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Property Management

A comparative analysis of adaptive reuse decision-making models and their alignment with project phases

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Abstract

Purpose – Existing adaptive reuse decision-making models lack a comprehensive analysis of their functionality relevance across the distinct phases, as well as clear definitions of these phases and thorough exploration of their categorizations, criteria and related factors. This research defines the actual phases of adaptive reuse, examines existing decision-making models and explores how these models align with the distinct adaptive reuse phases.

Design/methodology/approach – The research employed a comparative analysis to explore the frameworks of various decision-making models, emphasizing their application and focus within the adaptive reuse of existing and heritage real estate. Primary and secondary sources were identified through a systematic snowball sampling technique. Additionally, a focus group workshop was conducted with an expert panel to distinguish, explore and define the adaptive reuse phases in practice.

Findings – The findings of this research underscore the diverse nature of decision-making models in adaptive reuse, revealing variations in categorizations, hierarchical structures and methods of evaluation, as well as limited attention to the specific case of heritage buildings and an emphasis on the initial phases of adaptive reuse. Besides, by defining the actual adaptive reuse phases in practice, it makes a connection between phases and adaptive reuse decision-making models.

Practical implications – This research helps decision-makers understand the phases and activities of adaptive reuse, identify the existing adaptive reuse decision-making models for different project contexts and their applicability to different phases and support improved decision-making throughout adaptive reuse projects.

Originality/value – This study connects adaptive reuse decision-making models to adaptive reuse phases, providing practical guidance on selecting appropriate models and highlighting the differences between heritage and non-heritage adaptive reuse.

Keywords Adaptive reuse, Decision-making models, Built environment management, Real estate management, Adaptive reuse process

Paper type Research article

1. Introduction

Decision-making processes linked to the planning, design and construction of a real estate asset are diverse and multidimensional (Bullen and Love, 2011). Several scholars have highlighted that managing and making decisions in the adaptive reuse of heritage buildings is particularly challenging (Douglas, 2006; Mısırlısoy and Günçe, 2016). When making choices between reuse options, especially for historical buildings, it is important to consider various factors and how

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these factors interact (Wang and Zeng, 2010). This assessment process is not only concerned with the preservation of historical, economic, scientific and aesthetic values but also integrates long-term development visions and planning strategies, making it a multifaceted procedure (Li *et al.*, 2021). The rising popularity of multiple criteria decision analysis approaches in decision-making for real estate adaptation can be attributed to the complex interactions of various factors and the involvement of numerous stakeholders during the reuse process (Vizzarri and Fatiguso, 2020). A few studies have explored the various phases of adaptive reuse projects in real-world contexts (Arfa *et al.*, 2022; Shehata, 2014), and others have compared the characteristics of different decision-making models (Umar and Said, 2018; Nedeljkovic *et al.*, 2023) or reviewed methodologies for reusing existing buildings (Aigwi *et al.*, 2019). A significant gap still remains in the literature regarding which specific phase(s) of the adaptive reuse process these decision-making models and criteria are most applicable and relevant. Understanding what to consider and when during the decision-making process is essential. Without a clear distinction between phases, the applicability and impact of a decision-making model may be limited or misaligned with the practical requirements of projects. Moreover, the real-world applicability and compatibility of these models in heritage adaptive reuse projects warrant further consideration (Unver *et al.*, 2022) when addressing existing challenges in the field.

Furthermore, Heritage adaptive reuse preserves the social and historical values of heritage buildings for both present and future generations (Langston *et al.*, 2008). However, while many scholars have developed decision-making models for adaptive reuse in general, relatively few have focused specifically on heritage buildings (Van Horenbeek *et al.*, 2010). Decision-making in the context of heritage buildings differs from that of non-heritage structures, as it must account not only for tangible values – such as architectural integrity and authenticity – but also for intangible values, including sociocultural significance. Therefore, distinguishing between the decision-making processes for heritage and non-heritage buildings is important to ensure that the values of heritage assets are appropriately recognized and addressed. Furthermore, an extensive literature review by Vafaie *et al.* (2023) highlights that while numerous factors can be considered in adaptive reuse decisions, the hierarchy and interrelationships between these factors – particularly in the context of heritage buildings – remain unclear. To ensure successful decision-making that does not prioritize certain aspects while neglecting others, it is crucial to consider all relevant factors and the sequence in which they should be addressed across different scenarios – distinguishing between heritage and non-heritage buildings.

Accordingly, this research seeks to:

(1) Identify and define the actual phases of the adaptive reuse process in practice;

(2) Examine existing decision-making models in the field of adaptive reuse, analyzing their characteristics – such as categorizations, hierarchical structures and evaluation criteria – by comparing them on a macroscopic scale;

(3) Explore how these models align with the distinct phases of adaptive reuse in practice.

Building on these findings, this research will not only provide insights into decision-making models, the identification of phases and their relevance to these models but will also help lay the foundation for the future development of decision support models in the field of adaptive reuse of (heritage) real estate.

