

Systematic Review

Adaptive Reuse of Urban Structures as a Driver of Sustainable Development Goals: A Systematic Literature Review

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Abstract: The adaptive reuse of urban structures is gaining significant attention due to its multiple benefits for sustainable urban development. Current research on repurposing initiatives provides valuable insights that can guide these practices from a research-based perspective. This paper aims to systematically review the existing literature on the adaptive reuse of buildings to develop a framework that outlines studies and findings on how repurposing practices contribute to specific sustainable development goals and their targets. The systematic literature review focuses on research published from 2018 to the end of 2024, serving as the foundation for this framework. The findings indicate that repurposing projects can make direct contributions to nine sustainable development goals. The strongest impacts were identified in relation to goals 4, 11, and 17. For goal 4, repurposing projects serve as valuable case studies, demonstrating how existing architecture can function as an asset that benefits urban sustainability. Concerning goal 11, the literature emphasises the importance of inclusivity in decision making throughout various stages of adaptive reuse and highlights the protection of unique architectural features as a strategy to enhance social capital and provide cultural and economic improvements. Adaptive reuse supports goal 17 by fostering public–private partnerships and encouraging transparent policy communication, which aids the development of new policies focused on sustainability. The results can assist urban planners, architects, and developers in making research-based decisions regarding underutilised buildings in urban contexts.



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1. Introduction

In recent years, adaptive reuse (AR) of buildings has received growing interest in practice and academic research as the process progresses cities towards sustainable development [1]. AR is defined as ‘any work and intervention in a building to change its capacity, function, or performance to adjust, reuse or upgrade a building to suit new conditions and requirements’ [1], p. 1. An initial analysis of the current literature on AR revealed the contribution of this process to multiple sustainable development goals (SDGs) from social, economic, environmental, and cultural perspectives [2,3]. The broad impact of repurposing practices on urban sustainability arises from the opportunity that AR encompasses not only cultural heritage buildings that carry recognised historical legacy and value, but also structures

that are at various stages of vacancy due to urban transformations [4]. Examples include industrial architecture and multi-storey parking garages [5]. Many of these urban structures offer considerable potential for new uses, since they are often subject to less restrictive policies and conservation guidelines than historic buildings. Urban transformation requires new specialisations for different underused architectural typologies to progress the SDGs. In this process, research-driven decision making on the future of vacant urban structures can contribute to the development of sustainable urban form.

Urban change is a continuous process [6]. Understanding and reflecting on the evolving nature of cities is crucial to managing sustainable and resilient urban growth [7]. Sustainability in urban settings is concerned with improving human well-being and quality of life while protecting the natural systems that support this quality of life. A critical goal of urban sustainability is to maintain the functional integrity of cities, ensuring that they can thrive and meet the needs of their inhabitants [8]. This complex objective requires actions that transform the world towards a more just and peaceful future. In 2015, the international community adopted the 2030 Agenda for Sustainable Development, which comprises 17 SDGs and 169 targets to balance social, economic, and environmental sustainable development [9]. Agenda 2030 concerns interrelated issues such as environmental degradation, gender equity, health, poverty, and hunger that require global effort [10]. The SDGs represent general reference points for sustainable development progress; however, addressing the goals must transform existing institutional structures at multiple levels, including business, academia, and civil society. Past global governance relied mainly on market-based approaches and top-down regulation. Together with the definition of the SDGs, a new approach to governance was introduced, which is primarily dependent on the setting of goals [11]. Transformation to ‘governance through goals’ shifts from rule-based governance to goal setting that engages stakeholders at various decision-making levels to implement the SDGs and their targets. Weiland et al. noted that a radical change in society’s thinking is necessary to progress the SDGs [10]. This particularly includes actors making decisions on the quality of urban life [12], as cities represent the largest source of carbon dioxide, the largest energy consumers [13], and spaces that affect residents’ well-being [14]. Research-based evidence on strategies that can deliver the SDGs in cities is critical for goal-setting governance [11].

A comprehensive understanding of the contribution of the AR process to the SDGs can improve decisions about the future of underused architecture. Repurposing vacant urban structures can generate financial and nonfinancial benefits [15]. However, comparing the performance of repurposed buildings with that of newly constructed and demolished buildings is complex due to significant differences in technology and design solutions. Most decisions on the future of underused buildings are based on incomplete data or knowledge for value assessment [16]. Stakeholders often view demolition and new construction from a project-based approach, as a method to directly meet the current market demand for modern spaces, focusing primarily on financial profits [17]. An initial review of academic sources indicated that the current literature adequately examines the contribution of AR to the SDG framework. However, no comprehensive studies have presented a systematic review of the literature on this timely research topic. Therefore, this paper aims to systematically examine the current literature on AR of buildings to develop a framework of research studies that provide data on the direct contribution of repurposing practices to specific SDGs and their targets. The findings of this study can be applied by decision makers, urban planners, architects, developers, and the community to make research-based decisions about underused or obsolete buildings in an urban context.

1.1. Adaptive Reuse

Buildings are demolished when they no longer hold value, which is typically determined by the market. In high-density urban areas where land is scarce, demolition followed by new development is often regarded as the best strategy for creating quality architecture with significant market value [17]. Evaluating and comparing the social, environmental, and economic performance of repurposed structures versus new ones is challenging due to the substantial differences in space and technological solutions [14]. From the stakeholders' perspective, demolition and new construction are seen as a more straightforward approach, effectively addressing environmental sustainability and the market demand for modern spaces [13]. Recent research shows that AR provides a sustainable alternative to both demolition and new construction. This approach transcends traditional renovation by transforming the social, economic, and environmental impacts of buildings [4]. Thus, it is essential to develop research-based evidence to guide informed decisions regarding the future of vacant buildings.

Repurposing existing structures offers significant environmental, economic, and social benefits that contribute to urban sustainability. From an environmental perspective, AR is recognised as the most sustainable method of developing and using a building [18]. According to Sanchez and Haas [19], key principles of circular building include product recovery management, design for disassembly, sequence planning, life cycle assessment, adaptability, closed material loops, deconstruction, and dematerialisation. In light of these principles, shifting from demolition and new construction to AR fosters urban environmental sustainability. The benefits of this approach include lower material, energy, and transport demands. A growing body of literature highlights that repurposing a structure is often more cost-effective than demolition and new construction. Douglas [1] noted that utilising existing infrastructure reduces overall construction time, resulting in minimised financial expenses. Repurposing buildings carries significant historical, cultural, and architectural value, enhancing the social profitability of the urban area. The continuity of the urban fabric is crucial in shaping the attitudes and behaviours of both the local community and visitors [20,21]. AR helps preserve the character of streetscapes, thereby providing psychological reassurance to urban residents [13,17,22,23]. The practice can serve as an effective tool in social planning for underutilised districts [17,24], by restoring informal social control and enhancing the perception of neighbourhood safety, ultimately fostering community cohesion [25–27]. Given the social, economic, and environmental benefits of AR, it is crucial to systematically evaluate the current literature to define the framework of research studies that provide data on the direct contribution of repurposing practices to specific SDGs and their targets. The summary of current data can be used by architects, urban planners, developers, and the community to progress research-informed AR of underused buildings in rapidly growing cities.

1.2. Systematic Approaches to Adaptive Reuse as a Research-Based Practice That Advances Sustainable Development Goals in Cities

A research-based approach to architectural design is critical for a sustainable urban future [28]. Looking at design from a research-based perspective bridges the gap between research and practice by exploring the possibilities for their integration to enhance the understanding of the design process and deliver the required effects [29]. Shifting from project-based to research-based practice empowers stakeholders to lead projects towards value-driven outcomes and opens opportunities for architects to combine creative thinking and strategic decision making, leading to the achievement of defined project objectives [30]. Based on recent knowledge and creative competencies, the AR process can enhance the 'governance through goals' approach, thus improving the implementation of the SDGs and

their targets. From a management perspective, a research-based approach is crucial for developing decision-making guidance that supports urban innovation [31], including AR processes [32]. The innovation design approach to repurposing practices can further address urban sustainability objectives, as the process can progress a shift in society's thinking [33] needed to implement the SDGs [10]. Innovation design is the process that connects society, technology, and science through products, transforming existing conditions into preferred ones [31]. Hobday et al. advocate for transitioning theoretical research on innovation to practical applications where design leads the implementation of innovation [34]. Biermann et al. highlighted the role of academic support in integrating the social, economic, and environmental pillars of the SDGs in different agendas [11]. As such, this study presents a systematic review of research evidence on recent methods and case studies of AR of vacant buildings that advance the integration of the SDGs and their targets in cities.

