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Research paper

BUILDING TRANSFORMATION AS A RESPONSE TO SUSTAINABILITY CHALLENGES AND EMERGING HOUSING MODELS

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Abstract

Contemporary social, environmental, and economic challenges are reshaping housing practices by promoting more efficient and responsible use of natural resources. Within this framework, the adaptive reuse of existing buildings has emerged as a key strategy for sustainable development, enabling the transformation of obsolete or underutilized structures into new architectural functions while minimizing resource consumption and environmental impact. Such transformations are closely linked to contemporary lifestyles, which are increasingly influenced by changing family structures and evolving patterns of work, generating a growing demand for more flexible, adaptable, and resilient living environments.

This paper examines the transformation of existing buildings with diverse original functions into residential spaces while preserving their essential architectural form, thereby offering a sustainable response to contemporary housing needs and emerging residential models. The research focuses on the adaptive reuse of public and non-residential buildings for housing purposes, exploring the spatial, functional, environmental, and social dimensions of these transformations. The primary objective of the study is to analyze and systematize architectural approaches to adaptive reuse through three selected case studies that exemplify successful strategies for addressing contemporary sustainability challenges. By identifying key design principles and transformation mechanisms, the research contributes to a broader understanding of how existing building stock can be converted into sustainable, flexible, and context-sensitive housing models capable of responding to the changing demands of contemporary society.

Key words: *adaptive reuse, building transformation, existing building stock, contemporary housing, sustainable architecture.*

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1. INTRODUCTION

Contemporary architectural aesthetics are increasingly shaped by the principles of sustainable development, which serve as a fundamental framework for achieving a balanced relationship between humans and the natural environment. One of the most complex challenges facing contemporary society is environmental pollution and the excessive consumption of energy resources within the construction sector [1]. A significant proportion of the existing building stock fails to meet contemporary environmental protection requirements, exhibiting low energy efficiency and high maintenance costs. These challenges can be addressed through the application of sustainable design principles, as well as the integration of advanced materials and technologies aimed at energy generation, conservation, and efficiency improvement [2]. However, a significant challenge facing contemporary architectural and construction practice is the existence of a deteriorated building stock that has lost its original function or no longer serves any meaningful purpose. In this context, an important question arises: should such buildings be demolished, or should they be assigned new functions through adaptive reuse strategies? Current practice demonstrates that demolition is not always the most rational or sustainable solution. On the contrary, the preservation and enhancement of existing structures through carefully planned interventions often result in more effective and environmentally responsible outcomes. Furthermore, a key principle of sustainable architecture lies in designing and transforming buildings in a manner that enables them to accommodate future changes and evolving user requirements, thereby extending their lifespan and increasing their long-term functional value [3].

From the perspective of sustainability, building transformation, or adaptive reuse, represents one of the key approaches to sustainable architecture, as it enables the extension of a building's life cycle through its adaptation to new needs and conditions of use [4]. Adaptive reuse constitutes a specialized form of building refurbishment that presents complex challenges for designers. The conversion of a building to a new functional use introduces additional regulatory requirements and may require amendments to planning regulations or formal approval for a change of use. Despite these challenges, the substantial economic, environmental, and social benefits associated with adaptive reuse make it an increasingly attractive strategy for investors and policymakers [5]. Building transformations can be implemented at different scales and in various forms. They encompass interventions ranging from the preservation of a building's external appearance while reorganizing its internal spatial layout, to the restoration and reconstruction of historic buildings, as well as changes of use, extensions, and additions to existing structures [6]. The scope of interventions may range from minor modifications to comprehensive spatial and functional transformations, depending on the characteristics of the building and the objectives of the adaptive reuse project. Adaptive reuse is particularly significant in contexts with historical, architectural, or cultural value. By revitalizing existing buildings, it helps preserve the identity of place and the continuity of local culture while preventing the deterioration or loss of valuable built heritage [7].

In this way, adaptive reuse creates a connection between the past and the evolving needs of contemporary communities by enabling existing buildings to accommodate new functions while preserving their authenticity. Owing to their distinctive character and historical significance, such spaces often offer a unique experiential and cultural value, making them particularly attractive to users.