2. Literature review

2.1 Decision-making process in adaptive reuse

The decision-making process for adaptive reuse – whether for heritage or non-heritage buildings – involves several steps, adding to its overall complexity. One of the earliest decisions is whether to pursue adaptive reuse, to preserve the building with minimal and essential interventions or to opt for demolition. In the subsequent stages, a range of parameters must be considered based on the specific circumstances of the building. Decision-making

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models for adaptive reuse generally address specific phases of the process rather than its entirety, reflecting the complexity of both the sequencing of decisions and the prioritization and classification of relevant criteria. It is important to raise greater awareness of the impact of adaptability through measurable examples and to promote an integrated and collaborative approach to building design and construction – one that engages all relevant stakeholders and considers the entire life cycle of the project, across all phases (Mlote *et al.*, 2024). Over the past decade, both academic researchers and industry practitioners have increasingly aimed to transform traditional decision-making processes into knowledge-driven approaches by incorporating data analytics tools and decision support methods (Zhao *et al.*, 2021) for developing more well-implemented adaptive reuse projects.

2.2 Multi-criteria decision-making models

Multi-criteria decision-making (MCDM) is an approach concerned with assessing and choosing among several alternatives, each with its own merits and drawbacks. It can be defined as a consistent approach to selecting or grading projects or options that are ranked differently by relevant criteria. Furthermore, the complexity inherent in heritage reuse strategies necessitates the use of multi-criteria decision aid methodologies, as these approaches are well suited to representing and managing complex decision-making processes and the multiple dimensions of a project (Morkūnaitė *et al.*, 2019). MCDM also enables the comparative evaluation of alternative projects across multiple criteria simultaneously, while incorporating the perspectives of different stakeholders involved in the decision-making process (Della Spina *et al.*, 2023). These approaches offer a structured and systematic means of identifying more rational solutions by considering and weighing various factors that influence these processes.

2.3 Adaptive reuse phases

Studies that identify the phases of adaptive reuse projects in real-world cases and distinguish them from those of new construction stages are limited. Andriessen (1999) in his thesis Transformation of Office Buildings divided the building transformation process into five phases: initiative, definition, design, pre-construction and realization. Similarly, Vervloed (2013) outlined the adaptive reuse process for heritage buildings in seven phases – initiative, definition, design, permission, execution and aftercare – and highlighted that monumentally listed buildings are subject to national regulations during the early stages of the project. In a related thesis, Pallada (2017) synthesized findings from various studies and categorized the phases as idea formation, refining ideas, feasibility studies, contract negotiations, preparation and execution. These students and researchers also identified a series of activities within each phase that stakeholders and decision-makers must address in adaptive reuse projects. More recently, Arfa *et al.* (2022) grouped these activities into four main phases: pre-project, preparation, implementation and post-completion. While many studies outline similar activities, variations persist in both terminology and sequencing. To refine these phases for adaptive reuse in real-world projects, we validated the literature findings with experts and practitioners through a focus group workshop, which enabled us to establish more accurate and comprehensive phases to support the decision-making process.

3. Research design and method

This research is grounded in a qualitative and analytical approach to investigate existing decision-making models for adaptive reuse and assess their relevance to the distinct phases of the adaptive reuse process. To address the three research objectives, a multi-method strategy was implemented. This included: (1) a focus group workshop to define and validate the practical phases of adaptive reuse based on stakeholder expertise; (2) a snowball sampling method for systematically identifying relevant literature and decision-making models; and (3) a comparative analysis to evaluate the characteristics, frameworks and applicability of these

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models across the adaptive reuse process. To ensure a systematic evaluation, a set of comparative criteria was established based on insights from the literature. These criteria include: (1) categories addressed (physical, economic, social, technological, etc.), (2) building typology, (3) hierarchy (presence or absence of hierarchical structuring), (4) type of criteria (qualitative, quantitative, or mixed), (5) applicability to new or existing heritage buildings and (6) the overall purpose of the model. These criteria structure the main methodological foundation of the study and are applied in the description of individual models and the following stages of the research, and are presented more comprehensively in Table 10.

3.1 Focus group workshop

Given the complexity of adaptive reuse projects, which involve a wide range of stakeholders with diverse interests and expertise, it was essential to incorporate multiple perspectives when identifying the actual phases of adaptive reuse in practice and addressing the first research objective. Therefore, the focus group workshop was selected as the most appropriate data collection technique for this part of the study, as it provides an opportunity to test assumptions and to gather beliefs and opinions from experienced participants with a wide variety of perspectives (Krueger and Casey, 2015; Aigwi *et al*., 2019, 2020; Hennink, 2014). A focus group can be described as a "group interview" in which participants interact to share different ideas on a common topic based on their experiences (Ritchie and Lewis, 2003).

Despite the advantages of the focus group workshop, this method, like other research approaches, is subject to potential bias. One such bias arises when a small number of participants dominate the discussion, potentially suppressing quieter members and causing inaccurate results. To mitigate this, a clear structure and time schedule were established at the outset, ensuring each expert had sufficient time to present their views comprehensively. All participants were willing to engage in the discussion actively, and the moderator's facilitation skills (Smithson, 2000) – in this case, the researcher – contributed to effective data collection and session management. Participants were also selected from diverse professional backgrounds, with approximately equal representation from each field, to ensure balance and capture the views of various decision-makers involved in adaptive reuse projects. In addition, the non-sensitive nature of the topic did not challenge participation or introduce additional bias (Mwilongo, 2025). Finally, the findings were cross-checked with existing literature on adaptive reuse phases, enhancing reliability and validity by linking theory and practice. Collectively, these measures helped minimize potential bias.

The seven participants gathered for the focus group workshop were highly experienced, each with between 10 and 30 years of involvement in decision-making processes, representing diverse professional perspectives (Table 1). The session brought professionals from both public and private sectors, including real estate developers, architects, project managers, heritage consultants and legal/policy representatives from municipal authorities and the national heritage agency. All participants had played key roles in adaptive reuse projects and contributed insights grounded in their practical experience in both the Dutch context and international projects. The session was held at the Faculty of Architecture and the Built Environment, Delft University of Technology, the Netherlands. More detailed information about the participants is presented in the table below.

