

TRENDS AND PROSPECTS OF MODERNISATION OF MULTI-STORY RESIDENTIAL BUILDINGS ON THE BASIS OF SUSTAINABLE DEVELOPMENT

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Abstract. According to the results of generalisation; quantitative, qualitative and comparative analysis of the reconstruction of residential buildings, trends and prospects for the reconstruction and modernisation of multi-story residential buildings are determined, considering the principles of sustainable development.

The problems, trends and prospects of the reconstruction of multi-story buildings were determined, which made it possible to find optimal ways of modernising residential buildings, considering controversial issues, opportunities and goals of sustainable development. The controversial issue is to find a balance between real opportunities, current and planned projects and ways of implementation, considering economic opportunities, legislation and controversial issues between Condominium and co-owners of multi-apartment buildings.

The problems are highlighted and ways to solve the improvement of projects for the modernisation of multi-story buildings are found. Possibilities and options for cost-effective modernisation of multi-story buildings are taken into account. The interests of all stakeholders were taken into account and ways to overcome misunderstandings were found.

When all issues are resolved, not only the interests of the project executor, the Condominium, co-owners of multi-apartment building, organisations and funds which financing the project, as well as the capabilities of the state and current legislative and regulatory acts regulating the financing and implementation of the project of modernisation of multi-story buildings are taken into account. Much attention is allocated to the goals of sustainable development of cities and communities. After all, when modernising multi-story buildings, it is necessary to focus not only on the needs of the present, but also to considering the needs of future generations and focus on effective, economically profitable prospects of the present and the distant future, taking into account the need for a healthy environment. Thanks to the amendments to the legislation, it became possible to improve the energy efficiency of buildings and reach a higher quality level in the modernisation of multi-story buildings.

Keywords: sustainable development, modernisation, reconstruction, multi-apartment buildings, multi-story buildings, residential construction, residential buildings.

Introduction. When examining the trends and prospects for the reconstruction of multi-story residential buildings based on the principles of sustainable development [1], it is essential to pay close attention not only to project implementation methods but also to opportunities, methods, and existing legislation [2, 3]. Consideration must be given to the goals of sustainable urban and community development, drawing from the outcome document of the United Nations General Assembly Summit [4]. It is crucial to recognise that existing financing programs do not always align with the needs, especially when it comes to comprehensive modernisation. Given that the burden of financing, in whole or in part, falls upon co-owners of multi-story buildings, represented by the Association of Co-Owners of Multi-Apartment Buildings (Condominium) as a non-profit organisation [5], the issue of disagreements among project participants arises. This problem also needs to be resolved, as the presence of such disagreements makes it impossible to implement programs and projects for the modernisation of multi-apartment residential buildings. When planning residential construction modernisation and searching for funding, many factors related to the process need to be taken into account: the project's relevance to the specific construction, the percentage and

proportionality of financing, the willingness of co-owners of multi-story buildings to participate in the project, and the state's ability to participate in the process. The lack of standardised projects, which do not cater to the individual needs of the building, is a significant problem. Sustainable development principles are often disregarded, as nearly all projects are oriented toward partial, rather than complete, modernisation, which also increases the project cost with the perspective of full modernisation. The need for co-financing by co-owners of multi-apartment buildings complicates the swift approval of work plans and sometimes renders project execution impossible.

When modernising a multi-story building, it is prudent to consider all factors and implement a reconstruction project, taking into account not only the comprehensive needs of today but also finding a balance between the current needs of humanity and the ability to meet the needs of future generations. Grounded in sustainable development principles, it is essential to focus on the need for a safe and healthy environment. Therefore, when planning project implementation, attention should be directed not only to economically advantageous materials and resources but also to ecological products and materials and systems that preserve the environment.

Analysis of Recent Research and Publications. The topic of modernising multi-story buildings and sustainable urban and community development has been under investigation for many years, both in a general sense and through specific case studies in various countries. V. Stankevičius together with other researchers, paid attention to the modernisation prospects of buildings in Lithuania and sheds light on the practical significance of modernising Soviet-era structures characterised by low insulation standards and requiring substantial energy consumption [6]. M. Piekarski with colleagues, in their article on the transformation of socialist realist housing architecture into a contemporary sustainable living environment, thoroughly examine the challenges of multi-apartment building construction from the 1950s and suggest potential directions for modernisation in alignment with contemporary housing requirements derived from the theory of sustainable development [7].