Two recent studies have been identified that have proposed frameworks based on systematic reviews of current research evidence to advance the integration of research data and practice on the relationship between AR and urban sustainability. Armstrong et al. conducted a systematic review of the literature to analyse the approach to building vacancies as a starting point for sustainable AR practice [4]. The study indicated that obsolescence has not yet been examined efficiently, while considering various stages of vacancy in an urban structure can produce different AR solutions. The developed framework for sustainable AR of buildings integrates vacancy within decision making by proposing alternatives to approach the repurposing process, including AR for a mix of uses, temporary AR, or selective demolition [4]. In a study by Arfa, Zijlstra, et al., a systematic review of publications addressed AR phases and developed a "10 step" model for the repurposing process of historic buildings [35]. Within the four strategic phases, including pre-project, preparation, implementation, and post-completion phase, the logical line of steps defines the procedure which should be followed to conduct AR of heritage buildings that improve the qualities of cities and societies. Taken together, these studies contribute to the development of a research-based approach to AR within the sustainable development framework. However, the systematic literature reviews presented are not directly focused on repurposing practice as a driver of the SDGs, but rather a procedure that can trigger improvements in urban sustainability in general. The present study aims to address that gap by conducting a systematic review of the literature on AR of buildings to develop a framework of research studies that provide data on the contribution of repurposing practices to specific SDGs and their targets. The aim of the paper supports the 'governance through goals' approach to the progress of the SDGs by providing research evidence to practitioners.

2. Materials and Methods

This research consisted of four steps. First, based on the initial literature review, the following research question was formulated for the systematic review: How does AR of urban structures contribute to the achievement of the SDGs? Second, the relevant literature was searched using the Preferred Reporting Items for Systematic Reviews (PRISMA) [36]. Then, a systematic review of the literature was conducted to respond to the research question. Finally, a conceptual model of the contribution of AR to the achievement of the SDGs was proposed. The primary analysis of the literature indicated that there is no current overview of studies that evaluate the contribution of AR of urban structures to the progress of the SDGs. As new AR practices arise in cities, this paper aims to systematically review recent studies evaluating the repurposing process within the framework of sustainable development.

2.1. Systematic Literature Review

A systematic review uses unequivocal systematic methods to juxtapose and synthesise the results of research studies that address the formulated research question [37]. The systematic review presented in this paper aims to offer a current summary of research evidence on the role of the AR of buildings in meeting the SDGs that are crucial for our resilient future. The findings can be applied by decision makers, urban planners, architects, and developers when deciding on underused or obsolete buildings in an urban context.

A systematic literature review was conducted following the Preferred Reporting Items for Systematic Reviews (PRISMA) [36,37] to identify studies that discuss the AR process within the framework of the SDGs. The search strategy focused on identifying research papers published in peer-reviewed journals and books in English from 2018 to the end of 2024. This time limitation was defined to analyse contemporary additions to the literature that present data on AR interventions in the sustainability domain. The considered types of studies included descriptive studies, systematic reviews, survey and interview studies, meta-analysis, and single and multiple case studies. The sources searched included Scopus, Web of Science, and Science Direct. These databases were selected because they could contribute to the literature search and analysis of bibliographic information. Keywords included 'Adaptive Reuse' OR 'Adaptive Re-use' AND 'Buildings' OR 'Architecture' AND 'Sustainable Development Goals' OR 'Sustainable Development Goals Framework'. These keywords were strategically selected to conduct the study from an architectural perspective and do not exclude buildings that are not acknowledged as architectural heritage. The aim of the paper narrows down the systematic review to architecture and buildings; thus, the studies focused on other repurposing practices, such as urban design, landscape, or civil structures, were excluded from the review.

Based on the defined strategy, an objective search identified 125 research papers. All studies were analysed using a close reading technique. In total, 14 records were removed due to duplication and seven due to reuse of the same dataset. In addition, 13 journal articles whose full versions could not be accessed by the research team were excluded from the review. This accessibility criterion reduced the number of sources; however, it was necessary for a complete understanding of the study and data collection. Three records could not be retrieved from the journal website due to an error in downloading. In the initial literature screening process, full-text papers were rejected if they did not include architecture as the subject of the AR process, due to the architectural focus of the research question defined in this paper. One paper presented a student research project with unreliable methodology, leading to the exclusion of this record from the review. Five papers were excluded because of the focus on modernisation instead of AR. Finally, 75 research papers were included in the review. The list of sources for the systematic review is presented in Table 1.

Four researchers conducted the initial article selection process, which followed the identical protocol to develop reproducible search results. A thorough, objective, and reproducible search within three databases aimed to minimise the risk of bias due to missing evidence. The researchers assessed the quality of selected studies through a close reading technique, using identical eligibility criteria, including viability of research aims, methodology, and results. A single failed eligibility criterion was considered sufficient for a study to be excluded from a review. The PRISMA model for the literature search is presented in Figure 1.

Table 1. The list of sources for the systematic review.

Author(s) (Year)	Reference	Addressed SDG(s)	Addressed Target(s)	Methods
Aigwi et al. (2019)	[38]	4, 11, 16, 17	4.7, 11.4, 11.7, 16.7, 17.17	Performance-based MCDA methodology
Amro & Ammar (2024)	[24]	8, 10, 11	8.9, 10.2, 11.3	Case study
Amro et al. (2023)	[39]	4, 7, 10, 11, 16, 17	4.7, 7.2, 10.2, 11.3, 16.7, 17.17	Case study analysed using the Quintuple Helix Model
Arbab & Alborzi (2022)	[3]	11, 12	11.6, 12.5	Literature review, case study
Armstrong et al. (2023)	[4]	7, 10, 11, 17	7.2, 10.2, 11.3, 17.14	Systematic literature review
Aydemir & Akın (2024)	[40]	4, 11	4.7, 11.6	Analysis of the outcomes of a fourth-year architectural design studio
Bianchi & De Medici (2023)	[41]	10, 11	10.2, 11.3	Literature review, case study
Bosone et al. (2021)	[42]	11, 12	11.6, 11.7, 12.5	Literature review
Çelebi Karakök & Ertaş Beşir (2023)	[43]	8, 11	8.9, 11.4	SWOT analysis
Cerreta et al. (2020)	[44]	10, 11, 16, 17	10.2, 11.3, 11.7, 16.7, 17.17	A case study analysed using the Living Lab approach
Cinquepalmi et al. (2023)	[45]	10, 11, 12	10.2, 11.3, 11.6, 12.5	Document analysis, case study
Collins & Overbey (2020)	[46]	4, 11, 12	4.7, 11.6, 12.5	Case study
Dabbene et al. (2024)	[47]	11, 16, 17	11.4, 11.7, 16.7, 17.17	Literature review Case study
De Gregorio et al. (2020)	[25]	8, 10, 11, 12	8.5, 10.2, 11.3, 11.6, 11.7, 12.5	Case study
Dell’Ovo et al. (2021)	[48]	4, 10, 11, 16, 17	4.7, 10.2, 11.3, 16.7, 17.17	Multi-criteria decision-making methods, case study
Della Spina et al. (2023)	[49]	4, 11, 12, 16	4.7, 11.4, 11.6, 12.5	A’WOT multi-methodological approach based on the combined use of a SWOT analysis and an AHP multi-criteria analysis
Della Spina (2020)	[50]	4, 10, 11, 16, 17	4.7, 10.2, 11.3, 16.7, 17.17	Multi-criteria evaluation
De Medici et al. (2019)	[51]	11	11.4, 11.6	Case study
Dişli & Ankaralıgil (2023)	[52]	11, 12	11.4, 11.6, 12.5	Qualitative analysis, literature review, case study
Djebbour & Biara (2019)	[53]	11, 17	11.4, 17.14, 17.17	Case study, comparative assessment of AR projects, semi-structured interviews
Djebbour & Biara (2020)	[54]	10, 11	10.2, 11.3, 11.4, 11.7	Semi-structured interviews, historical document analysis
Du & Wang (2024)	[55]	11	11.6	Visual methods, case study
El-Belkasy & Wahieb (2022)	[26]	10, 11	10.2, 11.3	Case study, survey research

Table 1. Cont.