The workshop was divided into two stages. The first involved an open discussion on the adaptive reuse process, drawing from real projects, drawing on participants' experiences from real-world projects involving the transformation of existing and heritage buildings into new uses. This stage helped to build a shared understanding of the topic among experts from different professional backgrounds. It also functioned as an introduction to the main task, which centered on a participatory card-sorting exercise.

The blank cards labeled Phase 1, Phase 2, Phase 3 and Phase 4 were distributed, and participants were asked to write down the major activities and decisions associated with each phase as presented in Figure 1. To promote reflection and clarify the distinction between

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Table 1. Experts experiences and roles

Current role/Title	Organization	Previous/Additional roles
Senior Architect and Advisor in "Reuse and Renovation sector"	Municipality of Rotterdam	Architect specialized in heritage and Adaptive Reuse
Advisor in Architectural History	Ministry of Cultural Heritage Agency of the Netherlands (RCE)	Worked at Education, Culture Executive Agency and as an Advisor in European Commission
Project Leader of Adaptive Reuse Structures	Architecture and Urbanism Firm	Construction and Technical project coordinator
Senior Real Estate Advisor and Senior Research Market Analyst	Real Estate Agency	Project leader/advisor in adaptive reuse and transformation existing buildings
Advisor on Sustainable and Healthy Building	Municipality of Rotterdam	Urban Planner of public sector
Senior Policy Advisor of Building Reuse	Cultural Heritage Agency of the Netherlands (RCE)	Architect Course Coordinator for Heritage Philosophy program and policy programmer
Technical Engineer	Royal Technical Consultancy	Expert of Technical Transformation of Existing/Heritage buildings

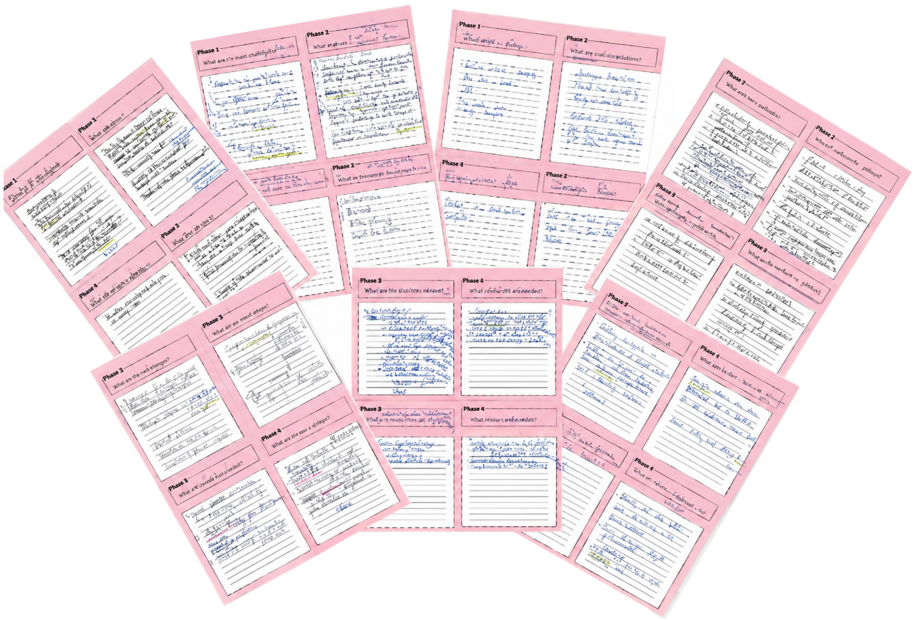


Figure 1. Some examples of phase cards shared during the workshop for participants to complete

phases, concise summaries of selected theoretical models and phase definitions identified in the literature were simultaneously presented on a screen. The focus group workshop, as a qualitative participatory approach (Freitas *et al.*, 1998), incorporated affinity mapping through a card-sorting exercise in a structured (phase-based) format. The purpose of this exercise was to organize and group relevant activities associated with each phase, distinct from one another,

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and to contribute to a comprehensive definition of four adaptive reuse phases. Following the workshop, all handwritten inputs from the cards were transcribed into a tabular format in a Word document, consisting of four columns (phases) and seven rows (participants). Subsequently, as a secondary and more systematic technique for identifying and analysing deeper patterns, thematic analysis was employed to identify, group and synthesise similar activities within each phase. This process resulted in the emergence of four principal themes, corresponding to the four phases of the adaptive reuse decision-making process.

It is important to note that the identification of adaptive reuse phases in this research is not solely based on the workshop results. A selection of relevant literature, which discusses various definitions and structuring of reuse phases, was also reviewed. However, the primary emphasis of the focus group workshop was to gather practice-based insights from experienced stakeholders. Accordingly, the focus group served both to validate, define and enrich these existing phase definitions through practice-based insights. The combined input from the literature and stakeholder perspectives forms the basis for a more comprehensive and grounded understanding of adaptive reuse phases, which is discussed further in the results section.

