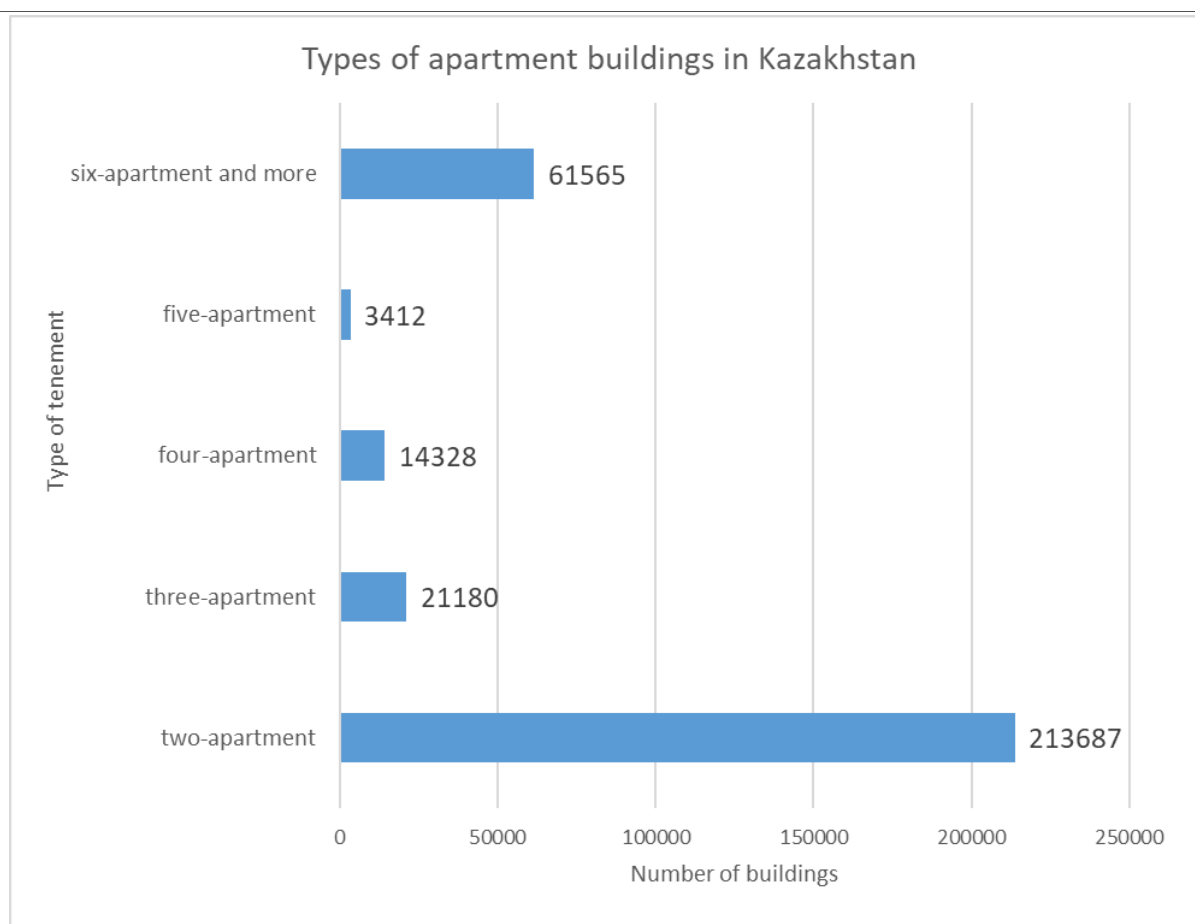


Figure 2. Types of apartment buildings in Kazakhstan (Source: authors)

According to statistics, 258 121 houses were built before 1990, which is 83% of all apartment buildings in Kazakhstan (Figure 3) [17]. Housing of this period is mainly represented by standard series of residential buildings of different structures. At the same time, Table 1 shows that most of the residential buildings of the period under review were built before 1970, which include houses of the first mass series and, to a lesser extent, multi-apartment housing built according to individual projects. In general, the development of the housing stock in Kazakhstan proceeded systematically with an alternating increase and decrease in the pace of construction. Only since 1991, a sharp decrease in the volume of construction can be observed, which is primarily due to the transition from standard to individual design.