Author(s) (Year)	Reference	Addressed SDG(s)	Addressed Target(s)	Methods
Fava (2024a)	[56]	11, 16,	11.3, 16.7	Literature review
Fava (2024b)	[57]	10, 11, 17	10.2, 11.7, 17.17	Survey study, case study
Fedorczak-Cisak et al. (2020)	[58]	4, 11	4.7, 11.4	WINGS method modified by the fuzzy extension
Foster (2020)	[59]	11, 12	11.6, 12.5	Systematic literature review
Gaballo et al. (2021)	[60]	11, 12, 17	11.6, 12. 5, 17.14	Documentation review
Giuliani et al. (2020)	[61]	10, 11, 16, 17	10.2, 11.3, 16.7, 17.17	Multilevel site analysis, multi-attribute decision-making analysis
Gravagnuolo et al. (2021)	[62]	4, 10, 11, 12	4.7, 10.2, 11.3, 11.4, 11.6, 12.5	Action research: empirical experimentation Heritage mapping Survey research
Hanapi et al. (2022)	[63]	8, 11, 12	8.9, 11.6, 12.5	Analytical comparative study, case study
He et al. (2022)	[64]	8, 11	8.9, 11.4	Case study, field study, semi-structured interviews
Hein et al. (2023)	[65]	8, 11, 12	8.5, 8.9, 11.4, 11.6, 11.7, 12.5	Case study
Iodice et al. (2020)	[66]	8, 11	8.5, 8.9, 11.4	Spatial analysis (GIS), case study
Khalil et al. (2018)	[67]	7, 8, 10, 11, 12	7.2, 9.8, 10.2, 11.3, 11.6, 11.7, 12.5	Case study, digital simulations
Lami et al. (2023)	[68]	4, 11, 16, 17	4.7, 11.4, 16.7, 17.17	Case study
Li et al. (2024)	[69]	11, 16, 17	11.3, 11.4, 16.7, 17.14, 17.17	Survey study
Lo Faro & Miceli (2019)	[70]	4, 8, 10, 11, 16, 17	4.7, 8.5, 10.2, 11.3, 11.7, 16.7, 17.17	Literature review, case study, historic documentation analysis
Madandola & Boussaa (2023)	[71]	8, 11, 12, 16, 17	8.5, 8.9, 11.6, 11.7, 12.5, 16.7, 17.17	Case study, field observations, interviews, document analysis
Mazzetto & Vanini (2023)	[72]	8, 10, 11	8.5, 10.2, 11.3	Literature review, documentation analysis, comparative case study
Meng et al. (2023)	[73]	4, 11	4.7, 11.4	Literature review, case study, quantitative analysis
Milošević et al. (2020)	[74]	4, 16, 17	4.7, 16.7, 17.17	Case study, quantitative methods for developing a multi-criteria decision-making framework

Table 1. Cont.

Author(s) (Year)	Reference	Addressed SDG(s)	Addressed Target(s)	Methods
Miran & Husein (2023)	[75]	7, 11, 12	7.2, 11.6, 12.5	Literature review, case study, quantitative analysis (SPSS)
Mohd Abdullah et al. (2020)	[76]	4, 11, 17	4.7, 11.4, 17.17	Literature review, case study
Münster (2024)	[77]	11	11.4, 11.7	Multiple case study, field observations, semi-structured interviews
Naima (2021)	[78]	10, 11, 16, 17	10.2, 11.3, 11.4, 16.7, 17.17	Case study, literature review, documentation review, field observations
Niemczewska (2021b)	[79]	11, 16, 17	11.4, 11.7, 16.7, 17.17	Surveys, in-depth interviews, case study
Niemczewska (2021a)	[80]	4, 11, 17	4.7, 11.4, 17.17	Case study, mixed-method approach
Niu et al. (2018)		11, 12	11.6, 12.5	Mixed-method approach, multiple case study
Nocca et al. (2024)	[81]	10, 11, 16, 17	10.2, 11.3, 16.7, 17.17	Value-based approach using the TOPSIS multi-criteria evaluation method, case study
Parpas & Savvides (2018)	[2]	10, 11	10.2, 11.3, 11.4	Multi-criteria analysis, case studies
Pintossi, Ikiz Kaya, van Wesemael, et al. (2023)	[82]	11, 17	11.4, 17.14	Multiple case study, comparative case study, stakeholder engagement workshops
Pintossi, Ikiz Kaya, & Pereira Roders (2023)	[83]	11, 17	11.4, 17.14	Case study, stakeholder engagement workshops
Pintossi et al. (2021)	[84]	10, 11	10.2, 11.3	Case study, stakeholder engagement workshops, historic urban landscape approach
Radosavljević et al. (2019)	[85]	8, 11	8.9, 11.4	Documentation review, case study
Ragheb (2021)	[86]	4, 10, 11, 16, 17	4.7, 10.2, 11.3, 16.7, 17.17	A'WOT method model, questionnaire
Saleh & Ost (2023)	[87]	11, 12	11.6, 12.5	Stakeholders workshops, flourishing business model
Sharifi (2019)	[88]	4, 11	4.7, 11.4	Case study, mixed methods
Stanojev & Gustafsson (2021)	[89]	8, 10, 11, 12, 17	8.5, 8.9, 10.2, 11.3, 11.4, 11.6, 12.5, 17.14	Mixed methods, documentation review, database review
Sukri et al. (2024)	[90]	8, 10, 11	8.9, 10.2, 11.3, 11.4	Mixed methods, case study, survey research

Table 1. Cont.

Author(s) (Year)	Reference	Addressed SDG(s)	Addressed Target(s)	Methods
Szopińska-Mularz (2022)	[5]	2, 4, 7, 8, 10, 11, 12, 16, 17	2.4, 4.7, 7.2, 8.5, 10.2, 11.3, 11.6, 12.5, 16.7, 17.17	Literature review, semi-structured interviews, case study
Szopinska-Mularz & Lehmann (2019)	[91]	2, 11, 12	2.4, 11.6, 12.5,	Case study, documentation analysis
Śladowski et al. (2021)	[92]	4, 11	4.7, 11.4	Multi-criteria analysis, case study
Torrieri et al. (2019)	[93]	4, 10, 11	4.7, 10.2, 11.3	Multi-criteria analysis, case study
Tu (2022)	[94]	8, 10, 11	8.9, 10.2, 11.3, 11.4	Survey study, confirmatory factor analysis
Tu (2020)	[95]	4, 8, 11	4.7, 8.9, 11.7	Interviews, case study
Vardopoulos (2019)	[96]	4, 10, 11, 16, 17	4.7, 10.2, 11.3, 16.7, 17.17	Mixed methods, literature review, Fuzzy-DEMATEL analysis
Vardopoulos et al. (2020)	[97]	10, 11	10.2, 11.3	Case study, survey study
Vardopoulos et al. (2021)	[98]	11	11.4, 11.6	Combination of PESTLE, SWOT, and analytical hierarchy process; case study (Greece)
Vardopoulos (2022)	[99]	11, 16, 17	11.3, 11.4, 16.7, 17.17	Case study, online survey, regression analysis
Vardopoulos (2023)	[100]	11, 12, 16, 17	11.4, 11.6, 12.5, 16.7, 17.14, 17.17	Case study, literature review, multiple linear regression analysis
Vardopoulos et al. (2023)	[101]	8, 11, 17	8.9, 11.4, 17.14	Case study, literature review
Vythoulka et al. (2021)	[102]	4, 11, 12	4.7, 11.4, 12.5	Archival research, case study, survey study
Yoon & Lee (2019)	[103]	11, 17	11.4, 17.14, 17.17	Literature review, case study
Zheng et al. (2022)	[23]	10, 11, 16, 17	10.2, 11.3, 11.7, 16.7, 17.17	Maslow's hierarchy of needs, case study, mathematical and statistical methods

2.2. Methods for Data Analysis

The selected papers were downloaded and indexed using Mendeley Reference Manager software and Microsoft Excel. The review was conducted through close readings, and sources were coded concerning the contributions to specific SDGs and their targets. Data analysis was carried out in two rounds by four researchers, and each of them received the same number of different journal articles for analysis. After the first round of review, the two researchers exchanged sources to develop the second round of review. This method of data analysis aimed to reduce the risk of bias that arises from overlooking significant data or results. The crucial objective of this investigation was to identify how the results of

the selected research papers contribute to the realisation of a specific SDG and to define the target within this SDG that can progress due to the presented results. The review specifically examined the direct contributions of research findings to individual SDG. While indirect impacts on other SDGs were noted, these will be further explored in the next study. This focused approach was chosen to clearly demonstrate how current research on AR of buildings places the results within the set of SDGs. The juxtaposition of developed qualitative and quantitative evidence was interpreted and summarised in Table 1.