3.2 Snowball sampling method

To stimulate adaptive reuse, tools, models and procedures are needed (Olivadese *et al.*, 2017) and explore these existing decision-making models in (heritage) buildings adaptive reuse, a systematic snowballing sampling technique was implemented to recognize and select relevant literature. This method involves identifying research subjects by having one subject refer the researcher to another subject, who then refers the researcher to a third and so on (Vogt, 2005). Initial searches were conducted using Google Scholar, based on keywords such as adaptive reuse, decision-making models, building adaptation and heritage preservation. The snowballing approach included both forward and backward citation tracking, expanding the scope of the review through references cited by, and citing, foundational texts. Sources included peer-reviewed journal articles, conference papers, doctoral theses and other academic outputs. Each document was screened by title and abstract for relevance, followed by a full review if deemed pertinent. The focus of analysis was on the structure, criteria, hierarchy and applicability of decision-making models in both heritage and non-heritage building contexts.

3.3 Comparative analysis

In academic literature, comparative analysis in decision-making models is frequently employed to evaluate the applicability and performance of various methodologies. As Higgins (1986) defines it, "comparative analysis is a methodology, rather than a substantive area of study and should be employed where it can illuminate specific questions and hypotheses." Given the dynamic and multifaceted nature of decision-making, comparative analysis remains a crucial tool, guiding both practitioners and scholars through complex decision-making processes and enhancing the quality of outcomes. In this context, this research aims to explore existing decision-making models through a comparative analysis of their frameworks, evaluating their applicability and comparing their emphasis within the domain of adaptive reuse of heritage buildings. Additionally, it seeks to provide valuable insights and distinctions among these models, contributing to a deeper understanding of their strengths and limitations and their relationship to the adaptive reuse decision stages.

4. Results

The results section is divided into two parts, aligned with the study's objectives. The first part focuses on defining and distinguishing the phases of adaptive reuse, while the second part reviews the decision-making models within the field.

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4.1 Adaptive reuse phases

Adaptive reuse projects involve distinct phases, interface definitions, decision steps and planning methods (Eray *et al.*, 2019). To effectively facilitate decision-making process through decision-making models, it is important to precisely understand the adaptive reuse phases both in theory and practice and to identify the stages at which these models can be most efficiently applied. Accordingly, this section is based on the theoretical definitions of adaptive reuse phases which were previously reviewed in the literature review and is complemented by an examination of practical perspectives gathered from practitioners and stakeholders during a focus group workshop. This integration aims to enrich the data, validate the theoretical findings through practical insights, and establish a coherent link between theory and practice, ultimately leading to the definition and structuring of four comprehensive adaptive reuse phases in real-world projects.

4.1.1 Empirical findings. The findings presented in this section are based on a focus group workshop involving professionals from both the public and private sectors, including architects, project managers, heritage advisors, technical experts, developers and government representatives, together with insights derived from the existing literature.

As mentioned in the previous section, one of the initial stages of the workshop involved an open discussion, providing experts with the opportunity to share their practical knowledge and real-world experiences from different adaptive reuse projects. As the discussion on the adaptive reuse process commenced, the experts agreed that there are no clearly distinguished phase definitions for adaptive reuse projects that not only rely on theoretical perspectives but also incorporate the insights of practitioners. While a summary of the literature on adaptive reuse phase definitions was presented on the screen, the discussion became more focused on identifying what could be added or refined to establish a more comprehensive structure for defining the phases.

During the open discussion, the experts' perspectives overlapped on several key points. They agreed that there is a lack of comprehensive research addressing the clear distinction between adaptive reuse phases and the associated decision-making process. Furthermore, when discussing the activities associated with each phase, most experts believed that even if the initial analyses, monument assessment, involvement of multidisciplinary stakeholders and legal verification of the building were completed successfully, the feasibility of the project would remain uncertain without sufficient financial resources or sponsorship. An expert stated that "without funding, the project cannot move beyond." In other words, it was emphasised that if the economic conditions do not support the project, the implementation phase cannot proceed until adequate funding is secured. On the other hand, representatives from the cultural heritage agency and the heritage advisor emphasised, more than the other participants, that even in the absence of financial support, "heritage-listed buildings should be preserved because of their inherent value" and "should not be demolished unless serious circumstances," such as critical structural deficiencies affecting public safety, make demolition unavoidable. However, they also acknowledged that "the preservation of heritage buildings is not always achieved in real-world projects." In addition, representatives from the municipalities highlighted the importance of complying with urban planning policies, city-scale development strategies, master plans and planning regulations before major project decisions are made. From a technical perspective, it was also noted that the adaptive reuse process may involve iterative movement between phases, as design decisions and structural implementation may require continuous refinement even after reaching the third phase. Following the discussion and further deliberation, each expert independently completed the cards by recording all activities and phases they considered relevant to the adaptive reuse process. The information from all completed cards was then compiled, and the process of identifying, recognising, classifying and synthesising similar activities into the main adaptive reuse phases was undertaken, resulting in the four phases presented below.

Following the discussion and further deliberation, blank cards were distributed to each expert. Each participant independently completed the cards by recording the phases and activities they considered relevant to the adaptive reuse process. The information from the completed cards was then compiled, and the process of identifying, recognising and classifying

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the data was undertaken using thematic analysis. This process led to the identification of four principal themes, corresponding to the four phases of the adaptive reuse process and the activities associated with each phase, as described below and illustrated in Figure 2.

