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Adaptive Reuse of Buildings for Sustainable Built Environment: A Bibliometric Analysis

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ABSTRACT

In recent years, adaptive reuse has attracted growing scholarly and practical interest owing to its potential to prolong the operational life of existing buildings, curb demolition-related waste, and reconcile heritage conservation with the broader aims of sustainable construction. Despite this rising interest, the body of knowledge on the subject remains dispersed: relevant contributions are distributed across conservation theory, circular-economy scholarship, urban regeneration studies, and environmental impact assessment, each approaching the topic from a distinct disciplinary vantage point and rarely engaging with one another. Such fragmentation complicates efforts to discern unifying principles or to determine where genuine scholarly consensus lies. The present study sets out to trace how research on adaptive reuse has developed over time, to identify the principal themes it addresses, and to assess its bearing on debates surrounding sustainable building practice. To this end, a bibliometric approach was applied to 468 English-language journal articles indexed in Scopus and published between 1996 and 2025, with the dataset extracted on 21 January 2026. The analysis paired performance-based indicators with science-mapping techniques: VOSviewer was employed to examine keyword co-occurrence, retaining terms that appeared at least ten times, while Bibliometrix and its Biblioshiny interface supported the tracing of thematic evolution and the execution of Multiple Correspondence Analysis. Findings indicate that publication output remained modest prior to 2010, rose gradually throughout the following decade, and accelerated markedly after 2020, producing a pronounced overall increase in scholarly output. Four principal thematic clusters emerged from the analysis, encompassing cultural-heritage protection alongside a discernible reorientation — from discourse centered on environmental protection toward a sharper emphasis on sustainability and circular systems. The study stops short of asserting that adaptive reuse directly alters built-environment practice; rather, it demonstrates that the concept is steadily gaining prominence in the literature as a means of linking cultural continuity with environmental performance, circular-economy principles, heritage preservation, and urban renewal.

Keywords: adaptive reuse, circular economy, cultural heritage, sustainable built environment, urban regeneration

1. Introduction

Today's cities are shaped not only by new construction and emerging design concepts but also by the accumulated stock of older structures, spaces, and cultural narratives built up over decades. Choices about whether to occupy, retrofit, demolish, or replace such structures form part of a wider conversation about sustainability within architecture and urban planning. Existing buildings embody the materials from which they were built, the labor invested in their construction, the memories accumulated within their spaces, and the cultural significance they carry [1][2]. Their demolition entails tangible environmental costs and severs a city's living link to its past.

Sustainability within the built environment is not confined to questions of energy use. Construction activity steadily draws down resources, generates pollution, produces waste, and reconfigures land use patterns [3], [4]. Sustainable architecture must therefore extend beyond the design of new, environmentally efficient buildings to encompass how cities maintain, adapt, and manage the structures they already possess. Adaptive reuse contributes to this broader agenda by lengthening building lifespans and accommodating new functions while preserving elements of original form and cultural meaning [5][6]. Within heritage conservation specifically, it performs a distinctive role: sustaining buildings as active, purposeful assets rather than consigning them to the status of untouched relics. The reuse of existing structures also supports the preservation of collective memory, place attachment, and community identity — an effect particularly evident in historic districts and former industrial areas [6][7].

Adaptive reuse nonetheless presents a range of practical difficulties, including financing constraints, regulatory obstacles, technical complexities, gentrification pressures, and the risk of heritage being commodified for commercial purposes. These challenges indicate that adaptive reuse cannot be reduced to a purely design-oriented question; it is equally a social, economic, and policy matter [2][7]. Recent scholarship has increasingly drawn adaptive reuse into closer dialogue with circular-economy thinking, given that the reuse of buildings conserves resources, extends the service life of materials, reduces demolition waste, and lessens demand for new construction inputs [8][9]. Circular-economy frameworks, however, tend to privilege quantifiable indicators — carbon reduction, material recovery, lifecycle performance — that do not necessarily capture cultural authenticity, collective memory, or social meaning. This produces a genuine tension between heritage-based values and the measurable logic underlying sustainability assessment.