2. RESEARCH METHODOLOGY

This study investigates the adaptive reuse of the existing building stock as a strategy for creating new forms of housing. In this context, building transformation is examined as a sustainable approach that simultaneously enables the preservation of existing structures and their adaptation to contemporary residential functions. The research adopts a multi-method approach that integrates theoretical analysis with empirical investigation. The methodological framework is based on a comparative case study analysis supported by typological and spatial-functional analyses. These methods enable a systematic examination of the architectural characteristics of existing buildings, the processes of their transformation, and the housing typologies resulting from adaptive reuse.

Comparative analysis serves as the principal analytical framework of the study. Three case studies were selected according to predefined criteria: (1) the diversity of the buildings' original functions, (2) the successful conversion of the buildings into residential use, (3) the architectural and spatial complexity of the transformation process, (4) the availability of relevant project documentation and reliable information regarding the completed projects, and (5) geographical diversity. The application of these criteria ensured the selection of representative examples illustrating different adaptive reuse strategies while providing a sufficiently broad basis for comparative analysis across diverse cultural and urban contexts. The comparative evaluation is conducted using a unified analytical framework in which each case is assessed according to the same parameters: the original function and architectural characteristics of the building, the extent of spatial and functional interventions, the relationship between preserved and newly introduced architectural elements, the resulting housing typology, and the contribution of the transformation to environmental, functional, and cultural sustainability. Applying identical evaluation criteria to all case studies ensures methodological consistency and facilitates the identification of common design principles as well as context-specific solutions.

Based on these selection criteria, three representative case studies were chosen for detailed analysis. The first case study examines Grange Hall, a former nineteenth-century school building in London. The second focuses on Rassvet Loft, an adaptive reuse project involving the conversion of the former Rassvet furniture factory in central Moscow into residential units. The third case study analyzes House Altinho, a historic house in Lisbon that was transformed into a contemporary residential building while preserving its architectural identity.

Considered collectively, these case studies represent three distinct building typologies—educational, industrial, and warehouse buildings—illustrating different

approaches to adaptive reuse across diverse cultural contexts. Their comparative analysis provides a foundation for identifying transferable design principles and supports broader conclusions regarding the role of adaptive reuse in promoting sustainable housing development while preserving the architectural and cultural values of the existing building stock.

3. ANALYSIS OF CASE STUDIES ON THE ADAPTIVE REUSE OF BUILDINGS FOR RESIDENTIAL FUNCTIONS

The selected case studies illustrate three distinct approaches to the adaptive reuse of existing buildings for residential purposes. Although the projects differ in their original functions, architectural characteristics, and geographical contexts, they share a common objective: preserving the existing building structure while adapting it to contemporary residential needs. The comparative analysis focuses on identifying the transformation strategies, spatial interventions, and design approaches that enable the integration of new residential functions while maintaining the architectural identity and contextual values of existing buildings.

The analyzed examples demonstrate that adaptive reuse requires context-specific solutions tailored to the architectural, historical, and functional characteristics of each building. Through the preservation of existing structures and the introduction of carefully considered interventions, adaptive reuse contributes to sustainable development by extending the functional life of buildings and enhancing the adaptability of the built environment.

3.1. GRANGE HALL | Nissen Richards Studio London | United Kingdom

Grange Hall (Figures 1–4) is a historic school building constructed in 1837, originally designed for educational purposes. Following the cessation of its educational function in the 1960s, the building was temporarily used as a storage facility before being converted into a multi-family residential building. Owing to its outstanding Georgian architectural features and historical significance, preserving its architectural identity was the primary objective of the transformation project. The adaptive reuse strategy adopted a conservation-led approach that retained the original building form, structural system, material palette, and significant façade elements while introducing contemporary residential functions [8]. Rather than creating a strong contrast between the historic fabric and new additions, the design achieved a balanced integration of heritage values and contemporary architectural expression [9]. The principal spatial intervention involved the reorganization of the interior while preserving the existing building envelope. The structure was divided into nine independent residential units through vertical zoning across two storeys and a converted attic. Bedrooms were located on the lower floors, while the living areas occupied the attic level, maximizing the potential of the existing roof space. Original window openings on the principal façade were preserved, whereas new openings on the side elevations improved natural daylight without altering the building's historic character.