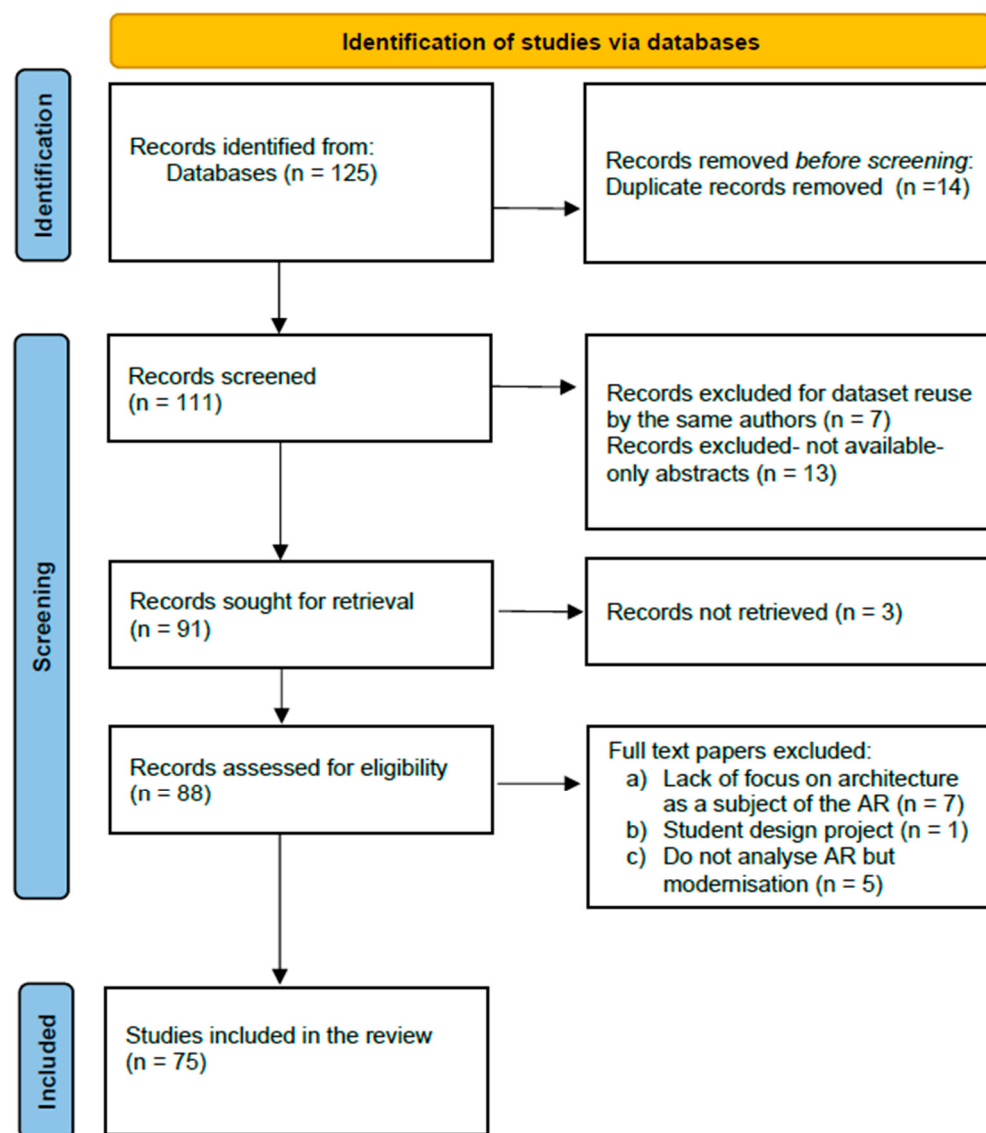


Figure 1. PRISMA flow diagram for the systematic literature review.

2.3. Methods for Framework Development

A framework provides a set of concepts, values, and practices that constitute a foundation for inquiry [104]. Frameworks play a vital role in assisting scholars and practitioners by providing tools to navigate specific complexities, thereby empowering stakeholders to explore new epistemological, ontological, analytical, and practical dimensions, ultimately fostering the integration of knowledge needed to develop sustainable solutions [105]. Partelow (2023) highlights the inherently subjective and normative logic in the development of frameworks [106]. In this study, the development of the framework aims to systemise the results of the literature review by linking the SDGs and their targets with the specific contributions that AR processes can deliver to progress sustainable urban

development. The framework supports the location of current research findings on AR in the concept of SDGs and applying them to practice and policy building.

The qualitative contribution of the analysed papers to the specific target was defined using a close reading technique. The findings were processed using an empirical generalisation method that allowed the data to be organised into common themes [106]. This process facilitated their standardisation for theory building aimed at improving SDG governance. The results were organised in a table regarding the SDGs and the specific target they addressed.

3. Results

3.1. *The Contribution of Adaptive Reuse to Sustainable Development Goals*

The contribution to SDG 2, target 2.4, is evident in the potential for repurposing existing buildings for urban food production. Two studies analysed the AR potential of inner-city modern movement car parking structures, which are becoming underused in central urban locations, for controlled environment agriculture practices [5,91]. Multi-storey garages are recognised as concrete megastructures that are difficult to repurpose for social uses, such as offices or housing, due to their low floor-to-floor height and limited sunlight access. A speculative investigation provided qualitative and quantitative data on the potential evolution of this specific architectural type as a driver of sustainable change in a food supply system that can trigger social, environmental, and economic benefits in the inner-city [91]. Szopińska-Mularz conducted planning, architectural, and environmental analysis of the proposed AR for food production and developed a guiding tool that aims to define the repurposing potential of car parking structures for controlled environment agriculture within contextual urban sustainability objectives [5].

Several studies focus on education on sustainable development and sustainable lifestyles through AR interventions, which contribute to SDG 4, target 4.7. In architectural education, design studios that include AR projects provide opportunities to advance alternative design approaches focused on sustainable urban development and potentially open discussions on new spatial norms and standards to emerge [46]. Collins et al. [46] presented two educational projects in the architecture teaching course to demonstrate the role of the AR concept in engaging students in real-life challenges aimed at sustainable design. Aydemir and Akin [40] evaluated the work of the architectural design studio focused on repurposing high-rise office buildings in Istanbul, Turkey. As a result of the educational course, the students provided recommendations on energy upgrades, integration of productive and recycling systems, structural improvements, and new mixed-use functional programmes. Together, these studies highlight the role of education on AR at the university level in rethinking and reworking the existing architectural design towards the SDGs.

Education and training are presented in the different phases of AR interventions. Educational workshops, lectures, and community-led activities for residents, local authorities, and experts from all sustainability areas are widely discussed in the literature as opportunities to improve understanding of the role of sustainable regeneration in urban development [39,62,90]. Training and educational actions are seen as a method that reveals unknown community needs, which can trigger new heritage-led activities [62]. The educational role cultural heritage AR was highlighted in the study that analysed the case of Kythera Island in Greece. The paper employed mixed methods to explore the models to protect the cultural asset of the island and enhance its sustainability potential. The results indicated that the repurposing of cultural heritage includes educational values that arise from a participatory approach to the preservation of cultural reserves [102].

As a further contribution to SDG 4, target 4.7 is recognised in studies that developed guiding tools, frameworks, and models aimed at different stages of the AR process. These tools provide qualitative and quantitative data that educate stakeholders on sustainable interventions during the repurposing process, including the selection of the building for AR [5,38,49,68,74,88], the new usage strategies [48,50,58,70,86,92,93], data management [45,48,55], and evaluation methods [73,76,80,95,96]. When planning sustainable AR, critical decisions must be made regarding selecting buildings for the intervention. Aigwi et al. [38] developed a multi-criteria decision analysis (MCDA) tool that enhances decision making about prioritising underused historical buildings for AR. The tool allows for balancing the diverse interests of stakeholders and supports the visualisation of impacts in five priority areas: economic sustainability, built heritage preservation, socio-cultural aspects, building usability, and regulatory aspects. Much of the literature has emphasised the importance of defining the usage strategies for repurposing architectural heritage to maximise the project's contribution to urban sustainable development. Sharifi [88] proposed an AR potential model that analyses architectural heritage from the perspective of obsolescence to define the critical time to implement functional alternatives. The study recommends adopting new policies for the sustainable management of building use to minimise the risk of reducing its useful life. Lo Faro and Miceli [70] highlighted the three levels of compatibility in the AR design phase: functional compatibility, historical and aesthetic compatibility, and life-cycle sustainability. The study proposed a methodology to repurpose the religious heritage for healthcare facilities with a key objective of social sustainability. Fedorczak-Cisak et al. [58] developed a fuzzy model to select an alternative use for the historic building in Zakopane, Poland. The study indicated the context-specific character of sustainability indicators that resulted from the application of the model. Torrieri et al. [93] integrated MCDA and a financial assessment model to evaluate alternative repurposing scenarios for an ancient monastery in Mugnano, Italy. The paper highlighted the role of the community and stakeholders in deciding the future of underused buildings from a bottom-up approach that offers opportunities to balance the preservation of heritage architecture with economic feasibility.