4.1.1.1 Phase 1 – initial analysis and project definition. Maintaining and enhancing elements or characteristics that convey cultural, historic, architectural or economic value is necessary to support appropriate property use (Jaafar *et al.*, 2025) and requires an initial analysis of the building. Accordingly, this stage involves analyzing the building's physical and functional capacity, conducting an initial value assessment – particularly in the case of heritage structures – and carrying out a preliminary financial analysis. Moreover, it includes identifying and engaging the relevant stakeholders required for collaboration during the initial stages. As a result, initial scenarios, development concepts and early design sketches are typically proposed during this phase.

4.1.1.2 Phase 2 – preparation and design development. Phase 2 primarily focuses on the progression of the design stages, beginning with a detailed analysis of the structural layout, possibilities for extension and the level of building protection. A review of planning regulations and permit procedures is essential for developing comprehensive design plans. This phase also includes a thorough value assessment of the building – particularly for heritage structures – as well as the identification of potential risks and the formulation of a risk management plan. Another key aspect involves identifying the necessary specialised stakeholders, coordinating efforts between the public and private sectors and initiating preliminary contract negotiations. Additionally, it is important to assess local area demand, identify potential users and their needs, and, most critically, conduct cost and financial evaluations before moving to the execution stage.

4.1.1.3 Phase 3 – execution and implementation. The third phase marks the transition from design development to actual execution. At this stage, the final assessment of the building's monumental status and the appropriate level of intervention – particularly for heritage buildings – is completed before implementation begins. It involves reaching agreements on the definitive design plans, completing all legal procedures and finalizing the tendering process. This includes applying for necessary permits – such as heritage and environmental approvals – and finalizing contracts to be signed by all relevant stakeholders. Simultaneously, the surrounding environment and neighboring properties should be informed, and preparatory cleaning or clearance work is carried out on the building where necessary. This phase also focuses on the final organization of costs, stakeholder arrangements and the formation of the execution team required to carry out the project. Legal procedures, tendering and final approvals are finalized during this stage. The

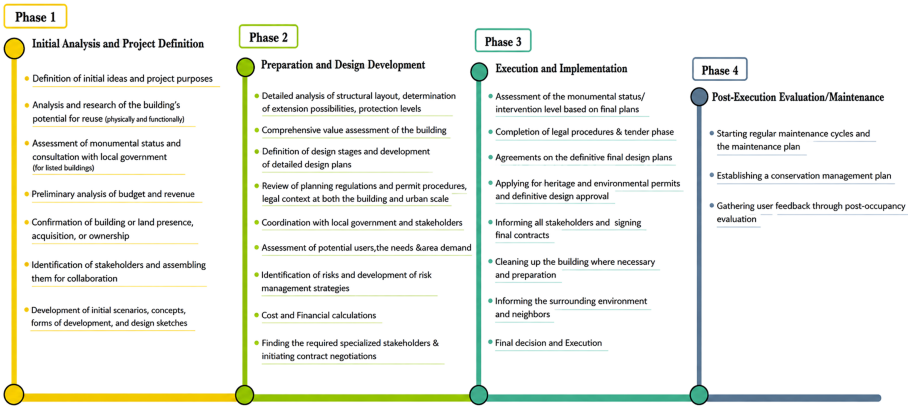


Figure 2. Definition of phases, summary of workshop results

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definitive design plans are confirmed, contracts are signed, and the construction or adaptation work is initiated. In the case of heritage buildings, this phase also ensures compliance with heritage protection regulations and finalizes the appropriate level of intervention.

4.1.1.4 Phase 4 – post-execution evaluation and maintenance. The final phase involves evaluating the project after a certain operational period, implementing the conservation management plan and initiating regular maintenance cycles. This stage includes assessing the project's successes and shortcomings, gathering feedback from users and stakeholders and planning for future interventions as needed. Ongoing maintenance and the adaptation of conservation strategies ensure the building remains functional and retains its cultural and architectural significance over time.

The adaptive reuse process in real-world projects generally unfolds through four interconnected phases, each comprising distinct yet overlapping activities designed to ensure the long-term viability and success of the project.

4.2 Adaptive reuse decision-making models

In the second phase of the results section, this paper aims to explore existing adaptive reuse decision-making models, examining their intended purposes, the input criteria they involve, their defining characteristics and other relevant aspects that shape their application and effectiveness.

4.2.1 Preliminary assessment Adaptation Model (PAAM). The preliminary assessment adaptation model (PAAM), which was presented by Wilkinson (2014), relies on a series of conditions that must be satisfied for an existing building to qualify for adaptation (Figure 3). This decision-making model is a qualitative framework that allows early assessment by non-experts for a better understanding of building's adaptation potential for an "alterations and