Differing conceptions of sustainability transition help account for the persistence of this tension. Progress toward sustainability can be driven by multiple mechanisms, including technological innovation, regulatory change, shifting industry norms, or evolving social attitudes [25]. Viewed in this light, adaptive reuse is not merely a reaction to building obsolescence; it forms part of a broader transformation in how cities govern ageing building stock, regulate demolition, account for embodied carbon, and align heritage policy with low-carbon urban development goals. Notwithstanding its growing relevance, research in this area remains scattered and insufficiently consolidated, approached from a wide array of disciplinary directions spanning architecture, architectural history, construction management, environmental assessment, urban planning, and policy studies. Much existing work is case-specific or regionally bounded, concentrating on technical appraisal, stakeholder decision-making, financial feasibility, or governance arrangements. Although this diversity has clear value, it also obscures the identification of core concepts, landmark contributions, regional patterns, and the field's developmental trajectory.

These circumstances define the problem addressed in this article. Existing literature documents the advantages and difficulties associated with adaptive reuse but has yet to map clearly how heritage values, circular-economy principles, urban renewal, and sustainability transitions interrelate. Absent such an integrative perspective, adaptive reuse risks being understood too narrowly — either purely as a preservation instrument or purely as an environmental strategy — leaving unresolved the tensions among cultural value, financial rationale, decision-making processes, and observed environmental outcomes. This study accordingly pursues three guiding questions: (1) How has adaptive reuse been situated within discourse on the sustainable built environment? (2) What dominant themes and points of tension connect adaptive reuse with heritage

conservation, the circular economy, and urban renewal? (3) What theoretical and practical insights arise from treating adaptive reuse as a domain in which cultural continuity and environmental performance intersect?

This study is distinguished by its attempt to hold heritage values and sustainability imperatives together rather than treat them as separate concerns. Rather than presenting reuse simply as preferable to demolition, it interrogates the contradictions, emerging trends, and knowledge gaps that characterize the field — an undertaking of relevance to researchers, designers, planners, and policymakers seeking to develop reuse strategies that are environmentally sound, culturally grounded, and workable within existing institutional arrangements.

2. Method

2.1. Research design

This study employed bibliometric analysis to trace the structure and trajectory of adaptive reuse research within the broader field of sustainable built environment scholarship. This method was selected for its capacity to process large publication datasets and to reveal patterns that conventional narrative reviews often overlook [10], [11]. The analysis integrated performance analysis with science mapping. The performance component considered publication volume, national contributions, citation impact, and the most influential publications, while science mapping examined conceptual linkages through keyword co-occurrence, the evolution of themes over time, and factor analysis.

2.2. Data source and search strategy

The information about the books was gathered from the Scopus database on January 21, 2026. Scopus was selected because it covers a broad range of peer-reviewed journals in fields such as architecture, urban studies, environmental studies, construction, and sustainability research. Its export format is compatible with VOSviewer and Bibliometrix. This study used a single database approach to prevent duplicate entries and problem with citation information that might happen if data was combined from Scopus and Web of Science. However, not including other databases is a known limitation.

The search query was formulated to capture the intersection between adaptive reuse, the built environment, and sustainability. The final query was: TITLE-ABS-KEY ("adaptive reuse" OR "adaptive re-use" OR "adaptive re use" OR "building reuse" OR "reuse of buildings") AND TITLE-ABS-KEY ("built environment" OR architecture OR building) AND TITLE-ABS-KEY (sustainability OR sustainable) AND PUBYEAR < 2026 AND LIMIT-TO (SRCTYPE, "j") AND LIMIT-TO (PUBSTAGE, "final") AND LIMIT-TO (DOCTYPE, "ar") AND LIMIT-TO (LANGUAGE, "English").

The query was about words that are directly connected to adaptive reuse and reusing buildings. Wired terms such as “retrofitting”, “building rehabilitation”, and “heritage reuse” were not included in the main question because they could bring in the information about technical energy improvements, general conservation efforts, or heritage management that doesn’t involve using the building for its intended function. This decision improved precision, though it may have excluded some relevant work. The search returned 468 journal articles published between 1996 and 2025.

2.3. Data cleaning and analytical procedure

The exported dataset included titles, abstracts, author keywords, index keywords, authors, affiliations, cited references, publication years, sources, and citation counts. Records were screened to ensure that they matched the inclusion criteria. Duplicate checking was conducted using title, DOI, and publication year fields. Because the dataset was exported from a single database, duplicate records were limited. Keyword cleaning was conducted before network analysis by harmonizing variants such as “adaptive re-use” and “adaptive re use” under “adaptive reuse,” standardizing singular-plural variations, and excluding generic or geographically specific terms that did not support conceptual interpretation.

