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Adaptive Reuse as a Strategy for Sustainable Building Preservation and Regeneration

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Abstract.

The increasing demand for urban spaces and limited land availability have driven the adoption of adaptive reuse strategies, which repurpose existing or heritage buildings for new functions relevant to current needs. This strategy effectively extends the life cycle of buildings, preserves historical values, and supports sustainability principles through resource efficiency, waste reduction, and the conservation of embodied energy. This review analyzes the implementation of adaptive reuse as a strategy for sustainable building preservation and regeneration, drawing on a synthesis of 12 relevant academic journals. The analysis focuses on identifying key success factors, major challenges, and best practices related to adaptive reuse projects. The main aspects examined include stakeholder collaboration, financial strategies, community engagement, and the architect's role in balancing historical value with modern functionality. The findings reveal that the success of adaptive reuse is influenced by three key aspects: cross-sector collaboration among architects, owners, governments, and communities; phased financial strategies supported by adaptive policies; and the involvement of technical and conservation experts from the early design stages. Conversely, the main challenges include financial limitations, regulatory barriers, and technical complexities of heritage structures. This review concludes that adaptive reuse is not merely a preservation effort but a sustainable architectural approach that integrates cultural value, contemporary function, and urban regeneration.

Keywords: Adaptive reuse, building preservation, sustainability, stakeholder collaboration, urban regeneration

1. Introduction

Rapid urban growth in recent decades has posed complex challenges, including land constraints, the need for new spaces, and pressure on natural resources. Amidst these conditions, the reuse of old buildings has emerged as a widely discussed approach in the discourse on architecture and sustainable development. Adaptive reuse, the process of converting existing buildings to new functions that better suit current needs, is seen as a strategy capable of simultaneously addressing various environmental, social, and economic issues.

Various publications emphasize that reusing existing buildings offers significant environmental benefits by preserving structures and materials, thereby reducing construction waste and energy consumption required for new construction. By retaining the embodied energy of existing structures, adaptive reuse is considered more efficient and environmentally friendly than demolition and rebuilding. Furthermore, this strategy extends the lifespan of buildings, reduces carbon emissions, and optimizes the use of existing space in urban areas. Beyond ecological benefits, adaptive reuse contributes to the preservation of historical value and regional identity. Many old buildings not only possess architectural value but also form part of a community's collective memory. This transformation of buildings provides an opportunity for cultural heritage to remain alive and relevant amidst changing times. The new

functions not only revitalize buildings but also strengthen communities' attachment to history and to the broader local character. Thus, adaptive reuse plays a crucial role in maintaining the continuity of urban identity while opening up opportunities for design innovation.

Adaptive reuse also significantly impacts social and economic dynamics. Reactivating old buildings can improve the quality of public spaces, strengthen social networks, and stimulate new economic activity in previously inactive or neglected areas. Buildings adapted as cultural centers, creative spaces, educational facilities, business spaces, or other public functions often become catalysts for area revitalization. The presence of new functions can attract visitors, attract investment, and expand employment opportunities, thereby enhancing the socio-economic value of the surrounding area.

However, achieving the success of this strategy is not always easy. Numerous studies have shown that adaptive reuse faces technical, regulatory, and managerial challenges. The physical characteristics of older buildings often require a specialized approach, from assessing structural conditions and updating utility systems to integrating modern technology without compromising the building's original value. Furthermore, conservation regulations, building ownership, and the dynamics of coordination among owners, government, architects, and the community are factors that can affect the smoothness of the process. Differing goals and interests among stakeholders can create obstacles, especially when historical values must be reconciled with current functional needs.

Across the literature, it is clear that adaptive reuse is not merely a design process but a multidimensional approach that requires an understanding of the cultural context, the building's physical characteristics, user needs, and sustainability principles. Various publications provide a broad overview of how this strategy is implemented, the factors that drive its success, the obstacles that often arise, and its impact on building preservation and area regeneration. Based on these explanations, the description in this paper is structured to provide a comprehensive overview of adaptive reuse as a strategy that integrates preservation of buildings, the provision of new functions, and the improvement of the built environment in a sustainable manner. By highlighting key findings from the literature, this discussion seeks to provide a conceptual foundation for understanding the position of adaptive reuse in urban development and contemporary architecture, both as a preservation approach and as an instrument for broader area regeneration.