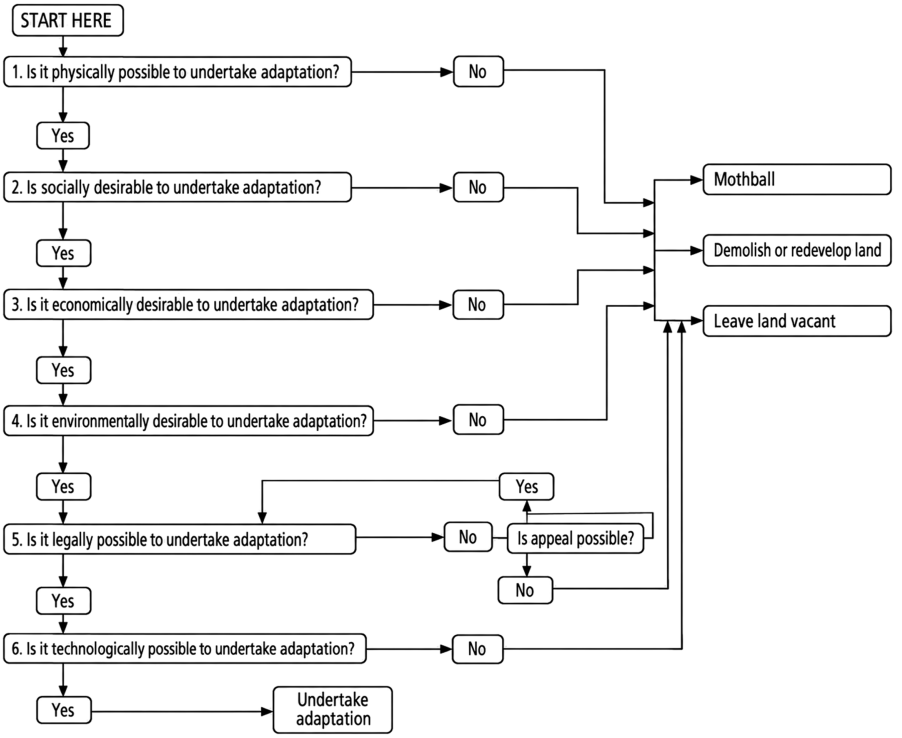


Figure 3. PAAM by Wilkinson (2014)

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extension" level of adaptation in the city of Melbourne. It is important to mention that the model does not contain the change of use in the adaptation strategy. Through using the six levels of adaptations namely: level 1 "minor," level 2 "alterations," level 3 "change of use," level 4 "alterations and extensions," level 5 "new build" and level 6 "demolition" and the influencing factors which are: Economic, Physical, Location and land use, Legal, Social and Environmental the PAAM model was proposed. The model has the first consideration of Physical suitability of a building for adaptation.

This model is largely based on the work of Chudley (1981), who tried to propose a sequence of steps that have to be taken into account for the initial assessment of a building adaptation. Wilkinson and her colleagues observed that Chudley's model covered most research-identified categories but lacked consideration of environmental and technical aspects; moreover, Chudley's model had not been tested in practice. To address these shortcomings, Wilkinson *et al.* (2014) reorganized Chudley's model, added environmental and technical factors and validated the PAAM through case studies. The key characteristics of PAAM are summarized in Table 2.

4.2.2 Adaptive reuse potential (ARP) model. The adaptive reuse potential (ARP) model, developed by Langston *et al.* (2008), is a key tool for evaluating a building's suitability for adaptation, meaning its high adaptation potential. It also helps identify the optimal timing when a building reaches its peak adaptive potential. The model requires an estimate of the building's expected physical life and its current age, both in years, along with assessments of physical, economic, technical, social, functional and legal obsolescence (Figure 4). When a building's age nears or falls below its expected useful life, the model indicates that planning for adaptation should begin. Applicable to all countries and building types, the model allows calculation of adaptive reuse potential at any point in a building's lifecycle, helping determine the best timing for intervention (Conejos *et al.*, 2012).

Physical obsolescence is assessed through maintenance policies and performance, while economic obsolescence is measured by location and proximity to a city center. Functional obsolescence is evaluated through the flexibility of a building's design, technological obsolescence through operational energy use, social obsolescence by the link between a building's function and the marketplace and legal obsolescence through the quality of the original design. Buildings initially constructed to low standards have a reduced useful life, with high-quality buildings facing no reduction (0%), low-quality buildings experiencing a 20% reduction and average-quality buildings experiencing a 10% reduction. Some important characteristics of *ARP* are summarized in Table 3.

4.2.3 AdaptSTAR model. AdaptSTAR is another decision-making tool developed by Conejos *et al.* (2012). In general, the principles of the adaptive reuse potential model have been developed and framed into the new tool, which is AdaptSTAR. This model is a five-star rating tool that involves a weighted checklist of design criteria that lead to future successful adaptive reuse of buildings (Conejos *et al.*, 2012). The criteria are based on the underpinning literature

Table 2. PAAM by Wilkinson (2014)

Characteristic	Description
Year	2014
Towards	Assessment of Building's Adaptation
Type of criteria	Qualitative
Stage	Phase 1, Phase 2
For	Non experts
Categories	Physical, social, economic, environmental, legal, technical
Hierarchy	Yes
Inspired by	Chudley (1981)
Developed in	Australia

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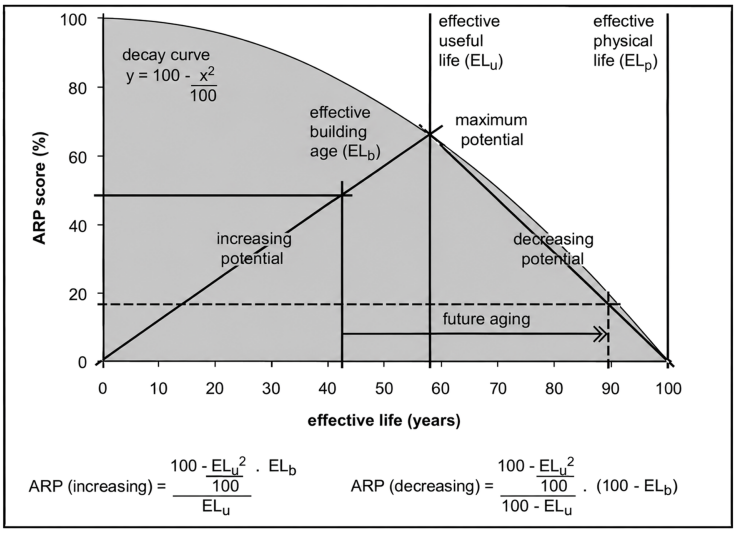