VOSviewer was used for keyword co-occurrence analysis [12]. The full counting method was applied so that each keyword occurrence was counted equally. A minimum keyword occurrence threshold of 10 was selected to balance analytical coverage and map readability. Lower thresholds produced a larger number of low-frequency terms and a less interpretable network, while higher thresholds reduced thematic diversity. With this threshold, 60 keywords from 2,597 identified keywords were included in the visualization.

Bibliometrix in R, through the Biblioshiny interface, was used for thematic evolution and Multiple Correspondence Analysis (MCA) [13]. The thematic evolution analysis divided the dataset into three periods: 1996-2011, 2012-2020, and 2021-2025. These periods were selected based on publication growth patterns and visible increases in research output. Thematic evolution was conducted using a maximum of 250 words and a minimum cluster frequency of 5. MCA was used to explore the conceptual proximity of keywords and to visualize the underlying structure of the field. The results are interpreted as bibliometric associations rather than direct evidence of practical causality.

3. Result and Discussion

3.1. Annual publication output

Each year, the number of publications is slowly going up, but not in a steady way, showing more research is being done on adaptive reuse in discussions about sustainable buildings. Figure 1 shows that there wasn't a lot of writing published between 1996 and the early 2000s, and in most years, there were fewer than five articles. A steady increase began to happen after 2010. This means that scholars started to pay more attention to adaptive reuse, especially because of its role in sustainability and the issues faced in the built environment.

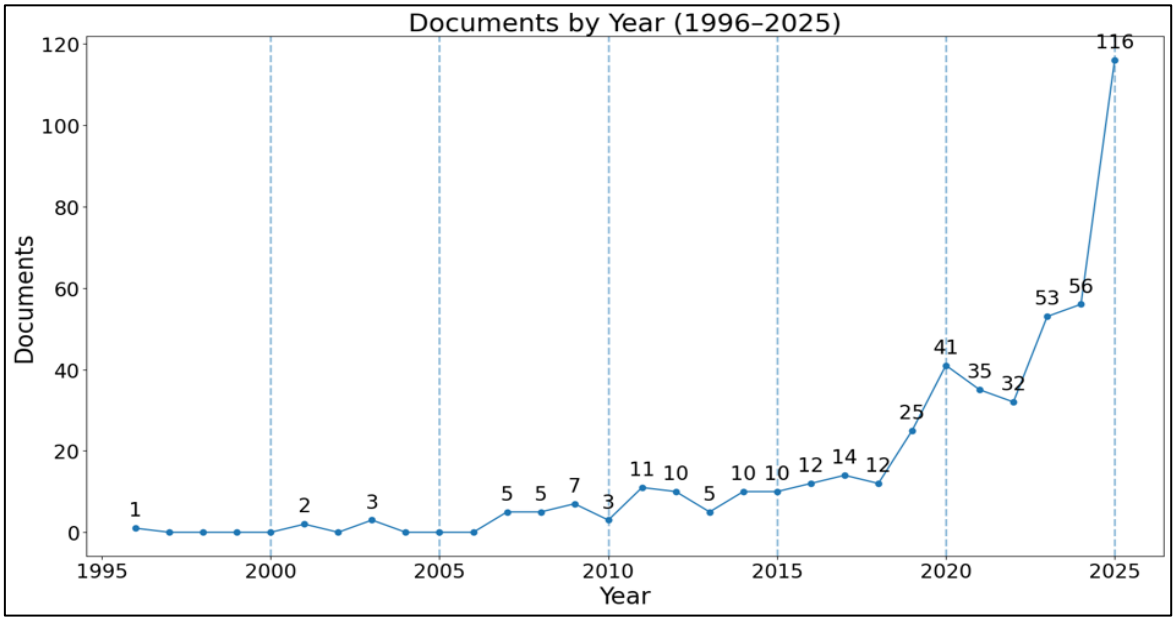

Figure 1 Annual publication output of adaptive reuse research, 1996-2025. Source: Scopus dataset analyzed by the authors.

After 2020, there's a clearer increase in the number of publications, going up from 41 in 2020 to 116 in 2025. This growth shows that more scholars are focusing on these topics during a time when discussions about the circular economy, lo carbon development, and embodied carbon became more frequent in research related to the built environment. However, because the 2025 indexing record could still change after the extraction date, the latest annual number should be used carefully and not considered as the final result.