The results of research into the regeneration of social housing in old structures that no longer meet modern needs from social, political, economic, and sustainability perspectives are documented in a report on the regeneration of large micro-districts of social housing [8]. The European Union, emphasising that research into housing modernisation is not solely the domain of individual researchers but is also commissioned by governmental organisations, financed this work. The study delves into the issues of social housing in old structures in cities like Paris, Brussels and Milan. The research is particularly intriguing given that the old multi-story housing in Ukraine can also be categorised as social housing, as it is challenging to label it as adhering to social, political, economic, and sustainable development goals.

In the 2022 report of the United Nations Human Settlements Programme (UN-Habitat), the issue of urban planning for sustainable and inclusive development is highlighted [9].

Numerous authors, particularly in the context of post-Soviet countries, have extensively examined modernisation of old buildings. R. Sendi and B. Kerbler study the residential complexes built after the Second World War in the countries of Eastern Europe and point out the need for the urgent implementation of an appropriate regeneration policy in order to create more attractive living conditions and prevent the potential degradation of neighbourhoods with such buildings [10]. The need to modernise the mass housing development of Soviet times is also noted by other researchers, who use the example of the city of Almaty (Kazakhstan) to demonstrate an approach to reconstruction [11]. Conditions and factors contributing to negative consequences of thermal modernisation in urban buildings are also. Specifically addressing the factors affecting the deterioration of the functioning of structures when partial modernisation is implemented [12].

The United Nations Development Programme guided by the principles of sustainable development and with the support of various funds and governmental institutions, is involved in projects aimed at the modernisation of multi-apartment residential buildings. An example of such a project can be found in the modernisation initiative in cities in Kazakhstan [13].

Ongoing research is essential, but over time, it may become less relevant due to the evolving nature of sustainable development goals, which tend to change along with shifting priorities and modernisation trends. The prospects for modernising multi-story buildings are also evolving with

the introduction of new inventions, materials, changes in legislation, and the availability of various programs and funds. Forums like the "Innovation and Modernisation of the Energy System in Central Asia," supported by global organisations, foster collaboration, innovation discussions, and lay the foundation for educating the next generation of energy experts while strengthening evidence-based policies [14]. This is vital because innovations in the energy system are a key component of modernising multi-story buildings and ensuring a safe and healthy environment.

Objective and Tasks. The objective of this study is to identify the optimal solution for the modernisation of multi-story residential buildings based on the principles of sustainable development. This includes taking into consideration the realities of existing and prospective projects, individual needs during the modernisation of residential structures, and aligning these with the financial, technical, legal, and regulatory aspects that are integral to the successful implementation of the project.

The set task was accomplished through the following steps:

Analysis of Modernisation Projects: Conducting an in-depth analysis of modernisation projects for multi-story buildings in Ukraine and other countries worldwide.

Analysis of Organisations and Funds: Investigating organisations and funds engaged in financing reconstruction projects.

Requirements and Stakeholder Analysis: Examining the requirements and parties involved in the modernisation process.

Legal Framework and Financing Options: Analysing and considering the legal framework and alternative financing options, which may include funding through Condominium or co-financing with property owners, while also addressing any contentious issues.

By undertaking these tasks, the study aimed to provide a comprehensive solution for the modernisation of multi-story residential buildings, adhering to sustainable development principles and addressing the multifaceted aspects of the modernisation process.

Materials and Research Methodology. Data for analysis were compiled through the search for existing projects related to the modernisation of multi-story residential buildings, both in progress and completed, within Ukraine and other countries. Furthermore, the study investigated the interest of co-owners of multi-apartment buildings and their potential participation in modernisation programs and projects. The results of this amalgamation yielded insights into the viability of organising and executing a reconstruction project under existing technical, financial, economic, and legislative conditions.