Figure 4. Adaptive reuse potential model by Langston *et al.* (2008)

Table 3. Adaptive reuse potential model by Langston *et al.* (2008)

Characteristic	Description
Characteristic	Description
Year	2008
Towards	Evaluating building's adaptation
Type of criteria	Qualitative, Quantitative
Stage	Phase 1, Phase 2
For	Non experts
Categories	Physical, economic, technical, social, functional and legal obsolescence
Hierarchy	No
Inspired by	. . .
Developed in	Hong Kong

and the interviews with professional stakeholders of 12 completed adaptive reuse case studies with different typologies in Australia. The criteria are presented in seven different groups: physical, economic, functional, technological, social, legal and political, and 26 sub-criteria (Figure 5). The scores assigned to each category were multiplied by corresponding weightings, derived from a survey conducted among twenty-nine seasoned architects. The resultant weighted category scores were summed and was employed to ascertain the assigned number of stars. The key characteristics of PAAM are summarized in Table 4.

4.2.4 IconCUR model. IconCUR (Langston and Smith, 2012) is a three-dimensional model used to assess a property's status based on three primary criteria: Condition, Utilization and Reward, represented as the *x*, *y* and *z* dimensions, respectively. The "condition" criterion is described as reflecting the physical characteristics of the property measured by design standard, maintained service level and regulatory compliance. The criterion of "utilization" is mentioned as reflecting the occupancy characteristics of the building evaluated through demand or relevance, fitness for purpose and user satisfaction. The "reward" criterion is calculated by multiplying the score for collective utility with the score for stakeholder interest

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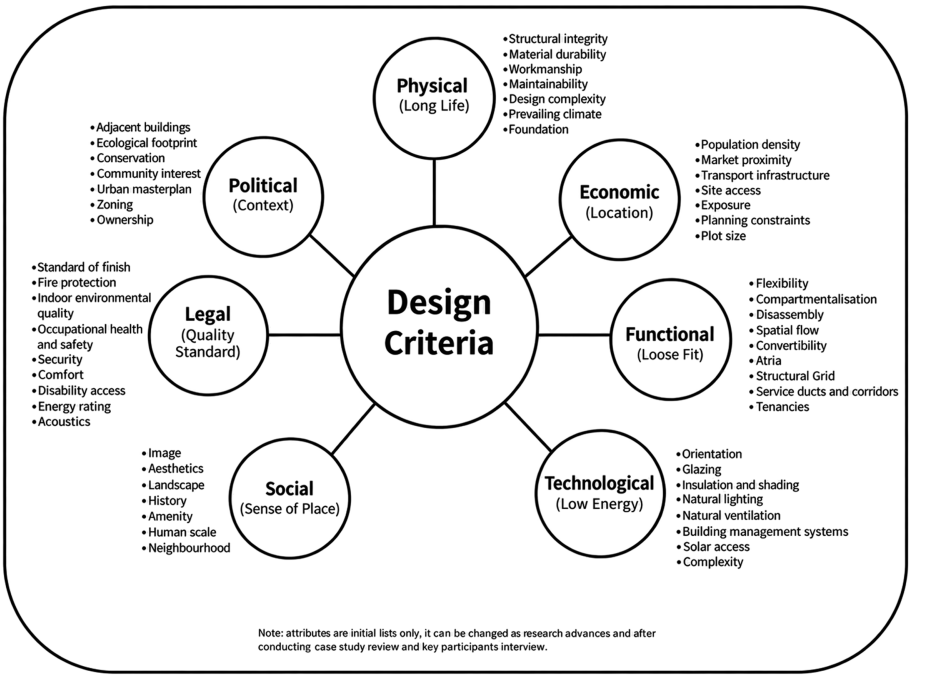


Figure 5. Proposed AdaptSTAR by Conejos *et al.* (2012)

Table 4. Proposed AdaptSTAR by Conejos *et al.* (2012)

Characteristic	Description
Year	2012
Towards	Successful future adaptive reuse projects
Type of criteria	Qualitative and Quantitative
Stage	Phase 1: Conceptualization, Phase 2: Design Developments, Phase 3
For	Experts/Designers
Categories	physical, economic, functional, technological, social, legal and political categories
Hierarchy	NO
Inspired by	ARP
Developed in	Australia

and dividing the result by 5. The decision-making process ideally involves consensus from professionals with varied responsibilities and perspectives. The model helps determine future decisions based on the relationship between a building's physical condition and its level of utilization. For example, low condition and low utilization lead to reconstruction or disposal, while high condition and high utilization suggest retention or expansion (Figure 6). IconCUR is useful when a property's coordinates can be quantified and follows a hierarchical scoring system from 0 (very low) to 5 (very high). In summary, IconCUR evaluates a building's current and potential performance, guiding decisions such as preservation, renovation, or disposal. Table 5 summarizes some important parameters of the IConCUR model.