3.2. Country publication output

When looking at the country level, research on adaptive reuse is found in different regions, but the amount of work done and how much it is cited vary a lot from one place to another. Table 1 list the top ten countries that

are most productive, based on where the main authors in the dataset are from.

Table 1 Top 10 most productive countries.

Country	Continent	Freq.	TC	AAC
Italy	Europe	56	1400	25.00
Australia	Oceania	37	2099	45.73
China	Asia	35	517	14.77
Turkey	Asia	33	600	18.18
United States	America	33	591	17.91
Malaysia	Asia	26	132	5.08
United Kingdom	Europe	25	409	16.36
Hong kong	Asia	24	1423	59.29
Poland	Europe	23	183	7.96
Egypt	Africa	21	340	16.19

Italy had the highest number of publications, followed by Australia, China, Turkey, and United States. When looking at how much influences articles have, Australia and Hong Kong had the highest average number of citations among the listed countries. This means that the amount of papers published and how often they are referenced do not always go up at the same time. This also means that some places with not many publications could still get a lot of global attention. This likely reflects either a concentration of highly cited research or close alignment with sustainability agendas and policy discourse.

3.3. Most cited publications

The most frequently cited works point to the core sources shaping scholarship on adaptive reuse. As shown in Table 2, these papers span themes including circular economy, decision-making frameworks, heritage conservation, and sustainable urban development.

Table 2 Top 10 most cited publications.

Rank	Publication Focus	TC	TC/year.	NTC
1	Foster (2020), circular economy strategies for adaptive reuse of cultural heritage buildings	451	64.43	12.64
2	Yung and Chan (2012), implementation challenges to adaptive reuse of heritage buildings	358	23.87	6.52
3	Langston et al. (2008), strategic assessment of building adaptive reuse opportunities	331	17.42	4.15
4	Bullen and Love (2011), adaptive reuse of heritage buildings	326	20.38	5.59
5	Bullen (2007), adaptive reuse and sustainability of commercial buildings	305	15.25	3.72
6	Brown and Buranakarn (2003), emergy indices and sustainable material cycles	301	12.54	2.43
7	Mısırlısoy and Günçe (2016), adaptive reuse strategies for heritage buildings	287	26.09	6.18
8	Bullen and Love (2010), adaptive reuse or demolition in practice	249	14.65	2.90
9	Gravagnuolo et al. (2019), circular economy strategies in historic port cities	188	23.50	4.43
10	Steinberg (1996), conservation and rehabilitation of urban heritage	183	5.90	1.00

Foster [8] leads in citation frequency, owing to its direct engagement with the intersection of cultural heritage building reuse and circular economy strategies. Yung and Chan [7] and Langston et al. [14] are also important because they discuss the difficulties of putting ideas into action and the structured methods for assessing things. Bullen [5], Bullen and Love [6], [17], Brown and Buranakarn [15], Misirlisoy and Gunce [16], Gravagnuolo

et al. [9], and Steinberg [18] says that the field has been shaped by arguments about the environment, efforts to save heritage, challenges with feasibility, and work on improving urban areas.

3.4. Keyword co-occurrence network

The analysis of keywords appearing together was carried out using 60 keywords that met the minimum requirement for how many times they showed up. Figure 2 shows the update VOSviewer network visualization, and Table 3 outlines the four main themes identified in the network.