Figure 1. First floor plan



Figure 2. Second floor plan



Figure 3. Front façade of the building



Figure 4. View of the building

Figures 1-4, Source https://www.archdaily.com/930782/grange-hall-house-nissen-richards-studio

3.2. Rassvet Loft Studio Renovation | DNK ag | Moscow, Russia

Rassvet Loft Studio (Figures 5–8) is an adaptive reuse project located in central Moscow on the site of the former Muir & Mirrielees furniture factory, later converted into the Rassvet machine manufacturing plant during the Soviet period. The transformation sought to preserve the site's industrial heritage while integrating it into the contemporary residential fabric of the city. The adaptive reuse strategy retained the existing structural framework and respected the historical identity and *genius loci* of the site. Instead of replacing the industrial complex with new construction, the project reinterpreted its architectural character for residential use. The design of the new additions was informed by the surrounding historic context, including the former factory, the Neo-Gothic cathedral, and the Shchukin Estate, ensuring continuity between the historic environment and the new residential development [10]. The principal intervention transformed the former industrial building into contemporary housing while preserving its prefabricated reinforced-concrete structure. New residential volumes were inserted within the existing envelope, with each structural bay accommodating a single residential unit. The original six-metre floor height enabled the creation of duplex apartments with mezzanine levels, while the attic and basement were converted into additional residential space and parking facilities. Ground-floor apartments were complemented by private courtyards, creating a clear transition between public and private space. A second intervention rehabilitated an ancillary building originally intended for demolition, converting it into a series of low-rise townhouses with internal courtyards, attic floors, and covered parking. The consistent use of handcrafted red clinker brick visually unified the development, strengthened its

relationship with the surrounding historic buildings, and transformed former service areas into high-quality public spaces.

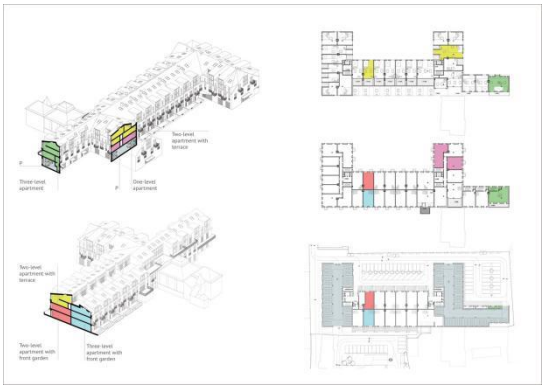


Figure 5. Axonometric view, section, and floor plans of the building.



Figure 6. Detail of the façade

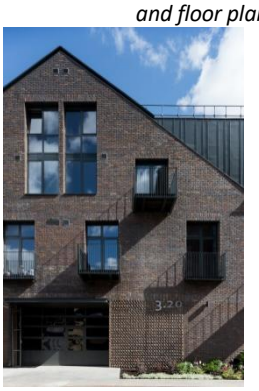


Figure 7. Detail of the façade



Figure 8. Industrial building transformed into multifamily building

Figures 5-8, Source: https://www.archdaily.com/904661/rassvet-loft-renovation-dnk-ag

3.3. House Altinho | António Costa Lima Arquitectos | Lisbon, Portugal

House Altinho (Figures 9–12) represents an example of the adaptive reuse and typological transformation of a former industrial warehouse into a contemporary single-family residence. Located on the banks of the Tagus River in Lisbon's Junqueira district, the project preserves the site's industrial heritage while adapting it to contemporary residential requirements. The adaptive reuse strategy is based on a conservation-oriented approach that retains the existing perimeter walls of the former warehouse as the defining element of the new architectural composition. By preserving the original urban morphology and reinterpreting the warehouse typology, the project establishes a dialogue between the historic industrial structure and contemporary residential architecture. The intervention combines the adaptation of the existing building with a volumetric extension that formally reinterprets the original warehouse while remaining within the permitted building envelope [12]. The principal spatial intervention organizes the residential programme within the preserved perimeter walls, complemented by internal courtyards and terraces that enhance spatial quality and natural lighting. The functional layout adopts an inverted vertical zoning strategy, placing the private (night) zone on the first floor and the public (day) zone on the

uppermost level in order to maximize southern orientation and views towards the surrounding urban landscape and the MAAT Museum [13]. The architectural treatment reinforces the relationship between continuity and innovation. Brick, selected to match the colour of the original masonry, ensures visual continuity with the historic structure, while its contemporary application through perforated brickwork clearly distinguishes the new intervention from the preserved building fabric.