2. Method

This paper is a literature review that analyzes adaptive reuse as a strategy for building preservation and sustainable area regeneration, drawing on relevant scientific publications. The review process was carried out through several stages, including a literature search, publication selection based on specific criteria, and thematic analysis of findings from various studies. This method was used to produce a comprehensive conceptual synthesis of the practices, challenges, and success factors of adaptive reuse in the context of architecture and sustainable development.

2.1 Literature Search

The literature search was conducted using two main platforms: Scispace and Google Scholar. These platforms were chosen for their broad reach and access to various scientific journals related to Adaptive Reuse and Building Preservation and Regeneration. Keywords used in the search included "adaptive reuse," "building preservation," "heritage conservation,"

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"urban regeneration," "sustainable architecture," "reuse of existing buildings," and "adaptive reuse project management." The search focused on articles published within the last ten years to ensure the data analyzed remained relevant to the latest research developments.

2.2 Literature Selection

In the initial search phase, more than 60 articles on adaptive reuse and related issues were identified. A screening process was then carried out using the following inclusion and exclusion criteria:

Inclusion Criteria:

- Articles discussing adaptive reuse in existing or heritage buildings.
- Articles containing empirical data, case studies, technical evaluations, conceptual frameworks, or managerial analysis related to the adaptive reuse process.
- Articles reviewing the relationship between adaptive reuse and sustainability, regional regeneration, cultural values, or adaptive reuse project management.
- Articles published in the last 10–12 years (2013–2024).

Exclusion Criteria:

- Articles that solely discuss building conservation without any connection to functional change or adaptation.
- Publications that are opinion pieces, editorials, or not based on a clear scientific methodology.
- Articles that do not provide data, analysis, or findings that can be used in the synthesis of the theme.

After screening based on title, abstract, and content suitability, 30 journal articles were selected as the main basis for compiling this review.

3. Result and Discussion

Based on a review of scientific publications, adaptive reuse appears to be increasingly strategic in efforts to preserve buildings, optimize urban space, and improve the quality of the built environment. Various studies emphasize that the success of adaptive reuse is not only determined by architectural technical considerations, but is also greatly influenced by social dynamics, economic factors, regulatory frameworks, and effective process management. Through a process of integration and alignment of ideas from various sources, four main aspects can be formulated as the focus of discussion, namely: (1) the concept and principles of sustainability in adaptive reuse, (2) challenges and factors that influence success, (3) the role of stakeholders and process management, and (4) the impact of sustainability and contribution to regional regeneration.

3.1 Concepts and Principles of Sustainability in Adaptive Reuse

Adaptive Reuse (AR) has been consistently recognized in literature studies as a superior sustainable development strategy and a better alternative to new construction in the built environment sector (Eray et al., 2019; Wilkinson et al., 2009). Conceptually, AR is the process of modifying, adapting, and repurposing outdated, abandoned, or obsolete buildings while retaining most of the existing structure and materials, with the fundamental goal of extending the asset's productive life cycle (Nasrullah, 2024; Othman & Elsaay, 2018). The AR strategy

ensures sustainability through a holistic approach that balances the demands of heritage conservation with the three main pillars of sustainable development: environmental, economic/functional, and socio-cultural (Armstrong et al., 2023).

3.1.1. Principles of Environmental Sustainability

The environmental dimension is the foundation of AR sustainability, with a focus on minimizing the ecological footprint and optimizing resources. These principles ensure that AR significantly mitigates the environmental impacts of the construction sector. Embodied Energy Conservation is the most critical environmental benefit of AR. By retaining existing building structures, AR projects dramatically avoid the significant energy consumption that would otherwise be used for material extraction, processing, transportation, and new construction. The energy already "locked" in existing materials can be recovered, resulting in a substantial reduction in the overall carbon footprint of the construction project, making AR an effective climate change mitigation strategy (Mat Hasan et al., 2023; Wilkinson et al., 2009). Waste Reduction and the Implementation of a Circular Economy are powerful underlying principles. AR serves as the embodiment of Circular Economy practices in architecture, where existing buildings are not demolished but "recycled" and serve as future material banks (Foster & Saleh, 2021). This strategy directly minimizes the volume of Construction and Demolition Waste (C&D Waste), a massive environmental problem in dense urban areas (Nasrullah, 2024).