The assessment methods represent another approach to share knowledge and skills that guide AR processes towards sustainable outcomes. The methodologies focused on evaluating the potential interventions through the framework of defined indicators. Meng et al. [73] focused on assessing the AR potential of industrial heritage. Based on the literature review, the evaluation system for AR potentiality assessment was presented, including three value levels, namely, autologous, retrofitting, and potential benefits analysed from a building and urban dimensions. Within each value, a system of indicators is presented and then weighted. The proposed quantitative assessment method improves the effectiveness of decisions about AR interventions. Mohd Abdullah et al. [76] identified and classified criteria critical for defining the repurposing potential of heritage shophouses. The criteria grouped into economic, environmental, social, architectural, technological, and legislative aspects can be used to assess the requirement and suitability for repurposing heritage buildings. Tu [94] proposed an assessment framework for heritage planning principles by analysing the attractiveness of destinations from a recreational standpoint. The study emphasises a balanced approach to AR interventions that enhance cultural heritage and offer social benefits. Another assessment method for planned AR interventions was proposed by Vardopoulos [96]. By applying a fuzzy DEMATEL model, the study identified economic, social, environmental, and cultural factors that arise from repurposing industrial heritage and assessed their interactions in qualitative and quantitative terms. The proposed model improves the assessment of AR projects concerning the direction and level of interaction among economic, social, environmental, and cultural contributions to local

sustainability. Taken together, these studies contribute to a research-based framework that provides knowledge about AR interventions oriented towards sustainable development.

Regarding SDG 7, the critical aspect of AR interventions is improving the environmental performance of the building [75]. Therefore, AR interventions include improvements in energy efficiency [4], which refers to target 7.2. When repurposing architectural heritage, opportunities arise to improve the energy performance of the building [67] and include energy efficient and productive technologies in the project [5,75]. In a case study of Villa Antoniadis in Alexandria, Khalil et al. [67] hypothetically applied different sustainable interventions, such as natural ventilation, double glazing, and photovoltaic energy generation. The study revealed the potential to reduce heating, cooling, and lighting energy consumption by 36.5% and the opportunity to generate 74.7% of the required energy to support these systems. In the AR preparation phase, the value and effects of traditional technologies, such as natural ventilation systems, can be re-analysed to reduce a building's energy consumption [39].

AR practices contribute to SDG 8, target 8.5, by providing jobs [25,71]. The continuous use of a building, including the change of function, enhances employment [66]. Alternative functions stimulate the local economy and provide new employment [107]. AR of architectural heritage boosts tourism, which is a significant stimulant of local economies that create new jobs [66,72]. Iodice et al. [66] applied GIS to analyse the dynamics between real estate and the accommodation facilities developed through the AR of cultural heritage in the inner-city of Naples, Italy. The study reported opportunities to reactivate the economy and provide new jobs when approaching cultural heritage as a resource that can be transformed to meet contemporary urban needs. Stanojev et al. presented the repurposing potential of existing structures in terms of eco-innovations, where new workers can be trained and employed in the ecological and green sectors [89]. Through AR, cultural heritage can be integrated into smart regional specialisation strategies and become a driver of innovation and economic growth [89]. Different architectural typologies are discussed as drivers of new employment, including historic ports [5,65] and religious buildings [70,71].

A significant objective of AR practices is to contribute to local economic growth by providing tourist destinations and activities [43,63,66,67,85], which is related to SDG 8, target 8.9. Repurposing architectural heritage enhances cultural tourism, promotes sustainable tourism [39,90], and encourages ecotourism practices aimed at protecting natural and cultural heritage [63,71]. Tu [94] revealed that in heritage management, biophilic elements can be recognised and upgraded to improve recreational values and provide spaces for social interaction, physical activity, and relaxation, positively influencing visitor well-being. AR is recognised as a process that diversifies the tourism economy by protecting the authentic character and unique elements of the architectural heritage [64,65,100]. Madandola and Boussaa [71] conducted a case study of the Old Oyo town in Nigeria to explore its transformation into a living heritage. The findings indicated the critical role of culture-led AR, which drives the economic, environmental, and social sustainability of the area. Moreover, repurposed cultural spaces for tourist attractions offer opportunities to develop small businesses that include the element of local culture or traditions, contributing to the reduction of poverty [71,89].

The contribution of AR to SDG 11 was identified in all the studies analysed, with crucial influence on targets 11.3, 11.4, 11.6, and 11.7. Considering target 11.3, repurposing architectural heritage can reverse negative social changes by revitalising the area, thus increasing the quality of life and positively impacting the well-being of residents [23,25,26,47,99] as the critical objective of urban planning and socioeconomic management of cities [54]. Djebbour and Biara [54] conducted 80 semi-structured interviews with managers, experts, and residents of Tlemcen in Algeria to analyse their knowledge on sustainable AR of architectural

heritage. The study highlighted the crucial impact of heritage buildings preservation on the well-being of the community. When respecting the historical and cultural significance of the existing building, AR enhances the collective memory and identity of the community and fosters a sense of belonging and continuity in the urban fabric [5,56,69,70,90]. Li et al. [69] conducted a survey study to analyse the factors influencing community-related intentions and behaviours in AR projects. The study revealed community involvement as a strategy that improves local identity and fosters a sense of belonging and pride among residents. The analysed studies highlight the inclusiveness and equity in decision-making processes [2,26,39,44,48,59,61,65,78,81,84,89,93], which provides a link to SDG 10, target 10.2, calling for empowering and promoting social, economic, and political inclusion of all. The value of inclusiveness and equity is highlighted when defining sustainable use strategies [39,50], such as involving the community in tourism activities [71,72], deciding on new businesses and spaces dedicated to vulnerable groups [24], and addressing needs in the post-pandemic context [57]. In a study by Della Spina [50], MCDA model was applied to historical fortifications located in southern Italy to support decision making about their AR. The findings indicated that the participation of various stakeholders in AR improves the acceptance of the final result [50]. Community involvement increases heritage awareness [94] and contributes to the sustainability of AR interventions [26,62,86]. Niu et al. [108] developed a tool to assess the holistic impact of the AR of architectural heritage in China for commercial uses on sustainable development. The study highlighted that the co-evaluation of the repurposing proposal generates novel cultural and social values that impact the community beyond economic benefits. Furthermore, Niemczewska [79] revealed that the perception and impact of AR interventions are more positive for the social groups that use the repurposed building than those for who do not have this possibility. Therefore, inclusiveness and equity in accessibility and the use of architectural heritage improve sociocultural sustainability in the area [80].

Cultural heritage represents a multidimensional capital that offers economic, social, and cultural benefits that can enhance urban regeneration [2,66,103]. As a contribution to target 11.4, AR preserves architectural heritage and protects its authenticity and uniqueness [53,54,68,77,79,80,88,92,96–98] as a basis for culturally sustainable development [49,101] and an improved tourism economy [47,64]. Repurposing a unique building from a context-specific perspective [51,58,73,102] can serve as a case study, a source of research, and an inspiration to progress revitalisation processes [85], which can lead to the revival and regeneration of the wider neglected area [89,99]. Vardopoulos [99] analysed the elements that influence public perception of the AR role in sustainable urban development by investigating an industrial building in Greece repurposed as a museum. The study revealed the actual impact of the AR intervention on the sustainable development of the surrounding area, which enhanced the quality of life of residents, empowered cultural initiatives, and promoted the area as a vibrant tourist destination. Bottom-up community-led initiatives can be successful in initiating AR interventions and balancing cultural heritage protection with economic viability [78,93]. Participatory AR is supported as an initiative that deepens a sense of responsibility and ownership for architectural heritage among residents [63,69,79,82,83,89,90] and preserves local culture [65,76,100]. Hanapi et al. [63] explored the impacts of AR on the industrial building for the Tate Modern Gallery in London, UK. The results emphasised the role of repurposing industrial buildings into cultural spaces to foster a strong sense of identity and continuity. The cultural values delivered can constitute a foundation for policy development aimed at pursuing cultural sustainability, supporting heritage-based actions [89,98], and progressing circular economy principles in cities [52,62].