Table 1. Number of apartment buildings by year of commissioning (Source: authors)

| Year of commissioning | before 1970 | 1971-1975 | 1976-1980 | 1981-1985 | 1986-1990 | 1991-1995 | 1996-2000 | 2001-2005 | 2006-2010 | 2011-2015 | 2016-2020 |
|-----------------------|-------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Number of houses | 121234 | 30342 | 38470 | 30133 | 37942 | 14306 | 6593 | 6836 | 15305 | 7487 | 4584 |

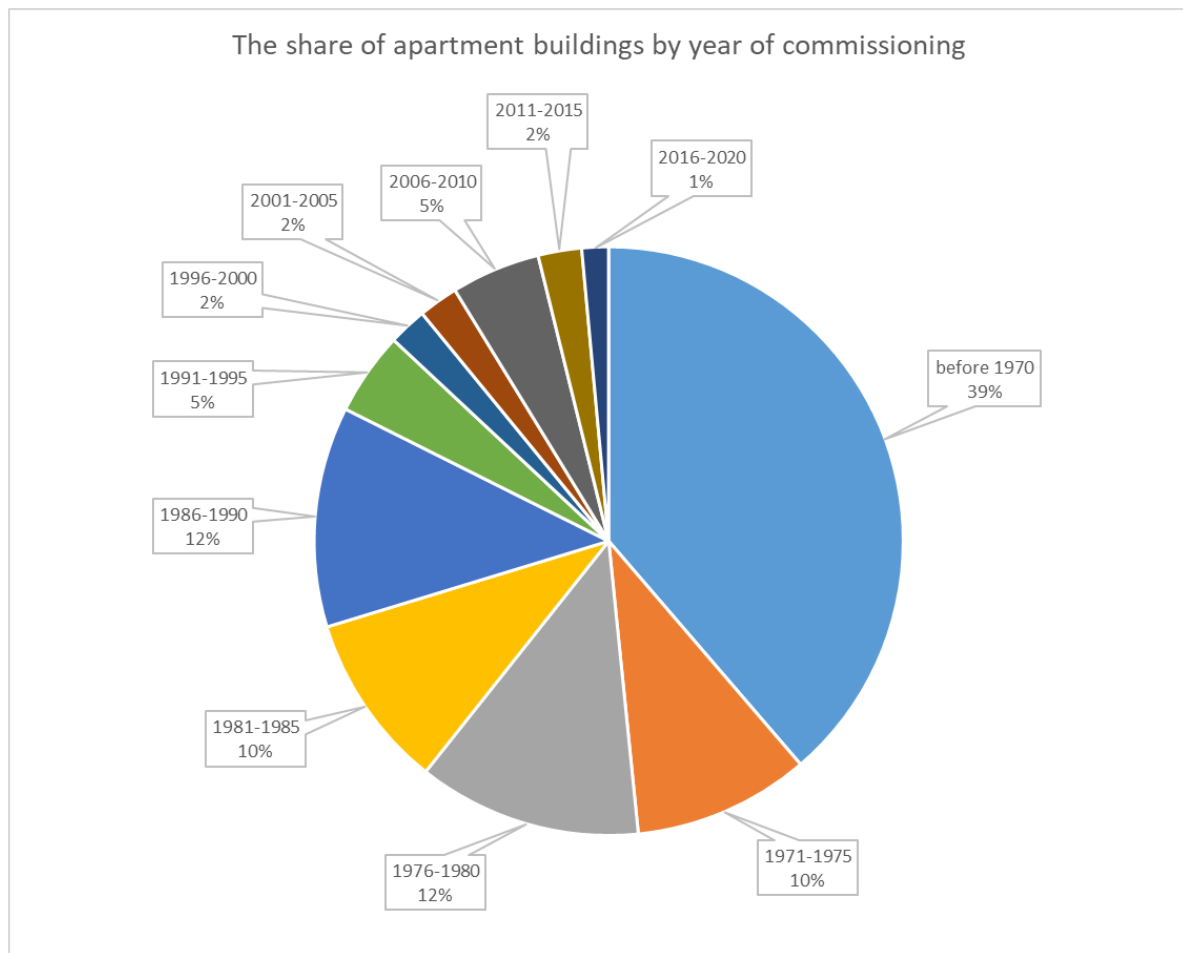


Figure 3. The share of apartment buildings by year of commissioning (Source: authors)

Considering multi-apartment housing in the context of design features, the following types of buildings can be distinguished: frame-reed or wooden, with load-bearing brick walls, large-panel, frame-panel or frame-brick, monolithic. The typology of multi-apartment housing based on structural materials is directly related to the historical periods of construction in the country. Since the 1930s, two-storey frame-reed and brick houses have been actively built in Kazakhstan. The most widely distributed series of KS-8-50, 261, 264, 105-4, 117-4, 207, 228, 230 and 204. These series had different layout variations, but mainly eight- and twelve-apartment residential buildings were built. With the development of the scientific and technical base and the study of the natural and climatic conditions of Kazakhstan, three-storey series 261-A, 275 and 1-308 are being developed, which correspond to the increased seismicity of the country's regions. Since 1959, the construction of large-panel residential buildings has begun, which have become the predominant type of development in all cities of present-day Kazakhstan. Four- and five-storey series 1-464A and 1-335A were built throughout the country, later transformed into the series 1KZ-464AS, 1KZ-464DS, 1-335AU, 1-335AK and UK-78-335A. Since 1970, with the development of panel housing construction, there has been a transition from the typical design of houses to the block-sectional method of construction, the object of typification of which was the block section. This is how the five-storey 69 series appeared, in which fundamentally new architectural and planning solutions were applied. At the same time, the problems of multi-storey construction in conditions of increased seismicity are being solved. The architects of the Central Research Institute of Housing developed the E-147 series, on the basis of which one of the most popular series – the 158 was subsequently designed. These series were built in both five-story and nine-story versions. Separately, it is worth noting the widespread series of houses in various regions of the country, designed taking into account natural and climatic conditions. So, based on the series 1-464A, a series 121 was developed for the northern regions, in the cities of Central and Western Kazakhstan, with an arid climate, series 86, 97, 1-105, 1-43 and 1-310 were actively used. All