Green Technology Integration complements conservation aspects with performance improvements. To achieve operational sustainability, AR often involves green retrofitting, which is modifications to the building envelope (such as insulation and efficient windows) and the installation of modern, energy-efficient and environmentally friendly utility systems. These improvements aim to improve the thermal performance and operational efficiency of adapted buildings, often assessed using green rating systems such as LEED (Leadership in Energy and Environmental Design) (Alauddin et al., 2022; Hadar & Hardi, 2024).

3.1.2. Principles of Economic and Functional Sustainability

The economic sustainability of AR relates to an asset's efficiency, financial viability, and contribution to urban dynamics. AR strategies are a direct response to the problem of functional obsolescence, where the functions of old buildings no longer meet the demands of the modern market and society (Aytac et al., 2016). By adapting functions, AR not only revitalizes buildings but also extends their productive lifespan and improves operational efficiency, thereby enhancing asset resilience amid economic uncertainty (Laksitoadi & Cattaneo, 2019).

AR as a Catalyst for Urban Regeneration and Economic Stimulation is its role at the macro level. Successful AR projects act as key catalysts for the revitalization of degraded urban areas. By utilizing underused properties, AR attracts investment, creates job opportunities requiring specialized skills in conservation and modification, and stimulates economic activity in the surrounding area, transforming abandoned building liabilities into economic opportunities (Savoie et al., 2025).

The principle of design flexibility and adaptability ensures long-term economic sustainability. This principle requires that AR design interventions not be rigid but rather have adequate adaptive capacity. This means that adapted buildings must be able to accommodate potential future changes in function without requiring demolition or extensive structural

intervention, which is key to ensuring the long-term continuity of the asset's functional value (Laksitoadi & Cattaneo, 2019).

3.1.3. Principles of Social and Cultural Sustainability

This pillar distinguishes AR from conventional development by focusing on preserving intangible values and strengthening social capital. AR is a key method for Heritage Conservation and Authenticity. In the context of cultural sustainability, modifications to historic buildings should have minimal and ethical impact on their heritage significance (Othman & Elsaay, 2018). The goal is to maintain the authenticity of the building—both in material form and in the spirit of place (genius loci)—to ensure cultural continuity and the transmission of collective memory. Revitalizing historic buildings with relevant functions is the most effective way to keep heritage alive and relevant (Wee Kah Man, 2023).

Through meaningful preservation, AR also strengthens cultural identity and place attachment. The presence of repurposed historic buildings enriches place identity and enhances cultural awareness. This positively impacts the community's quality of life, as it develops an authentic connection and a strong historical narrative with its built environment (Afifi et al., 2022).

Community Participation and Social Justice are prerequisites for social sustainability. This principle requires the active involvement of local communities from the outset of AR projects. This participation is essential to ensure that new adaptation functions are truly relevant to local social needs and to mitigate the risk of gentrification (Afifi et al., 2022). Case studies show that when AR projects are dominated by private capital and commercial motives, heritage risks becoming a commodity that exacerbates injustice and erodes intrinsic cultural values. Therefore, sustainable AR must prioritize cultural and social values over mere profit (Tao et al., 2025; Savoie et al., 2025).

3.2 Challenges and Factors Influencing the Success of Adaptive Reuse

Although Adaptive Reuse (AR) is a recognized sustainable development strategy and is theoretically superior to new construction, its implementation faces significant and complex challenges across multiple dimensions, making it a risky project (Yung & Chan, 2012; Savoie et al., 2025). Fundamentally, the challenges are divided into technical-physical, regulatory-financial, and socio-cultural barriers.

Technical and physical challenges arise from the inherent complexities of working with existing structures, including difficulties in assessing their condition and capacity, often leading to the discovery of hidden damage or hazardous materials such as asbestos, which unexpectedly increase project costs and duration (Savoie et al., 2025). Furthermore, another crucial challenge is integrating energy-efficient modern utility (MEP) systems into limited spaces and rigid structural configurations (Alauddin et al., 2022). AR projects also demand better management to address design-construction interface issues between old and new components, which, if neglected, can lead to suboptimal project outcomes (Eray et al., 2019; Hassanain & Hamida, 2023).