The research encompassed the following elements. **Legislative Foundation:** A thorough examination of the legislative framework, national building regulations, and the most recently adopted resolutions of the United Nations General Assembly, particularly those concerning the transformation of our world by 2030 for Sustainable Development, and reports on the regeneration of social housing micro-districts [2, 4, 8, 15]. The aforementioned documents, projects, and analytical instruments were scrutinised to address questions concerning the necessity of co-financing the modernisation by co-owners of multi-apartment buildings or Condominium, state involvement, and alignment with the objectives of sustainable urban and community development during project implementation.

The research methodology involved. **Objective Alignment Assessment:** Evaluating the congruence of predetermined objectives with real-world feasibility.

This approach aimed to provide a comprehensive understanding of research goals, financial considerations, legislative aspects, and their alignment with the principles of sustainable development within the context of modernising multi-story residential buildings.

Research Findings. The success of a multi-story residential building modernisation project is contingent on various stakeholders, making balanced management and equitable engagement a critical factor. The following key points emerged from the research:

1. **Balanced Project Management.** The management of the project must be executed in a balanced manner, with equal levels of responsibility and attention afforded to each stakeholder.

2. **Sequential Project Management Methods.** Project management methods should be

consistently applied to all activities throughout the entire project lifecycle.

3. **Harmonised Coordination.** All aspects of project management need to be coordinated and balanced to ensure the effectiveness of all project elements (components) during its development, planning, monitoring, and implementation stages.

4. **Collaborative Approach.** Project management should be collaborative, with the participation of all stakeholders in the identification, development, planning, implementation, and monitoring of the project. This approach ensures transparency and alignment, improves quality, strengthens human resources, and provides guarantees for project realisation at all levels.

5. **Ongoing Review and Reassessment.** The management processes of reviewing and reassessing are essential throughout the project's lifecycle to ensure that the development process, implementation plans, and expected outcomes remain relevant and significant for the present and the future. This practice enhances the accuracy of project design and planning for subsequent phases.

The project lifecycle for modernisation can be divided into three phases.

Pre-Investment Phase (Phase 1). This phase involves determining investment opportunities. During this phase, alternative options are analysed, and the preliminary project selection is made. This includes technical and economic justification, the decision to invest, and deriving conclusions from the project.

Investment Phase (Phase 2). In this phase, detailed project planning and contract negotiation take place. Organisational, financial, and legal foundations are established. Marketing activities are conducted, personnel are recruited and trained if necessary. The actual construction work is performed, and the project is handed over for operation.

Operational Phase (Phase 3). The operational phase is examined from both short-term and long-term perspectives. In the short term, possible issues related to each stage of work execution are studied. In the long term, the chosen strategy and the cumulative costs of project implementation are assessed. The results are evaluated in terms of benefits, including social, economic, financial, political, environmental, and other aspects.

Each stage involves specific actions, which are presented in Table 1.

Table 1 – Summary of Project Lifecycle Phases

Phase 1	Phase 2	Phase 3
Research: – Studying forecasts – Developing a program or searching for an existing one – Aligning the concept	Development of project cost estimates or approval of the developed program: – Project planning – Preparation of modernisation work – Contract negotiation – Preparatory work	Construction and installation work: – Modernisation work – Completion of the construction phase of the project – Handover of the facility – Contract closure – Analysis of results

The actions mentioned can be slightly altered depending on the organisational and financial components. However, considering that the Condominium, as the representative of the multi-apartment building co-owners, is the initiator, the client, or the party providing consent for the project and is a non-profit organisation under Ukrainian law [5], the financing of modernisation is carried out through the funds of financial institutions, non-profit organisations, funds, state funds, and so on. Of course, the work can be funded through loans or by the co-owners, who may participate in financing or co-financing with other organisations and funds. Given the above, there is a need to obtain the consent of all co-owners of the multi-apartment building for modernisation. As practice shows, if financing is covered by organisations, funds, the state, and other parties, obtaining consent is relatively easy. However, if the project requires co-financing by owners,

obtaining consent for the work becomes very difficult, as in many cases, the financial capabilities of co-owners may not cover their participation in the project. There are situations when even with full financing and the consent of the majority, some co-owners do not give consent or access to their premises if necessary, due to circumstances or their unwillingness. This is where the biggest challenge in project implementation arises. Today, typically, project financing for modernisation is done with the participation of non-profit organisations, funds, and their partners, so the process must adhere to transparency and compliance criteria. Since projects are usually financed by foreign organisations, compliance, as a measure of procedures, rules, and control measures, does not always align with the relevant requirements in accordance with current regulations and legislation, leading to questions about bringing all necessary processes into compliance.