of the above series, although they have planning differences, are generally characterized by a rigid three-dimensional structure associated with the technology of panel construction. In order to create more flexible spaces that allow to arrange trade enterprises on the first floors, to design multi-variant apartment layouts, since the mid-1970s, construction of the series begins: SZHKU-9, VT, VP. These series also include the 70 series, which has a similar structural scheme made of reinforced concrete frame. The final stage in the design and construction of mass housing is monolithic housing construction. Despite the absence of specific series, monolithic residential buildings have similar layout solutions, the main distinguishing feature of which is a reinforced concrete core of rigidity with self-supporting walls. Similar residential buildings have been built in Kazakhstan since 1970 in nine- and twelve-storey versions [3].

3. Results and discussions

According to the data given in Table 1 and the analysis of types of residential buildings in Kazakhstan, mass housing is 86.71% of all apartment buildings (Table 2). It should be noted that the data presented in Table 2 are averaged, but generally correspond to the current state of the housing stock in the country. Housing built according to individual projects is 12.19%, which includes all residential buildings built since 1995. These houses are relatively new and are characterized by insignificant moral and physical wear. Undoubtedly, apartment buildings on individual projects were built in earlier periods, but unfortunately, they have been preserved only in fragments in the historical centers of the cities of Kazakhstan. Consequently, the specifics of this type of housing involves restoration work, while preserving the architectural and planning features of buildings. Emergency residential buildings occupy an insignificant share of the housing stock. According to statistics from 2020 [17], 3 441 buildings are in disrepair, which is 1.1% of all apartment buildings. Thus, the main group of residential buildings subject to comprehensive renovation and modernization are apartment buildings of mass type.