Figure 9. Floor plans

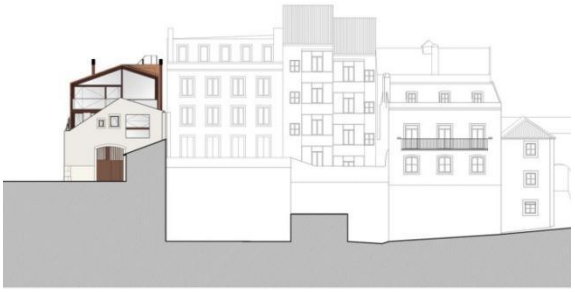


Figure 10. Façade drawing



Figure 11. Front façade



Figure 12. Back façade

Figures 9-12, Source: https://www.archdaily.com/962922/house-altinho-antonio-costa-lima-arquitectos/60bbf47bd898a00164926f16-house-altinho-antonio-costa-lima-arquitectos-photo

4. DISCUSSION

The contemporary concept of sustainability in architecture increasingly emphasizes the preservation and enhancement of the existing building stock, recognizing adaptive reuse as an effective alternative to new construction. By preserving existing structures, adaptive reuse reduces resource consumption, construction waste, and carbon emissions while extending the service life of buildings. Consequently, it represents an integrated approach that addresses environmental, economic, social, and cultural aspects of sustainability while responding to contemporary housing needs.

The comparative analysis demonstrates that, despite differences in their original functions, architectural characteristics, and geographical contexts, all three case studies share a common objective: preserving the existing building structure while adapting it to contemporary residential requirements. In each project, significant structural and spatial elements were retained, while new interventions introduced residential

functions without compromising the architectural identity of the buildings. These findings confirm the flexibility of adaptive reuse as a strategy applicable to diverse building typologies.

At the same time, the analyzed projects reveal different transformation approaches. Grange Hall demonstrates a conservation-led strategy focused on preserving the historical character and spatial organization of a former educational building. Rassvet Loft illustrates a more intensive transformation, where an industrial structure was reinterpreted through the introduction of contemporary residential typologies while maintaining its structural framework and industrial identity. House Altinho represents a context-sensitive approach that combines the preservation of an industrial heritage structure with contemporary architectural interventions and innovative spatial organization. These differences indicate that successful adaptive reuse depends on strategies tailored to the specific architectural, functional, and historical characteristics of each building rather than on a universal design model.

The findings support the research objective by demonstrating that adaptive reuse can facilitate the development of new housing forms within the existing building stock. The analyzed examples show that successful transformation depends on achieving a balance between heritage preservation and contemporary spatial requirements. Therefore, adaptive reuse should be understood not only as a conservation practice but also as a comprehensive design methodology that promotes architectural continuity, functional flexibility, and sustainable housing development.

5. CONCLUSION

Contemporary architectural practice increasingly recognizes adaptive reuse as an important strategy for transforming the existing building stock and developing new forms of housing. Adaptive reuse does not imply the replication of historical forms, but rather the creation of context-sensitive design solutions that establish continuity between inherited architectural values and future needs. Rather, it requires design interventions that respond to contemporary needs while respecting the architectural values and historical significance of the existing building. More broadly, processes such as adaptive reuse, rehabilitation, renovation, conversion, extension, and expansion establish continuity between inherited architectural values and future societal needs. From a sustainability perspective, this approach offers multiple benefits. It reduces the generation of construction and demolition waste, minimizes the consumption of new building materials through the reuse and recycling of existing structural and building components, and consequently contributes to a substantial reduction in environmental impacts. In the context of contemporary housing, adaptive reuse requires an innovative and carefully considered design approach, as emerging housing models are becoming increasingly flexible, dynamic, and responsive to the changing needs of modern society. Rather than prescribing a single housing typology or a fixed spatial model, each adaptive reuse project generates a context-specific architectural solution shaped by the characteristics of the existing building and the evolving functional requirements of its users.

The findings of this research suggest that adaptive reuse represents a viable alternative to new residential construction by encouraging innovative design approaches and supporting the development of new housing models. The reuse of existing buildings extends their service life, reduces pollution and construction waste associated with demolition, and decreases the demand for new construction materials. Consequently, adaptive reuse has the potential to make a substantial contribution to the environmental, economic, and social sustainability of the built environment.

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