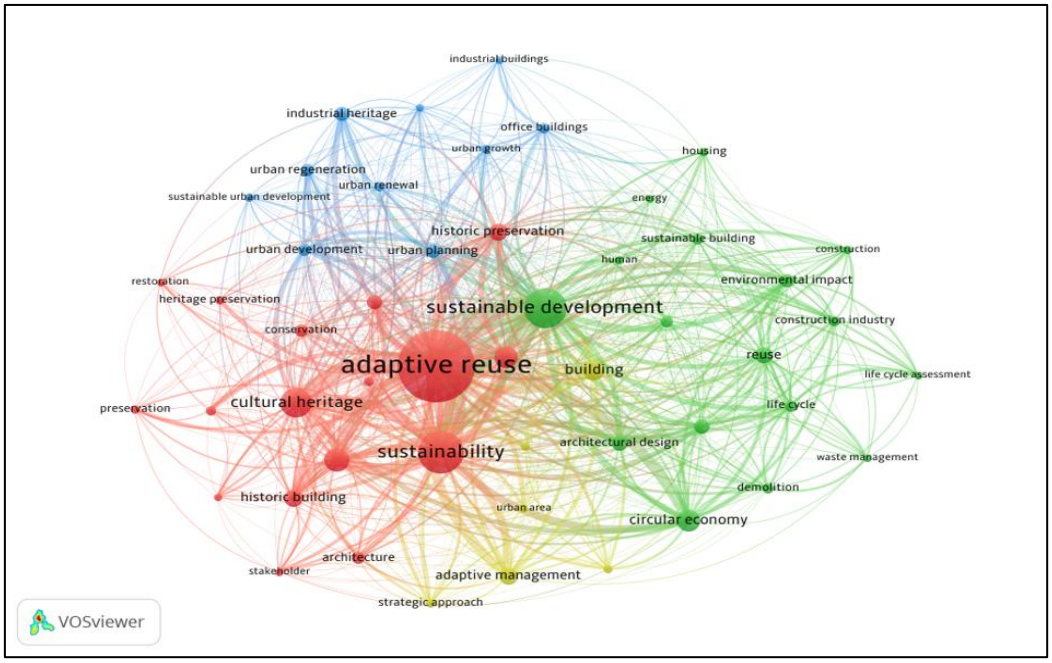

Figure 2 Co-occurrence network analysis of keywords. Source: VOSviewer.

Table 3 Thematic clusters and keyword co-occurrence analysis.

Cluster	Representative Keywords	Interpretation
Cultural Heritage Conservation	adaptive reuse (246; TLS 650); sustainability (115; TLS 423); cultural heritage (68; TLS 254); heritage conservation (50; TLS 207); decision making (45; TLS 214)	Heritage-oriented foundation of the field, linking reuse with conservation, preservation, and decision-making concerns
Sustainable Construction Lifecycle	sustainable development (104; TLS 455); circular economy (45; TLS 203); reuse (30; TLS 129); recycling (26; TLS 133); environmental impact (22; TLS 125); life cycle (19; TLS 118)	Technical and environmental orientation concerned with resource efficiency, demolition reduction, life-cycle thinking, and material circularity [19], [20].
Urban Planning And Regeneration	industrial heritage (25; TLS 94); urban planning (23; TLS 116); urban development (21; TLS 111); urban regeneration (21; TLS 70); urban renewal (15; TLS 70)	Urban transformation orientation, especially in post-industrial and historically layered contexts [21], [22], [23].
Strategic Adaptive Management	building (40; TLS 191); adaptive management (31; TLS 148); built environment (13; TLS 63); climate change (13; TLS 58); strategic approach (13; TLS 72)	Governance and management orientation that links adaptive reuse with strategic planning, climate response, and institutional decision making [24].

The red cluster is working on “adaptive reuse”, which comes up the most and has the strongest link in the network. This means that adaptive reuse is the term that appears most often in the dataset. The strong

connection to sustainability, cultural heritage, heritage preservation, and decision-making show that the field remains focused on heritage issues but it also starting to take part more in evaluating and managing sustainability.

The green cluster addresses more technical dimensions of the field — sustainable development, circular economy, recycling, environmental impact, energy efficiency, life cycle assessment, and waste management. This suggests that adaptive reuse is increasingly framed through the lens of resource efficiency and building longevity. That said, the network does not demonstrate that adaptive reuse has achieved circular performance in practice; it reflects growing conceptual alignment in the literature, not verified operational outcomes.

The blue cluster links adaptive reuse to industrial heritage, urban planning, urban development, urban regeneration, and urban renewal, indicating that reuse logic extends beyond individual buildings to inform broader processes of urban transformation. A smaller yellow cluster incorporates strategic adaptive management, climate change, and built-environment challenges. Collectively, these clusters depict a field situated at the intersection of heritage values, environmental performance, urban renewal, and governance.

3.5. Overlay visualization and thematic evolution

Figure 3 presents a keyword map organised by average publication year, revealing a discernible shift in research emphasis over time. Earlier scholarship concentrated on conservation, urban improvement, and the protection of significant sites, whereas more recent work has shifted toward resource efficiency, environmental-impact reduction, and longer-term planetary considerations — reflecting a broader reorientation of the field toward sustainability imperatives.