Table 2. Number of residential buildings subject to complex renovation (Source: authors)

| Multi-apartment residential buildings | Quantity, pcs. | % |
|---------------------------------------|-------------------|---------------|
| Housing on individual projects | 38 304 | 12,19% |
| Emergency residential buildings | 3 441 | 1,10% |
| Mass type housing | 272 427 | 86,71% |

To make architectural and urban planning decisions on the renovation of mass housing, a scientific study of the potential of these buildings is required. Potential refers to the study of architectural and structural features of buildings for possible adaptation and modernization. The analysis showed that mass housing in Kazakhstan consists of six groups of standard series. Each of the groups includes a different series of residential buildings (Table 3). Differentiation of building types, their diversity requires the development of separate solutions for each of them. Initially, it is necessary to determine the main vectors of modernization of typical residential buildings. According to research conducted in 2010-2013, the consumption of thermal energy in apartment buildings was 270 kW/sq.m. per year, which is significantly higher than the European average – 100-120 kW/sq.m. per year. About 30% of heat is lost through enclosing structures: facade walls, windows, roof, basements, floors of the first floors, entrances [9]. Thus, renovation should solve, first of all, the issue of energy efficiency of buildings. Solutions to improve energy efficiency should be based on full-scale surveys of buildings, with a detailed description of the condition of load-bearing and enclosing structures. At the same time, special attention should be paid to houses with a wooden frame, in order to maximize the preservation of this type of housing. The

next direction of modernization is to change the spatial and architectural planning solutions of buildings. Despite the criticism of the first mass series related to the service life of buildings and the condition of structures, studies have shown the potential for renovation of these typical houses. Residential buildings of the 60s are made of walls and foundations with a sufficient margin of safety (a margin of thickness of 30%), which allows to build floors, redevelop and apply solutions to change the volume of buildings [19].

Table 3. Classification of mass series of tenements in Kazakhstan (Source: authors)

| Multi -apartment residential buildings | Years of construction | Series name | Load-bearing structures |
|--|-----------------------|---|--|
| Frame-reed | 1930-1950 | KS-8-50 | Wooden frame |
| Brick | 1930-1960 | 261, 264, 105-4, 117-4, 207, 228, 230, 204, 275, 1-308 | Transverse-longitudinal load-bearing walls |
| Large - panel | 1960-1980 | 1KZ-464AS, 1KZ-464DS, 1-335AU, 1-335AK, UK-78-335A, 69, E-147, 158, 121, 86, 97, 1-105, 1-43, 1-310 | Reinforced concrete panels |
| Frame-panel | 1970-1990 | SZHKU-9 | Reinforced concrete frame |
| Frame-brick | 1970-1990 | VT, VP, 70 | Reinforced concrete frame |
| Monolithic | 1970-1990 | | Monolithic reinforced concrete |

4. Conclusion

A distinctive feature of the housing stock of Kazakhstan is the predominance of residential buildings of mass type. This category of housing includes typical apartment buildings that differ in the following parameters: structural schemes; years of construction; number of floors; materials of load-bearing and enclosing structures. The attitude towards a typical residential building in Europe began to change in the 1960-1970s of the last century [20]. The negative towards the mass housing was associated with the design method itself, excluding a specific, living inhabitant from the process. The inhumane features of typical housing identified by architectural scientists led to the transition to the design of residential buildings focused on a specific social group [21]. Today, there is a tendency in the world to renovate this type of housing, in order to preserve the urban context and the existing social ties in cities. The classification of typical apartment buildings in Kazakhstan obtained during the study (Table 3) allows us to identify groups of buildings with similar characteristics for further analysis and identification of renovation potential. It is important to note that architectural renovation solutions should be developed for each house separately, taking into account the unique urban situation. Nevertheless, the typical nature of housing suggests the possibility of creating a generalized renovation model for each series and group of series of residential buildings. Thus, the model, which includes scientifically based proposals and recommendations for renovation, will accelerate the adoption of design decisions in each individual case. One of the positive and important features of mass housing in Kazakhstan is its diversity. Multi-apartment housing, differing in age, number of floors, spatial solution will significantly improve the morphology of the building, bringing adaptability to the urban environment. Therefore, when conducting a full-scale survey of buildings and issuing an opinion on the condition of structures, it is necessary to consider all possible options for preserving the structure.