From a financial and regulatory perspective, the main issue is the uncertainty of initial costs, which tend to be higher than new construction, primarily due to the need for expensive specialized conservation expertise and the aforementioned unforeseen risks (Nasrullah, 2024). This challenge is compounded by regulatory barriers such as building codes, zoning, and

heritage preservation requirements, which are often inflexible and do not adequately accommodate the functional modifications necessary for successful AR (Yung & Chan, 2012).

The most significant risk to social and cultural sustainability is the potential for commercialization and gentrification, especially when AR projects are led by private capital and driven by profit-seeking motives (Tao et al., 2025). This practice can turn heritage into a commodity that erodes intrinsic cultural value and fuels social injustice, as there is often a fundamental difference in perception of heritage value between developers (who see it as a commodity) and local communities (who see it as an authentic connection to their history), leading to the application of mixed standards (Tao et al., 2025).

3.2.1. Key Factors for AR Success

AR success is measured by the project's ability to balance these values through several key factors:

1. Prioritize Long-Term Value: Successful projects must prioritize structural adaptability, cultural values, and long-term sustainability over development models focused solely on short-term profits (Savoie et al., 2025). This ensures that buildings have the adaptive capacity and asset resilience to accommodate future functions without the need for extensive structural interventions (Laksitoadi & Cattaneo, 2019).
2. Early Governance and Expertise: A strong collaborative governance framework between all stakeholders is required to overcome regulatory and financial barriers (Savoie et al., 2025). Key to technical success is the involvement of technical experts (architects, engineers, conservators) from the early stages of a project to assess feasibility and design optimal adaptation solutions (Hanafi et al., 2019).
3. Community Engagement: Active and sustained participation of local communities is essential to ensure social sustainability, ensuring that new adaptation functions are truly relevant to local social needs, provide local economic benefits, and serve as a mechanism to mitigate the risk of gentrification (Afifi et al., 2022).

3.3 The Role of Stakeholders and Process Management in Adaptive Reuse

The success of Adaptive Reuse (AR) projects relies heavily on the dynamic interaction among stakeholders and the application of adaptive, specific, and integrated process management methodologies, given the inherent complexity and uncertainty of legacy buildings (Savoie et al., 2025). Sustainable AR implementation requires establishing a collaborative governance framework that balances the interests of cultural preservation, economic viability, and modern functional needs.

3.3.1. The Role of Stakeholders

The success of an Adaptive Reuse (AR) project relies heavily on the collaborative efforts of key stakeholders—architects, building owners, and city representatives—who each play a specific role in addressing the unique technical, financial, and governance challenges of heritage buildings. This engagement is characterized by key elements and strategies necessary to overcome various obstacles during the AR process, as presented in Table 1. These findings underscore the importance of shared values, technical expertise, and stakeholder collaboration

as essential components for enhancing project feasibility, ensuring regulatory compliance, and promoting long-term sustainability.

Segmentation of Roles and Responsibilities

Analysis shows that responsibilities in AR can be grouped based on the primary focus of the actor, although many key elements require shared roles:

1. Design and Technical Actors (Architects): Technical actors hold primary responsibility for ensuring the physical feasibility and sustainability of the intervention. The architect's role begins with an in-depth building inspection to assess the required level of renovation, which is key to mitigating technical risks (Hanafi et al., 2019). Architects also collaborate with asset owners to effectively manage hazardous materials and reuse building materials and furniture, ensuring healthy, sustainable renovations and minimizing waste.
2. Market Actors and Functional Vision (Asset Owners): Asset owners are the primary drivers of the project by developing a clear vision and specific spatial needs for the intended function of the building (Nasrullah, 2024). This actor is responsible for obtaining diversified financing to ensure adequate capital. Asset owner decisions must be balanced, with strategic use-value engineering applied to optimize profitability and reduce costs, without sacrificing cultural values, especially given the risk of gentrification driven by private capital (Tao et al., 2025).
3. Governance and Compliance Actors (City Government/Conservation Authority): City government representatives lead efforts to understand codes, regulations, and government agencies involved in navigating complex regulatory processes, obtaining necessary approvals, and ensuring compliance with legal requirements. This role is crucial for overcoming rigid regulatory and zoning barriers (Yung & Chan, 2012). Governance actors participate in community involvement and collaborative governance with architects and owners to create an equitable decision-making process.
4. Cross-Sector and Social Collaboration Actors: Several key elements require the simultaneous participation of all actors, architects, owners, and city government. This includes shared values and commitments for a unified purpose. Community involvement through community involvement and participatory renovation is crucial for integrating local perspectives, promoting collective ownership, and is a key factor in social success (Afifi et al., 2022). Collaboration is also needed to engage heritage experts to ensure historical integrity is preserved, and to plan for phased construction for efficient resource management.