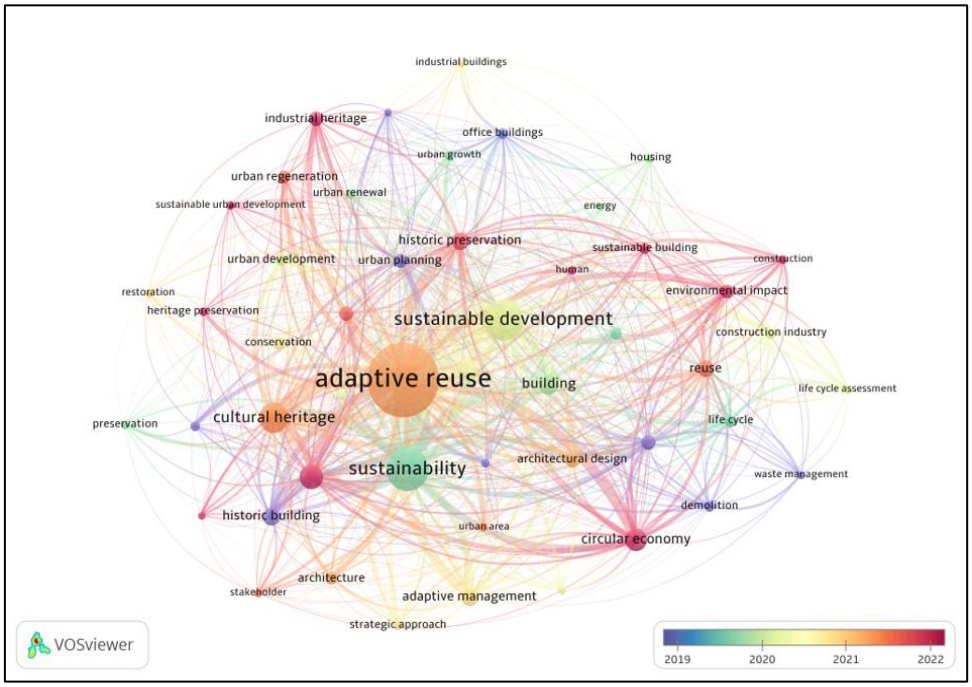

Figure 3 Overlay visualization of keywords based on average publication year. Source: VOSviewer.

Figure 4 traces thematic development across three periods: 1996–2011, 2012–2020, and 2021–2025. In the earliest phase, adaptive reuse emerged alongside sustainability, recycling, demolition, and urban planning as loosely related concerns. Between 2012 and 2020, sustainable development gained greater prominence, and adaptive reuse became more explicitly connected to decision-making processes. From 2021 to 2025, the concept moved closer to the center of sustainable-development and sustainability-governance discourse.

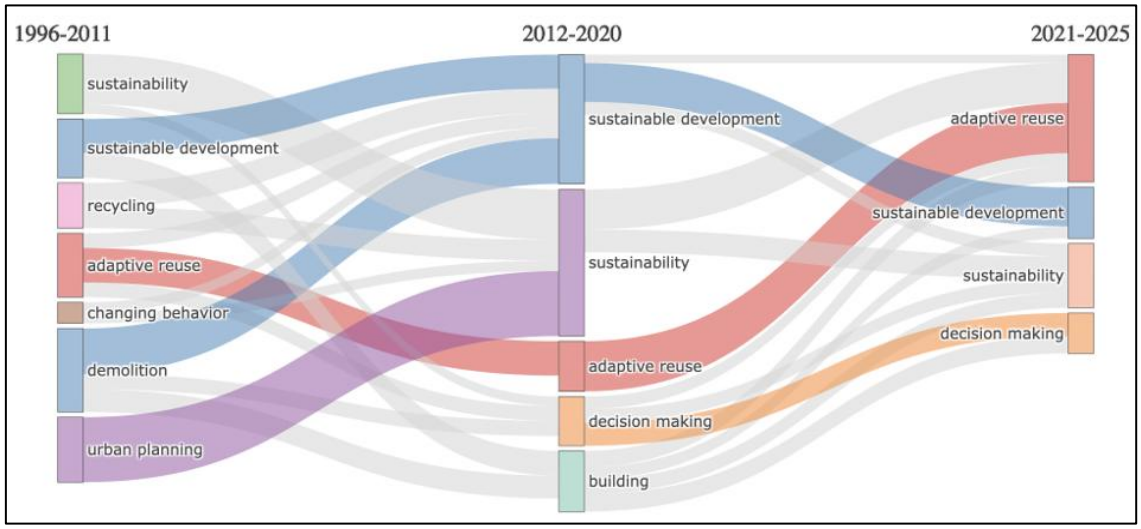

Figure 4. Thematic evolution of adaptive reuse research, 1996-2025. Source: Bibliometrix.