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Қазақстандағы тұрғын үй құрылысын жаңарту және жаңғырту мәселелері

Аңдатпа. Қазақстандағы қалаларда жаппай тұрғын үйлер көптеген жылдар бойы пікірталастар мен ғылыми ізденістердің тақырыбы болып табылады. Қанағаттанарлықсыз тұрғын үй жағдайлары, зиянды қалалық орта тұрғын үйді жаңарту бойынша нақты ұсыныстарды талап етеді. Бұл зерттеу Қазақстандағы жаппай тұрғын үйдің ерекшелігін ашады және тұрғын үй құрылысын жаңартудың орындылығын анықтайды. Ғылымның экономикалық, әлеуметтік және сәулет салаларының мамандары тақырыпты зерттегеніне қарамастан, бүгінгі күнге дейін келесі мәселелерді шешуде түсініксіздік сақталуда: елдегі қайта құру стратегиясы; тұрғын үйлерді қайта құру мүмкіндігі; жаңартылатын тұрғын үйлердің түрлері. Жобалық материалдарды, әдеби дереккөздерді және статистикалық деректерді салыстырмалы талдау нәтижесінде авторлар Қазақстан Республикасындағы жаппай сериялы көппәтерлі тұрғын үйлердің жіктемесін анықтады. Бұл жіктеу құрылыстың хронологиялық тәртібін, нимараттардың құрылымдық схемасының түрін және тұрғын үй серияларының атауын біріктіреді. Тұрғын үй қорының статистикалық деректерін әртүрлі параметрлер бойынша жүйелеу жөндеуге жататын көппәтерлі тұрғын үйдің үлесін аз қателікпен анықтауға мүмкіндік берді. Сонымен қатар, бұл жұмыс

тұтастай алғанда елдегі тұрғын үй қорының құрылымына, тұрғын үй-коммуналдық шаруашылықтың ерекшелігіне және сәулет-қала құрылысын жобалау процесіне байланысты жөндеу мәселесін ашады.

Түйін сөздер: жаңарту, жаппай тұрғын үй, тұрғын үй құрылысы, тұрғын үй сәулеті, қалалық ортаны қалпына келтіру.

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Проблемы реновации и модернизации жилой застройки в Казахстане

Аннотация. Массовая застройка городов в Казахстане является предметом дискуссий и научных изысканий уже много лет. Неудовлетворительные жилищные условия, нездоровая городская среда требуют конкретных предложений по реновации жилья. Данное исследование раскрывает специфику массового жилища в Казахстане и определяет целесообразность реновации жилой застройки. Несмотря на изученность темы специалистами из экономической, социальной и архитектурной областей наук по сей день сохраняется неясность в решении следующих вопросов: стратегия реновации в стране; возможность реновации жилых домов; типы жилых домов, подлежащих реновации. В результате сравнительного анализа проектных материалов, литературных источников и статистических данных авторы определили классификацию многоквартирных жилых домов массовых серий в Республике Казахстан. Данная классификация объединяет хронологический порядок строительства, тип конструктивной схемы зданий и наименование серий жилых домов. Систематизация статистических данных жилищного фонда по различным параметрам позволила выявить с небольшой погрешностью долю многоквартирного жилья, подлежащего реновации. Помимо этого, данная работа в целом раскрывает проблему реновации в стране, связанную со структурой жилищного фонда, особенностями жилищно-коммунального хозяйства и процессом архитектурно-градостроительного проектирования.

Ключевые слова: реновация, массовое жилье, жилая застройка, архитектура жилища, регенерация городской среды.

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