The problem also arises from the readiness of the Condominium and co-owners to adhere to rules and procedures, as Condominium also bears significant responsibility for organising and overseeing the modernisation process in which co-owners must actively participate.

Insufficient organisation, justification, supervision, and coordination of financing are also problematic, which can lead to project underperformance or even its termination. This not only jeopardises the achievement of sustainable development goals but can also harm the building's operation and structure.

Statistics indicate cases where significant investments allocated to building reconstruction, instead of improving conditions and operational characteristics; significantly deteriorate the facility's function and structural integrity. These negative consequences usually result from organisational and construction mistakes and involve a complex and prolonged process that can worsen the environment, the condition of the structure, and the indoor microclimate. Work stoppage can lead to the deterioration of the building's walls. Natural and climatic factors can cause material decay, leading to the release of substances harmful to humans into the environment. As a result, funds are effectively allocated to worsen operational conditions rather than providing a positive effect.

The issue transcends from a purely construction problem to an administrative and civil issue. It pertains to the long-term negative impact on the environment, posing a threat to the health of residents of the reconstructed objects. This is why significant attention should be given to the development and oversight of organisational and technological measures. This underscores the crucial importance of adhering to one of the most essential functions, in addition to transparency and compliance, that non-profit organisations follow, such as monitoring, evaluation, accountability and learning (MEAL).

The issues of partial modernisation are addressed in an article discussing the negative consequences of reconstruction [12]. One drawback is the universality of projects, which usually cannot cater to the individual needs of each building. This problem was attempted to be resolved and implemented within the framework of the program "Model Projects: Comprehensive Energy-Efficient Modernisation of Multi-Apartment Buildings." This initiative, driven by the energy efficiency in Ukraine agency (dena) and its partners, including Kompetenzzentrum Großsiedlungen e.V., IWO e.V., and the Competence Centre for Large Housing Estates, was launched at the request of the Federal Ministry for Economic Affairs and Energy of Germany. The project's goal is to develop effective and optimised solutions for comprehensive renovation, which is reflected in organisational, technical, and financial plans [16].

At the initiative of the President of Ukraine, a program for energy modernisation has been launched. As Prime Minister of Ukraine mentioned on the Government Portal [17], changes were made to several laws of Ukraine to facilitate the introduction of comprehensive thermal modernisation of buildings [2]. Additionally, the Government Portal reports the signing of a law to establish the State Decarbonisation and Energy Efficiency Transformation Fund, which will serve as a permanent and significant source of financing for numerous energy efficiency programs and projects in various sectors of the economy [18]. The President of Ukraine initiated a program aimed at protecting nature and the environment in Ukraine [19].

Such initiatives reflect the state's significant commitment to integrating European principles and sustainable development goals – addressing current societal needs with a view to future generations and environmental preservation. One of these approaches is the intention to modernise multi-apartment residential buildings without the financial participation of co-owners of these buildings, which streamlines the coordination of work between Condominiums and project participants.

Another drawback is the partial nature of modernisation in projects that exist, are ongoing, or are planned. Projects that are designed for partial modernisation with a view to full modernisation in the future tend to be more financially demanding and may not fully align with all sustainable development goals. Modernising a portion of a building to meet contemporary standards leaves the question of complete improvement, considering all needs, unresolved.

The higher cost of phased projects is related to the need to repeatedly search for or organise new programs and fund almost all phases of the project lifecycle each time (as shown in Table 1). Of course, the larger the project, the greater the financial burden. However, it is important to consider that the budget can be reduced through one-time actions for all work, making comprehensive modernisation more economically advantageous and aligned with sustainable development goals. It is also worth noting that phased implementation of full modernisation takes more time. Over time, circumstances change, leading to potential issues with previous agreements and plans, which can complicate the organisational aspects of the project and lead to cost escalation.