AR represents a critical element of urban development, where the transition to the circular economy begins [49,52,62]. Sustainable AR interventions enable the continuous use of a building, reducing the need for new urban greenfield development [51,68,71]. Repurposing practices place architectural heritage within a circular economy framework, where culture is a driving force for circular adaptive design [52,89]. According to Disli et al., the crucial parameters that contribute to the circular economy of buildings include regeneration, continuous use and maintenance, the potential to evolve for different functions and conditions, accessibility, waste minimisation, optimal resource use, and the ability to utilise building elements in different locations or situations [52]. The AR of underused or derelict urban structures contributes to SDG 11, target 11.6 and SDG 12, target 12.5 because the practice prevents and reduces waste, resource, and land consumption and improves the circulation of resources [60,63,89,108]. Gregorio et al. highlighted the potential of selective demolition within AR interventions as an instrument of circularity, where waste materials and components are reused in the area [25]. Another contribution to target 11.6 is observed when the environmental performance of the existing building is improved [25,40,46,65]. This can be achieved by implementing sustainable interventions such as double glazing, thermal insulation, lighting control, shading, natural ventilation, and photovoltaic energy generation [5,52,67,75,91], revitalising traditional technical solutions [39,67]. Several sources indicate that progressing AR towards circular economy principles represents a significant challenge for architects and urban planners [49,52,59,89]. Therefore, novel tools that support and provide data to assess and guide the circular AR design should be developed [42,48,49,59,62,87], including extensions of existing software for architectural and urban design [45,55]. For example, Cinquepalmi et al. [45] explored the evaluative parameters for repurposing a building and applied them to the evaluation system in a BIM and GIS environment. As a result, a tool was developed for rapid automatic pre-evaluation of the strategy for converting a degraded building into residential space. The study highlighted the problem of sustainable construction, especially energy improvement and the reduction of adverse environmental impacts arising from the construction of new buildings. In a case study of FIX Brewery AR intervention in Athens, Greece, Vardopoulos [100] applied multiple linear regression analysis to investigate the determining factors for public perceptions concerning the implications of repurposing projects on local urban sustainable development. The evidence presented revealed that AR interventions can balance financial investment, cultural heritage protection, and environmental improvements [100]. To achieve this balance, sustainability protocols and policies must provide stronger support for repurposing practices, for instance, by including a wider range of criteria to improve the potential of urban structures for future reuse [3,60,98].

The contribution of AR practices to target 11.7 is recognised when the project improves social inclusion and equity by reconnecting the architectural heritage with residents [47,70,79,80]. This can be achieved by inviting the community into the decision-making process, resulting in an AR strategy that incorporates the needs of residents [25,44,57,71]. In a study focused on recognising the value chains created by AR, Cerreta et al. [44] examined the former Morticelli Church, which has been repurposed as a cultural Living Lab in Salerno, Italy. The findings highlighted the significance of a co-exploration phase. This phase allows for the collaborative evaluation of potential uses and outcomes, adding new value to the project. Furthermore, participating in this co-evaluation during the reuse process has a positive impact on the surrounding neighbourhood. In another study that analysed the AR of a religious building for community-focused uses, the religious architectural heritage was recognised as a socially sensitive asset [70].

The alternative function should be thoroughly discussed with different community representatives to reduce conflicts of interest and inequalities [44,70]. Involving the resi-

dents in decision-making processes on various AR stages can provide new social spaces that enhance community cohesion [25,54,65,67,70] and include vulnerable groups, such as women and children [24]. When reusing buildings for social functions, special attention should be paid to the atmosphere perceived by the user [77]. In the interview study conducted by Munster, the themes that build the atmosphere of buildings repurposed for cafes include spaciousness, multifunctionality, authenticity, distinctiveness, traces of the past, presence of narratives, local integration, and inviting surroundings [77]. Meeting the basic and challenging needs of the community results in a positive perception of the atmosphere, which improves social sustainability on the neighbourhood scale. In a questionnaire study that included vulnerable social groups, Tu [94] revealed natural elements and natural landscapes as a critical asset that improves the results of the reuse of architectural heritage. The repurposing process conducted within the biophilic framework represents an opportunity to enhance recreational, health, and social assets [94].

The selection of stakeholders for decision making at various stages of the AR project is recognised in the literature as a process that influences the final contribution of the intervention to urban sustainability objectives [3,44,48,50,61,81,82]. In the analysed literature, the opportunity to contribute to SDG 16, target 16.7 is seen in the diversification of stakeholders through an inclusive and representative selection of community members, public decision makers, private investors, and experts relevant to the specific problem [3,38,49,71]. Cooperation among representatives of public, private, and non-government sectors improves participatory decision making and reduces technocratic approaches to urban renewal [39,48,53,103], which contributes to SDG 17, target 17.17. Participatory, inclusive, representative, and responsive AR planning incorporates the perspectives and needs of diverse stakeholders, fostering discussion and knowledge exchange to develop a “shared solution” for the future [50,78]. Cerreta et al. [44] advocated for the development of Living Labs to improve the participatory approach to decision making about the repurposing of architectural heritage. Involving various stakeholders in Living Lab activities, such as workshops, artistic actions, or public meetings, encourages the exchange of thoughts and discussions on possible scenarios and their values, which transform an anonymous community member from a user to a co-management actor [44]. Fava [57] highlighted the role of Living Labs in building urban resilience through AR practices, including the pandemic situation. A participatory and responsive approach that is present in Living Labs enhances socioecological planning by constantly adapting the heritage programs to the evolving needs of stakeholders, initiating discussions between planning and policy sectors and connecting actors and values arising from different disciplines. Living Labs also function as test platforms, mitigating risks involved in full projects.

The management of data in different AR phases is seen as a critical aspect of complex decision making, including various actors with varying levels of expertise and knowledge of the problem [48]. A further contribution to SDG 16, target 16.7 and SDG 17, target 17.17 is recognised in studies that propose tools that offer different approaches to data management, from collecting and processing to applying to design and presenting data to private, public, and community stakeholders. The analysed studies proposed tools that improve decision making in the pre-project and preparation phase of the AR intervention on selecting alternative uses of obsolete buildings when dealing with vulnerable contexts [49], balancing the diverse interests of stakeholders and supporting the visualisation of impacts [38], and considering specific architectural typologies [5,68,74]. The aim of the A'WOT analysis proposed by Della Spina et al. [49] is the classification and prioritisation of AR interventions in vulnerable contexts. The findings are informative in the AR decision-making phase by revealing the feasibility of the initial project and verifying its financial viability. The study highlighted the role of interdisciplinary collaboration in identifying

opportunities for pursuing social, cultural, economic, and environmental sustainability through AR projects. Milošević et al. [74] defined a fuzzy analytical hierarchy process for analysing the repurposing potential of industrial buildings. The study identified spatial, structural, and site subcriteria and determined their weights through expert evaluation of economic, social, and environmental benefits. Szopińska-Mularz [5] proposed a guiding tool to evaluate the AR potential of underused multi-storey parking structures for urban agriculture. Through a literature review, semi-structured interviews, and case studies, the research revealed planning, architectural and environmental opportunities, and limitations for AR interventions for local food provision targeted at urban sustainability objectives.

Other studies proposed decision-making tools to guide the development of repurposing proposals focused on specific sustainability aspects, including the circular economy perspective [48], participatory planning [50], social opportunities [70], and balancing the preservation of architectural heritage and economic feasibility [86,93]. Dell'Ovo et al. [48] highlighted the critical role of the following guiding tools for the management of the AR planning phase conducted as a participatory process. The study developed an MCDA approach that combines economic and qualitative indicators to assess four usage scenarios for repurposing heritage buildings in Italy from a circular economy perspective. Ragheb [86] proposed a multi-criteria strategic approach to decision making aimed at sustainable AR. The study analysed cultural heritage buildings in Alexandria, Egypt, and identified the use based on sustainability indicators for the intervention, including possible restoration and preservation of cultural heritage and the generation of cultural, social, and economic advantages. Several studies proposed tools that provide assessment methods for the post-completion phase of AR intervention by providing models of indicators or criteria that monitor and evaluate the quality of AR projects from the perspective of urban sustainability [47,79,80,96,97] and focusing on social needs, perceptions, and acceptance [23,99,100]. For example, Vardopoulos [96], based on a Fuzzy-DEMATEL analysis, identified critical factors that affect the local sustainable development through repurposing practices. The study focused on industrial architecture and revealed the contribution of AR to economic development activities, social regeneration, ecological efficiency, and the preservation of cultural heritage. Taken together, these studies provide data and guide public, public-private, and civil society partnerships to be effective in making decisions on AR interventions.