This progression should be interpreted as a shift in how scholars frame and connect ideas rather than as evidence that theory or practice has been fundamentally transformed. The findings also point to a gap: adaptive reuse research has yet to adequately examine whether these conceptual linkages translate into tangible project outcomes.

3.6. Factorial analysis

Multiple Correspondence Analysis (MCA) was applied to assess the degree of association among keywords. Figure 5 presents a two-dimensional map accounting for 23.5% of total variance, comprising 15.92% along the first dimension and 7.65% along the second. The map reveals several distinct conceptual groupings rather than a single dominant theoretical cluster.

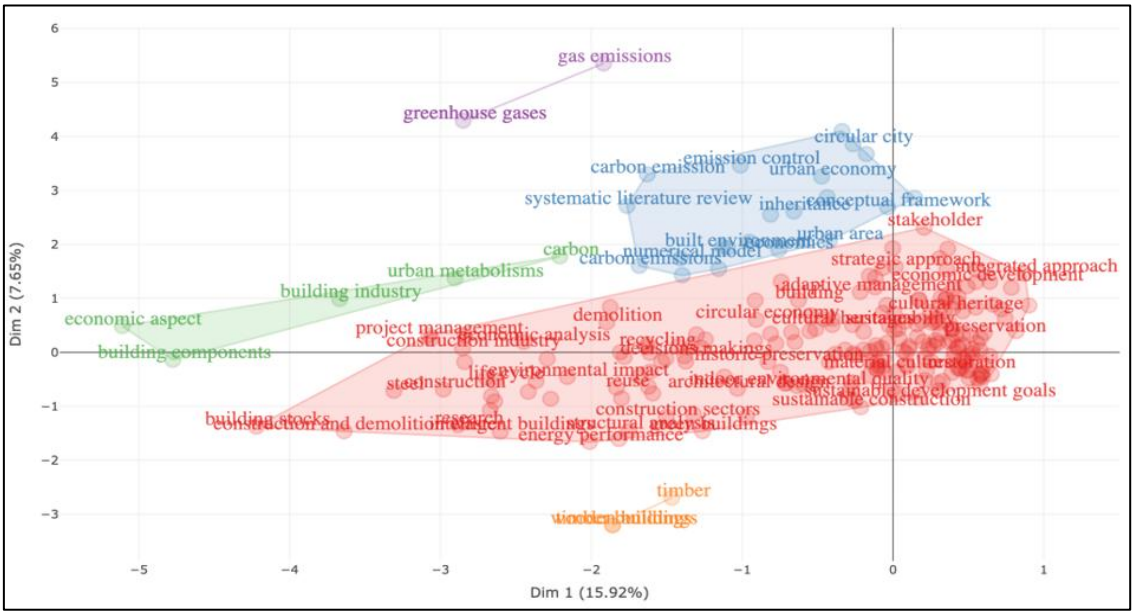

Figure 5 Factorial analysis of keywords based on Multiple Correspondence Analysis. Source: Bibliometrix.

The central grouping brings together adaptive reuse, sustainability, cultural heritage, circular economy, decision-making, and preservation, confirming that adaptive reuse occupies the conceptual space where heritage conservation and sustainability discourse converge. Other groupings are more specialised: terms such

as carbon emissions, greenhouse gases, urban economy, and circular cities form a coherent environmental cluster, while terms such as building industry, building components, and urban metabolism reflect a broader concern with how structures are produced and how construction systems function. Materials-related terms such as timber and timber construction appear toward the periphery of the map, suggesting relatively limited uptake within the literature.

These MCA results indicate that adaptive reuse is gaining discursive prominence while also revealing underlying fragmentation. Topics such as carbon accounting, urban metabolism, construction-industry analysis, and heritage preservation have yet to cohere around a unified framework, pointing to substantial opportunity for future research to integrate cultural interpretation, environmental-impact measurement, regulatory analysis, and financial feasibility assessment more closely.