The repetitiveness of identical, repeatable tasks in the case of phased modernisation, in comparison to the quantity of work in a full modernisation, is illustrated in Figure 1.

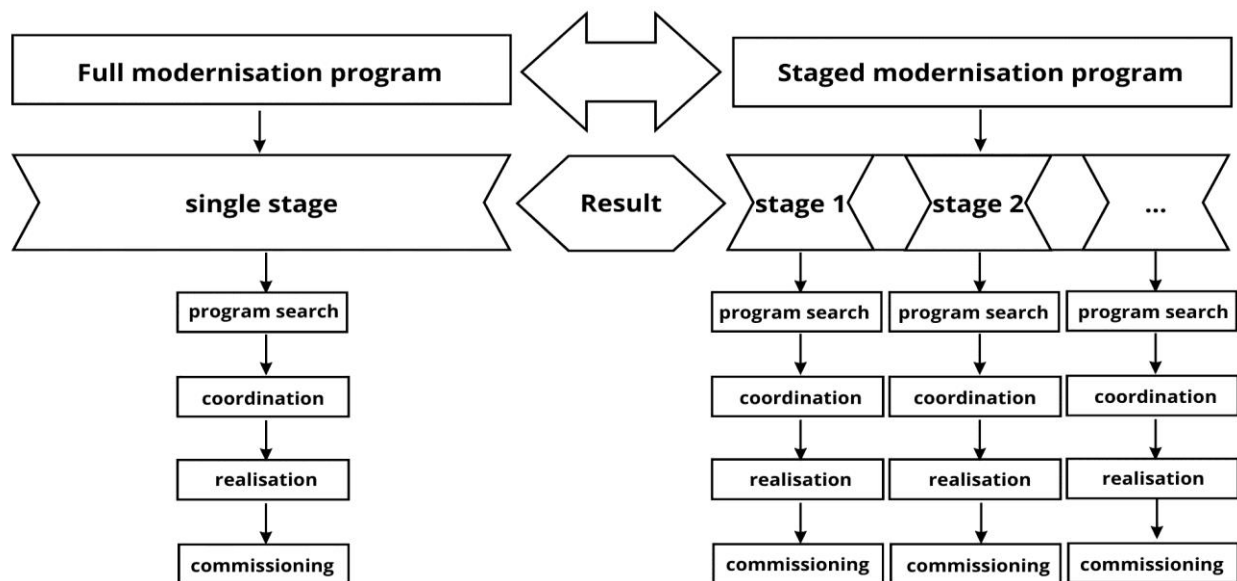


Fig. 1. Illustration of the modernisation program

It is worth mentioning that partial modernisation is generally less expensive than a complete one. However, when the ultimate goal is full modernisation, implementing the project incrementally will result in a higher overall project cost. Additionally, it may lead to additional engineering and architectural work due to the necessity of modifying previously completed stages.

Furthermore, it is important to consider that the modernisation program typically does not cover the entire cost of the work. Therefore, when proceeding incrementally with the perspective of full modernisation, the Condominium will face the challenge of securing funding and obtaining approval from co-owners at each stage of the project. For example, you can look at the "Energy House" program, which offers several program packages covering up to 70% of the total project cost, depending on the package of measures (scope of work) [20]. According to program information, participating in the full package of services will result in significantly greater energy savings than participating in a package with a partial scope of modernisation. Considering the

process of obtaining co-owners' approval and co-financing, gaining consent multiple times will be more challenging than settling the process once.

In planning, it is essential to pay attention to the calculation of project effectiveness, which involves surpassing the value of the outcome relative to the costs. In the case of residential building modernisation, efficiency should be understood as the achievement of all project objectives.

Conclusions. One of the goals of sustainable development is to overcome poverty. Achieving this goal allows us to consider the implementation of projects for full building modernisation, considering other sustainable development objectives. These projects can be funded by co-owners of multi-story buildings with the support of the state. These projects should be oriented towards the individual problems of each building or group of buildings, thus promoting greater consent from co-owners when the desire for more comfortable living conditions takes precedence over funding issues. Currently, the primary reason for co-owners' disagreement regarding modernisation is their financial inability to co-finance the project if it cannot be fully covered by existing programs. Partial modernisation programs align with sustainable development principles only partially as they do not cover all the needs and are only partly focused on the requirements for a safe and healthy environment, especially regarding future generations.