The analysed literature highlights the role of repurposing practices in enhancing policy coherence for sustainable development, thus contributing to SDG 17, target 17.14. Several studies indicate that a lack of supportive policies is a crucial barrier to progressing AR [60,69,76,82,84,100]. Repurposing architectural heritage can trigger new policy development by providing specific measures of its contribution to urban sustainability objectives [4,53,89,101,103]. Stanojev et al. highlighted the potential of AR practices as a foundation for policy development focused on pursuing cultural sustainability and supporting heritage-based actions [89]. However, no study was found that reveals an actual contribution of AR interventions to policy development.

3.2. Sustainable Development Framework

Based on the results of the systematic literature review, a framework of research-based evidence on the contribution of repurposing practices to specific SDGs and their targets is developed as presented in Table 2.

Table 2. Framework of research-based evidence on the contribution of AR practices to specific SDGs and their targets.

SDG	Target	Direct Contribution to the Target	Specific Opportunities	References
	2.4	AR of underused buildings for agricultural practices contributes to food supply as a secondary food source that improves food safety in cities.	AR of underused car parking structures allows for testing innovative agricultural systems and technologies to advance sustainable food production.	[5,91]
	4.7	- Incorporating AR projects into design studios advances architectural education within the urban sustainability framework; - Involving different stakeholders in AR projects often involves educational and training actions related to sustainable regeneration; - Studies on AR interventions formulate guiding tools that educate on the various steps of AR processes in the sustainability framework.	- Including AR projects in design studios triggers different design approaches and, potentially, new spatial norms and standards to emerge; - The areas of education and training should be focused on circular and sustainable production and consumption; - AR interventions can include specific educational activities to increase the community awareness of AR processes and sustainable culture; - Training and educational actions can reveal unknown community needs, which can trigger new heritage-led activities.	[5,38–40,46,48–50,58,62,68,70,73,74,76,80,86,88,92,93,95,96,102]
	7.2	AR interventions improve the energy performance of existing buildings.	- AR is an opportunity to modernise the building's infrastructure, including implementing sustainable, productive, and energy-efficient technologies; - AR of heritage architecture offers opportunities to rethink traditional technologies, such as natural ventilation systems, to reduce the energy consumption of a building.	[4,5,39,67,75]
	8.5	- AR enables continuous use of the building, which enhances employment; - AR process stimulates local economies that create new jobs.	- The AR implemented as eco-innovation creates jobs in the ecological and green sectors; - AR can provide new tourist destinations, thus providing new jobs in the tourism sector.	[5,25,65,66,70–72,89]
	8.9	- AR projects contribute to local economic growth by providing tourism activities; - AR diversifies the tourism economy by preserving and revitalising the authenticity and unique features of heritage architecture, enriching the visitor experience; - AR promotes social inclusion by involving local communities in tourism activities; - AR supports small businesses; - AR facilitates the recognition and revitalisation of biophilic elements, leading to improved mental and physical health for visitors.	- The creative and generative use of architectural heritage enhances cultural tourism and promotes sustainable tourism; - AR encourages ecotourism practices to protect natural and cultural heritage; - Through AR, small businesses related to local culture and traditions can arise; - AR can revitalise biophilic elements that enhance recreational values and provide spaces for relaxation, physical activity, and social interaction.	[39,43,63–67,71,85,89,90,94,101,109]

Table 2. Cont.

SDG	Target	Direct Contribution to the Target	Specific Opportunities	References
	10.2	- AR projects can reverse negative social changes by including a community in various stages of decision-making processes; - Stakeholder engagement and inclusiveness are crucial for planning the AR process from the building life cycle perspective; - AR projects can improve social inclusion and equity by reconnecting the building with residents; - The repurposed building can play the role of empowering the local community in conflict zones; - AR reinforces the collective memory and identity of the community, fostering a sense of belonging and continuity; - AR projects can revitalise the surrounding area, positively influencing the community, and are likely to increase quality of life and per capita income and reduce unemployment status.	- AR improves social inclusion when educating on the building's historical and cultural significance and including residents' needs in the functional program; - In conflict zones, providing new businesses and space dedicated to vulnerable groups in repurposed buildings offers an opportunity to empower the local community; - AR interventions can reduce inequalities through the use of the current digital era technological tools (e.g., social media).	[2,4,5,23–26,39,41,44,45,48,50,54,56,61,62,67,69,70,72,78,81,84,86,89,90,93,94,96,97,99]
	11.3	- AR triggers economic development activities, social regeneration, ecological efficiency, and preservation of cultural heritage; - AR improves community participation in decision making on various steps of the intervention; - AR through participatory approaches defines a 'shared solution' for the future that improves the level of acceptance of the final planning proposal; - Through participatory approaches, AR fosters a sense of ownership and responsibility towards cultural and environmental conservation among local communities.	- The co-evaluation process in AR practices generates new cultural and social values that impact individual stakeholders beyond economic benefits; - The community can initiate cooperation with authorities to protect and manage heritage buildings; - By utilising decision-making tools, AR can be effectively planned and managed to enhance urban sustainability.	[2,4,5,23–26,39,41,44,45,48,50,54,56,61,62,67,69,70,72,78,81,84,86,89,90,93,94,96,97,99]
	11.4	- Protecting the authenticity of cultural heritage is the critical principle of AR interventions; - AR enables the continuous use of buildings, which allows for preserving architectural cultural heritage and does not cause any further environmental damage; - AR links culture with the circular economy; - AR promotes cultural and natural heritage by providing educational actions that increase awareness of the role of cultural heritage in sustainable development; - AR enhances the integration of heritage with circular economy principles; - AR encourages ecotourism practices to protect natural and cultural heritage.	- Bottom-up community-led AR initiatives can play a critical role in protecting cultural heritage; - AR activates heritage nodes as the new generative value for the revival and regeneration of cities; - AR practices can trigger the development of policies that support cultural heritage projects; - AR design projects create new opportunities for promoting cultural sustainability; - A participatory approach in AR fosters a sense of ownership and responsibility towards the conservation of cultural and natural heritage among local communities.	[2,38,43,47,49,51–54,58,62,64–66,68,69,73,76–80,82,83,85,88–90,92,94,98–103]

Table 2. Cont.

SDG	Target	Direct Contribution to the Target	Specific Opportunities	References
	11.6	- AR improves the environmental performance of a building and promotes environmental sustainability; - AR practices reduce the need for new infrastructure development and minimise environmental impacts; - AR reduces waste and resource consumption, which can be enhanced when embedding circular economy principles in AR interventions; - AR interventions often include education on environmental management and impacts.	- Selective demolition can become an instrument of circularity if waste materials and components can be reused in the area; - Including circular economy principles in AR interventions contributes to resource use reduction and waste prevention.	[3,5,25,40,42,45,46,49,51,52,55,59,60,62,63,65,67,71,75,87,89,91,98,100,108]
	11.7	- AR can provide space and activities dedicated to vulnerable groups (women, children); - AR projects can improve social inclusion and equity by reconnecting the building with residents.	- Integrating natural and regional environments into AR projects enhances recreational, health, and social benefits; - When repurposing a building for a social function, the atmosphere perceived by the users is crucial for the attendance of the building; - AR interventions should incorporate the needs of the community in the functional program, including the needs of vulnerable social groups.	[23–25,42,44,47,54,57,65,67,70,71,77,79,80,95]
	12.5	- From the perspective of a circular economy, AR interventions contribute to environmental sustainability by actively using buildings, which ensures that materials stay in the value chain longer, ideally never entering the value chain at all; - Culture is the foundation for sustainable development, and it is the basis for pursuing the principles of circular economy in AR interventions.	- The use of contemporary technological solutions in AR practices contributes to circular design and progresses the transition of the construction sector towards circular economy principles; - Selective demolition can become an instrument of circularity if waste materials and components can be reused in the area; - Digital stimulations, along with BIM and GIS software, allow for reducing physical intervention requirements and minimise waste and resource consumption in AR projects.	[3,5,25,42,45,46,49,52,59,60,62,63,65,67,71,75,87,89,91,98,100,108]
	16.7	AR practices allow for balancing the diverse interests of stakeholders to develop an AR strategy focused on urban sustainability.	- Choosing the right stakeholders from various groups (community, authority, experts) and including their opinions in the AR process is crucial for the sustainability of repurposing interventions and their outcomes; - Decision making in AR should be a tailor-made procedure that increases community involvement; - AR, planned as a participatory process, allows for defining a “shared solution” for the future that improves the level of acceptance of the final result.	[5,23,38,39,44,47–50,56,61,68–71,74,78,80,81,86,96,99,100]

Table 2. Cont.