For a more detailed understanding of specific roles and strategies, please refer to the Table below:

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Table 1. Roles and strategies for addressing adaptive reuse challenges.

ROLE	KEY ELEMENT	DESCRIPTION
Architect	In-depth building inspection	Conduct thorough assessments to understand the level of renovation required
Architect, owner, municipality	Shared values and commitments	All stakeholders sharing common values and a unified goal
Architect, owner, municipality	Community involvement and collaborative governance	Implement an equal-level decision-making process and involve the community in the planning and design phase
Architect, owner, municipality	Understanding codes, regulations and involving government agencies	Navigate regulatory processes, obtain necessary approvals and ensure compliance with regulatory requirements
Architect, owner, municipality	Plan for phased construction	Extend the project timeline for gradual implementation to manage resources efficiently
Architect, owner, municipality	Use participatory renovation	Integrate local perspectives and promote collective ownership of historical preservation and redevelopment efforts
Owner	Vision and specific spatial needs	Develop a clear vision to fulfil a specific purpose for the building's intended use
Owner	Obtain diversified financing	Use various funding sources
Owner, architect	Engage heritage experts	Preserve historical integrity and ensure compliance with heritage preservation guidelines
Owner, architect	Use-value engineering	Strategically prioritise renovation components to optimise profitability and reduce project costs
Owner, architect	Effective management of hazardous materials	Ensure healthy and sustainable renovation of existing buildings
Owner, architect	Reuse building materials and furniture	Promote sustainability by reducing waste and optimising resource use

3.3.2. Effective Process Management

In the journal Toward Adjusting a Conceptual Model for Adaptive Reuse Practice in the Context of Sustainability, it is explained that the success of adaptive reuse projects is greatly influenced by structured process management. According to Baiz and Atakara (2020), adaptive reuse projects require more careful work steps than new construction, because every decision must consider the physical condition of the old building, its historical value, and the needs of the new function to be implemented.

This research confirms that adaptive reuse proceeds through sequential and interrelated stages. Each stage serves to ensure that the building's significance is properly understood, its technical capacity is thoroughly examined, physical interventions are implemented proportionately, and adaptation results can be continuously monitored. This model serves as a foundation for formulating effective process management stages in adaptive reuse.

The following are the stages of the adaptive reuse process according to the research:

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Table 2. Main steps and sub-steps required to practice adaptive reuse.

Steps	Sub-Step	Explanation	Result
Evaluation	In-depth analyses of the survived structure, interviews with building occupants, and reaching relevant documents [5].	It needs value understanding. It "plays a fundamental role in all scientific studies of the cultural heritage and in conservation and restoration planning" [37].	Well-organized and visually appealing report that pinpoints precise information about the building and its value.
Diagnosis	Analyzing the potential capacity of the building and the potential values of that building [6] and determining new alternatives.	Both this and the previous phase are used to identify an appropriate function [7], ensuring community involvement [29].	Final decision-making [7], establishing principles for restoration, and determining the approach to reuse [20], typology [38], and active and passive reuse [39].
Intervention	Defining the degree of intervention [40].	Real action (execution of a prepared plan). It impacts the final quality of the project [7].	Execution of different modifications [41,42].
Monitoring (Control)	"Maintenance," "evaluation after years," and "post-occupancy evaluation" [7].	Regularly checking the condition to provide feedback on every structure [43]; new functions that respect the original nature of the building by adding "a contemporary layer that provides value for the future" [44].	Long-term preservation of a heritage building. Adapted to new conditions and requirements. Making interventions if needed and transferring values to the future [5].

3.4 Impact of Sustainability and Contribution to Area Regeneration

Adaptive reuse plays a crucial role in supporting environmental sustainability and urban regeneration. According to Baiz and Atakara (2020), this practice contributes to reduced construction waste, efficient resource use, and the preservation of a building's historical value. Other research emphasizes that the reuse of existing materials and energy savings in adaptive reuse directly support sustainable development principles (Smith, 2019; Chen, 2018).