3.7. Synthesis, implications, and limitations

Taken together, the findings suggest that research on adaptive reuse has shifted from a predominantly preservation-oriented focus toward sustained engagement with sustainability concerns. Highly cited works and dominant keyword clusters confirm that circular-economy thinking, lifecycle assessment, and environmental impact now occupy a central position within the field. This does not imply that adaptive reuse has supplanted other sustainability strategies, nor that reuse invariably represents the optimal environmental choice; rather, it indicates that a growing body of scholarship treats adaptive reuse as a substantive response to demolition waste, material loss, heritage preservation, and urban improvement.

The findings also reveal a productive but unresolved tension. Heritage conservation is oriented toward cultural value, authenticity, memory, and historical continuity, whereas circular-economy and lifecycle frameworks prioritise functional performance, material efficiency, carbon reduction, and closed-loop resource systems. Adaptive reuse occupies the space between these orientations, and its value lies precisely in its capacity to bridge them — though that bridging function warrants careful scrutiny. A reuse rationale grounded solely in carbon metrics risks subordinating cultural significance, while one justified purely on heritage grounds may yield environmental claims lacking empirical rigour.

These findings carry practical implications for multiple audiences. Architects may approach adaptive reuse not as a stylistic preference but as a process grounded in existing spatial, structural, and cultural conditions. Urban planners can align reuse strategies with regeneration policy, particularly within post-industrial and historically significant areas. Policymakers can support adaptive reuse through incentive mechanisms, regulatory flexibility, mandatory embodied-carbon monitoring, and heritage-sensitive development guidelines. Sustainability practitioners can strengthen reuse projects by incorporating carbon-footprint analysis, whole-lifecycle assessment, and social-impact evaluation.

Several limitations merit acknowledgement. First, the dataset is confined to English-language journal articles indexed in Scopus, which ensures methodological consistency but excludes material from other databases, regional journals, conference proceedings, books, and professional reports. Second, citation counts are subject to temporal bias, tending to favour older publications and internationally prominent journals. Third, indexing coverage for 2025 may remain incomplete at the point of data extraction, given that recent records are often added with a delay. Fourth, the structure of keyword networks is sensitive to the parameters applied during preparation; different thresholds, or the inclusion of broader terms such as retrofitting, rehabilitation, or heritage reuse, could produce a meaningfully different map. Finally, keyword co-occurrence analysis, thematic evolution mapping, and MCA illuminate how ideas are connected within the literature but do not measure the extent to which these ideas have been implemented in practice, adopted in policy, or reflected in the actual environmental performance of built projects. Future research should combine bibliometric mapping with in-depth case studies, embodied-carbon assessment, policy analysis, and closer examination of social dimensions such as displacement, gentrification, and the commodification of heritage.

4. Conclusion

This study demonstrates that research on adaptive reuse has evolved from a fragmented discourse centered on heritage conservation and building modification toward a broader field engaged with sustainable development, circular-economy principles, lifecycle thinking, and urban regeneration. The bibliometric findings indicate that adaptive reuse is no longer understood merely as the repair or repurposing of obsolete structures; it is increasingly recognised as a strategy for extending building lifespans, reducing material waste, preserving cultural continuity, and supporting more resource-conscious urban growth. The marked rise in publications since 2020 reflects the field's growing centrality within sustainable-built-environment scholarship.

The principal contribution of this study lies in offering a clearer account of how research on adaptive reuse is structured. The findings reveal a field shaped by the convergence of several distinct domains — cultural-heritage protection, sustainable construction, urban planning and regeneration, and long-term adaptive governance — signaling that adaptive reuse cannot be reduced to technical modifications of building fabric. Rather, it positions existing buildings as carriers of cultural, environmental, and urban value. The future trajectory of sustainable architecture may therefore depend not only on how new buildings are designed but on how existing structures are maintained, adapted, and aligned with evolving social and environmental conditions.

These findings should be considered alongside the study's limitations. The dataset is confined to English-language journal articles indexed in Scopus, and coverage through 2025 may be incomplete owing to indexing delays. Bibliometric analysis can chart publication patterns, keyword associations, and thematic clusters, but it cannot evaluate how effectively particular adaptive reuse strategies perform in practice. Future research should combine bibliometric mapping with systematic literature reviews, comparative regional studies, embodied-carbon assessment, and policy-focused analysis — directions that are essential to distinguishing adaptive reuse as a compelling theoretical position from adaptive reuse as a locally grounded, culturally responsive, and implementable practice.

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6. Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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