SDG	Target	Direct Contribution to the Target	Specific Opportunities	References
	17.14	- AR interventions can drive public–private partnerships and transparent policy communication that support new policy on sustainable development; - AR contributes to a sustainable regeneration framework that can be used for policy formulation.	Developing AR as a participatory process enables decision makers to integrate various stakeholders' views into the evaluation, reducing conflicts between different interests and creating a broader consensus in complex choices.	[4,53,60,69,82,83,89,100,101,103]
	17.17	- AR promotes public–private partnerships to sustain cultural heritage projects; - Effective public, public–private, and civil society partnerships are supported by the decision-making tools available in the current literature.	- Choosing the right stakeholders from various groups (community, authority, experts) and including their opinions is crucial for the sustainability of the AR process; - AR interventions can be planned in Living Labs to encourage novel methods of public, public–private, and civil society partnerships.	[5,23,38,39,44,47–50,56,61,68–71,74,76,78–81,86,96,99,100,103]

4. Discussion and Conclusions

The research aimed to systematically examine the current literature on AR of buildings to develop a framework of research studies that provide data on the contribution of repurposing practices to specific SDGs and their targets. In the analysed literature, the direct contribution of the results to nine SDGs was identified. The current research identified a significant number of studies that discuss the role of education in sustainable and resilient development based on AR practices. This is related to SDG 4, target 4.7, where repurposing projects can serve as case studies for learning about existing architecture as an asset that can deliver multiple benefits to urban sustainability. The literature focuses on education on cultural values, circular economy in AR projects, and environmental opportunities arising from repurposing practices. Education on the SDGs is crucial to shifting the mindsets of various stakeholders [11], including the community, local authority, and developers.

The crucial area of research was focused on SDG 11, which directly concerns urban settings. The main contributions were identified within targets 11.3, 11.4, 11.6, and 11.7, holding a significant but general potential for sustainable urban development [11]. AR is investigated in the current literature as an inclusive, participatory process, where coevolution of the design proposal with various stakeholders, including vulnerable groups, is critical for the acceptance and realisation of the final project. Protecting the unique architectural features in repurposing practices is highlighted as a key to the authenticity of the repurposed artifact, which contributes to cultural benefits and economic revenues from the project, for instance, from tourism. The economic pillar of sustainability is deeply addressed at all stages of AR practice, including funding the project, developing AR around the principles of circular economy, and measuring the economic impacts of the implemented projects in the urban area. Environmental aspects are mainly highlighted in the context of education, building retrofit and implementing resource-saving and productive technologies.

Another significant contribution was observed to SDG 17, calling for an enhanced partnership for the goals. Several studies identified the potential to drive public–private partnerships and transparent policy communication that trigger the development of policies supporting AR projects. The research highlights novel methods of stakeholder collaboration that serve as testing spaces, such as Living Labs. However, no studies were identified that evaluated the actual contribution of a specific AR intervention to policy development. This is an important topic for further research.

Current research confirms that the SDGs are interconnected. The presented framework outlines how the analysed literature contributes to the SDGs and their targets; however, achieving one specific target can positively impact others. For example, SDG 2, target 2.4 calls for the enhancement of sustainable and resilient agricultural practices that contribute to food security. Ensuring equal access to and affordability of fresh and healthy food for all urban residents plays a significant role in reducing poverty and inequalities, thus advancing SDG 1 and SDG 10. Participatory and inclusive AR that respects the uniqueness and authenticity of the architectural artifact aligns with target 11.3 and target 16.7. These targets focus on promoting peace and justice through inclusive, responsive, and representative decision-making processes at all levels. The interrelation of the SDGs and their targets has implications for the use of the developed framework. The framework should be applied using an interdisciplinary and context-specific approach. When implementing the knowledge gained from AR research into practice, it is essential to consider the potential impacts on the achievement of other SDGs within the specific urban and architectural context. This approach can help identify additional opportunities or limitations for setting goals that address specific sustainability objectives.

The analysed studies examine AR as a complex, multidimensional process and provide valuable data from a research-based perspective. Key methodologies employed include case studies, multi-criteria decision-making techniques, literature and documentation reviews, site mapping, interviews and survey studies. These approaches address various architectural typologies, stages of vacancy, and urban conditions. The results of this study can help inform the goal-setting governance and contribute to a shift in thinking aimed at integrating the social, economic and environmental pillars of the SDGs in the AR agenda [11,31]. Since urban change is an ongoing process, a research-based approach to repurposing practices can enhance decision making and promote the implementation of innovations in cities [15,34]. Integration of academic research data and practical application should be advanced. Academia serves as a place for testing innovative approaches. Collaboration between researchers and practitioners is essential to achieve the SDGs. By applying and refining novel methodologies, practices and models in real-world settings, we can enhance their effectiveness.

The role of decision making in repurposing practices is well understood in the analysed literature. Numerous recent studies provide valuable decision-making tools, frameworks, and guidance that utilise qualitative, quantitative, and mixed methods to incorporate current knowledge across four strategic phases of AR: pre-project, preparation, implementation, and post-completion. This research has pinpointed essential guiding tools pertinent to the pre-project and preparation phases. These tools focus on several key elements, including the selection of buildings for the repurposing intervention [38,49] emphasising specific architectural typologies [68,74,91], the definition of the usage strategies [50,58,86,92,93,107], data management [45,48,55], AR potential evaluation [73,76,96], and the evaluation of opportunities and limitations for the repurposing process [82–84,91]. The guiding models for the implementation and post-completion phases primarily focus on evaluating the effectiveness and impacts of AR interventions from a sustainability perspective [41,47,51,80,81,108]. More research is recommended to create a robust database of existing guiding tools. The systematisation of current models regarding the AR phase and specific objectives would enhance their practical integration into decision making and advance the implementation of innovative projects that progress the SDGs in cities.

A systematic analysis of the current literature on the contribution of AR practices to the SDGs has identified several future research directions. First, there is a need to improve private–public collaboration in various phases of AR. Innovative methods for stakeholder selection and collaboration should be tested, for example, by incorporating

social research techniques and developing Living Labs. A participatory approach in these Living Labs can improve socio-ecological planning by continuously aligning heritage programs with the evolving needs of stakeholders [44]. This method is essential not only to foster critical discussions between the planning and policy sectors but also to build connections between diverse actors and values across various disciplines, ultimately leading to more effective and inclusive outcomes. Second, it is important to advance tools that guide the integration of circular economy principles into architectural design and urban planning. Many architects and planners find it challenging to implement the values of the circular economy in practice [49,89]. Therefore, these tools should be user-friendly and compatible with existing technologies, such as BIM and GIS software. Finally, all existing methods, tools, and frameworks should be reviewed and compartmentalised in an accessible manner for a non-academic audience. This study has highlighted a significant number of guiding tools available in the current literature. Their effective implementation, through collaboration between academia and practice, can enhance goal-setting governance, thereby advancing the SDGs through the application of AR practices in cities.

The results of this study are relevant to practitioners progressing AR projects at various stages to manage them as a research-based process. Developers can use the framework to assess the potential contribution of the repurposing practice to SDGs. Architects and urban planners can leverage the framework to gain a better understanding and knowledge of the potential of AR as a driver of SDGs, guiding their design efforts from a research-informed perspective. The framework can empower the community to initiate bottom-up repurposing projects and participate in discussions on the role of public engagement throughout their different stages. Public organisations can apply the framework of findings to inform policy development and lead AR projects as inclusive and ethical practices, thereby progressing the SDGs in cities.

The study was limited to the analysis of academic papers published in peer-reviewed journals and books from 2018 to the end of 2024. The research was conducted from an architectural standpoint, specifically limiting the scope to the AR of buildings. Papers that address other repurposing practices, such as urban design, landscape, or civil structures, were excluded from the review and are recommended for future research. The study focused on the direct contribution of AR of buildings to SDGs. Thus, future research should address the indirect enhancement of the SDGs through repurposing practices.

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