The involvement of the state can reduce the costly part of the project. It allows for comprehensive modernisation with the development of individual solutions for similar buildings with identical technical and engineering requirements. As a result, the cost of modernising one building will decrease, eliminating the need for additional financial expenditure on a new project for similar constructions when searching for new funding programs.

A comprehensive approach to modernising residential buildings, considering all necessary reconstruction work and project development for groups of buildings with identical architectural, engineering, and technical needs, will not only reduce the financial burden but will also enable the achievement of the goals of sustainable urban and community development. It will make the process more straightforward and efficient at all stages of the project's life cycle, through coordination and the identification and resolution of issues with the initial pilot building groups.

The modernisation of multi-story residential buildings in the context of sustainable development is achievable through a comprehensive approach aimed at achieving all the objectives related to city and community goals, including responsible resource consumption and production, industrial development, innovation, infrastructure, poverty alleviation, strong health and well-being, clean and accessible energy, economic growth, and decent work. Only a comprehensive approach to all these processes can ensure the successful implementation of projects and their efficient long-term operation.

Sustainable development as a whole, with goals outlined for the year 2030 and, in particular, sustainable urban and community development and effective governance, holds paramount importance in ensuring the quality of life for people [4].

Enhanced and well planned financial and project participation by local and state authorities, along with the improvement of citizens' economic standards, will provide the foundation for the prospect of complete modernisation of multi-story housing complexes.

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ТЕНДЕНЦІЇ ТА ПЕРСПЕКТИВИ МОДЕРНІЗАЦІЇ БАГАТОПОВЕРХОВИХ ЖИТЛОВИХ БУДИНКІВ НА ЗАСАДАХ СТАЛОГО РОЗВИТКУ

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Анотація. За результатами узагальнення; кількісного, якісного і порівняльного аналізу реконструкції житлової забудови визначено тенденції та перспективи реконструкції і модернізації багатоповерхових житлових будинків з урахуванням засад сталого розвитку.

Визначено проблематику, тенденції та перспективи реконструкції багатоповерхових будинків, що дало змогу знайти оптимальні шляхи модернізації житлової забудови з урахуванням спірних питань, можливостей та цілей сталого розвитку. Спірним питанням є знайти баланс між реальними можливостями, діючими і запланованими проектами та шляхами реалізації, враховуючи економічні можливості, законодавство та спірні питання між Об'єднаннями та співвласниками багатоповерхових будинків.

Висвітлено проблеми та знайдено шляхи вирішення вдосконалення проєктів з модернізації багатоповерхових будинків. Враховано можливості і варіанти для економічно вигідної модернізації багатоповерхових будинків. Враховано інтереси всіх зацікавлених сторін та знайдено шляхи подолання непорозумінь.

При вирішенні всіх питань враховано не лише інтереси виконавця проєкту, Об'єднання співвласників багатоповерхових будинків (ОСББ), співвласників багатоповерхового будинку, організацій і фондів, що фінансують проєкт, а також можливості держави та чинні законодавчі і нормативні акти, що регулюють фінансування та реалізацію проєкту модернізації багатоповерхових будинків. Велика увага приділена цілям сталого розвитку міст і громад. Адже при модернізації багатоповерхових будинків необхідно орієнтуватися не лише на потреби сьогодення, а й враховувати потреби майбутніх поколінь і орієнтуватися на ефективні, економічно вигідні перспективи сьогодення та далекого майбутнього, з урахуванням потреби у здоровому довкіллі. Завдяки внесенню змін до законодавства з'явилась можливість вдосконалити енергоефективність будинків та вийти на більш якісний рівень в модернізації багатоповерхової забудови.

Ключові слова: сталий розвиток, модернізація, реконструкція, багатоквартирні будинки, багатоповерхові будинки, житлова забудова, житлові будинки.

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