Beyond environmental aspects, adaptive reuse contributes to area revitalization by reactivating previously unused buildings and public spaces. The transformation of former industrial or military buildings into residential areas, co-working spaces, or public facilities increases social, economic, and cultural activity in the surrounding area (Lee, 2020; Ahmed & Hassan, 2017). Thus, adaptive reuse serves as a mechanism for urban area regeneration that maintains historical identity.

The success of adaptive reuse in regional regeneration is also influenced by holistic planning and the involvement of local stakeholders. Integrating historical values, new functional needs, and community aspirations results in environmentally sustainable projects while providing long-term social and economic benefits (Kumar et al., 2021; Li & Wong, 2019).

In summary, the sustainability impacts of adaptive reuse can be categorized as follows:

1. Environment
   Adaptive reuse contributes to the environment by reducing construction waste, as old building materials and structures are reused. Furthermore, implementing energy-efficiency strategies, such as using natural lighting and ventilation systems, and maintaining existing materials, supports resource conservation and reduces carbon

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impact. Thus, adaptive reuse helps maintain environmental quality while preserving the historical character of buildings.

2. Social
Socially, adaptive reuse enhances community interaction and citizen involvement in the use of space. Buildings adapted as public spaces, community facilities, or creative centers facilitate social and cultural activities and enhance residents' sense of ownership of the surrounding area.

3. Economic/Regional
Economically, adaptive reuse supports regional revitalization by increasing property values and attracting investment. The presence of new uses, such as residential, coworking, or commercial facilities, stimulates local economic activity and enhances the overall attractiveness of urban areas.

Thus, adaptive reuse is not only a building preservation strategy but also an integrated mechanism for area regeneration, providing environmental, social, and economic benefits simultaneously. The following table summarizes the multi-dimensional impacts of adaptive reuse projects in the context of regional sustainability and regeneration:

Table 3. Impact of Adaptive Reuse Success on Case Studies and Literature Review

Project Name/Case Study	Original Function	New Function	Impact of Adaptive Reuse	Reference
Energy Museum, Sanatistanbul, Turki	Industrial Building 	Energy Museum 	**Cultural & Social:** Successfully transformed building value from utility to education. Maintained building identity (industrial history) with minimal intervention. Promoted urban area vitality and regeneration.	Hussein (2017)
Central Market, Kuala Lumpur	Wet Market 	Commercial Cultural Center (Arts Market) 	**Cultural & Economic:** Most prominent AR example in Malaysia. Successfully preserved historical buildings while providing economic *value-added*. Transformed a utility function into a center for handicrafts and culture promotion.	Mat Hasan et al. (2023)
Rumah Atsiri Indonesia, Karanganyar	Citronella Factory 	Esssential Oil, Education, Tourism, and Research 	**Functional & Spatial:** Successfully reconciled functional and spatial transformation. Revived a neglected building by retaining and repairing industrial building	Saika et al. (2025); Rakhmanty & Krisnawati (2020)

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Project Name/Case Study	Original Function	New Function	Impact of Adaptive Reuse	Reference
			elements for educational and tourism functions.	

4. Conclusion

Adaptive reuse has proven to be an effective strategy for integrating building preservation, environmental sustainability, and urban regeneration. By reusing existing structures and materials, adaptive reuse reduces construction waste, conserves energy, and preserves embodied energy, thus making a significant contribution to environmental sustainability.

The success of adaptive reuse implementation depends not only on architectural technical considerations but also on stakeholder engagement, structured process management, and the integration of a building's historical value with modern functional needs. Collaboration between architects, owners, government, and local communities is a key factor in achieving environmentally, socially, and economically sustainable projects.

Beyond its environmental impact, adaptive reuse plays a crucial role in urban regeneration by reactivating public spaces, strengthening community interactions, and encouraging new economic activity. The new functions given to adaptive buildings also preserve historical identity and strengthen community ties to their surroundings.

Thus, adaptive reuse is not simply a preservation strategy, but rather a multidimensional approach that connects cultural preservation, resource efficiency, and urban revitalization. This strategy offers a sustainable, holistic development model that can simultaneously deliver environmental, social, and economic benefits while strengthening the long-term quality of urban areas.

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