4.2.5 Conversion meter. The Conversion Meter tool (Geraedts *et al.*, 2017) is designed to assess the risks and opportunities of converting vacant office buildings into residential dwellings. Its key characteristics are summarized in Table 6. It is an enhanced version of the Transformation Meter tool (Geraedts and van der Voordt, 2007), developed through literature

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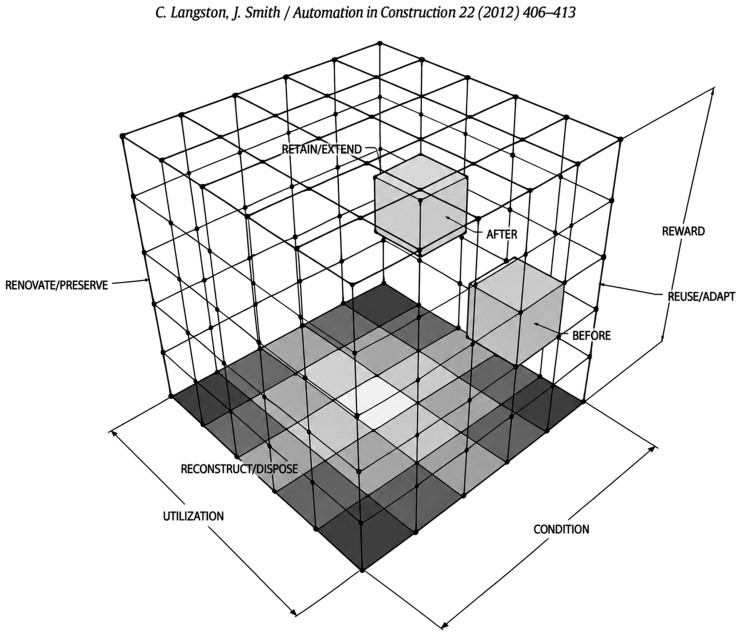


Figure 6. IconCUR 3d conceptual framework (Langston and Smith, 2012)

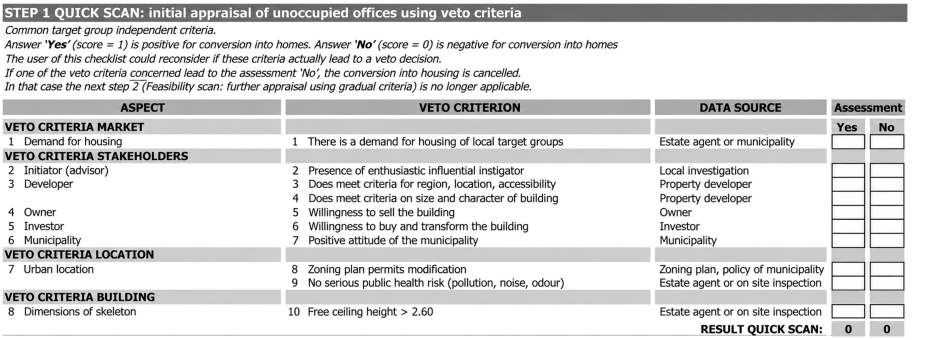
Table 5. IconCUR (Langston and Smith, 2012)

Characteristic	Description
Year	2012
Towards	Guiding decisions and evaluates building's performance
Type of criteria	Quantitative
Stage	Phase 1, Phase 2, Phase 4
For	Experts
Categories	Technical, Legal, cultural Categories
Hierarchy	Yes
Inspired by	. . .
Developed in	Australia

reviews, expert interviews and case studies. The tool consists of a series of checklists including yes or no questions, which have a hierarchical arrangement. It starts with a quick scan on the context of the building with yes/no questions, beginning with a quick scan of the building's context and "go/no go" criteria (Figure 7). It then moves to feasibility scans based on the building's location and physical features across functional, cultural, technical and legal categories. The summation of "yes" responses from each feasibility scan is calculated and the multiplied by a weight assigned based on the importance and it gives the user a score in the scale ranging from "no potential" to "excellent potential." The final stages of the Conversion Meter involve a "financial feasibility scan" which is considering acquisition cost, building condition, adaptation needs, units created and rental costs and "a risk assessment checklist" which is focusing on the physical aspects and suggests solution for identified risks.

4.2.6 Adaptive reuse assessment model (ARAM). The adaptive reuse assessment model (ARAM) is introduced for the evaluation of adaptability in heritage buildings. ARAM re-evaluates the prioritization of categories found in both Chudley's and Wilkinson's models,

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STEP 1 QUICK SCAN: initial appraisal of unoccupied offices using veto criteria

Common target group independent criteria.
*Answer **'Yes'** (score = 1) is positive for conversion into homes. Answer **'No'** (score = 0) is negative for conversion into homes*
The user of this checklist could reconsider if these criteria actually lead to a veto decision.
If one of the veto criteria concerned lead to the assessment 'No', the conversion into housing is cancelled.
In that case the next step 2 (Feasibility scan: further appraisal using gradual criteria) is no longer applicable.

ASPECT	VETO CRITERION	DATA SOURCE	Assessment Yes	Assessment No
VETO CRITERIA MARKET				
1 Demand for housing	1 There is a demand for housing of local target groups	Estate agent or municipality		
VETO CRITERIA STAKEHOLDERS				
2 Initiator (advisor)	2 Presence of enthusiastic influential instigator	Local investigation		
3 Developer	3 Does meet criteria for region, location, accessibility	Property developer		
	4 Does meet criteria on size and character of building	Property developer		
4 Owner	5 Willingness to sell the building	Owner		
5 Investor	6 Willingness to buy and transform the building	Investor		
6 Municipality	7 Positive attitude of the municipality	Municipality		
VETO CRITERIA LOCATION				
7 Urban location	8 Zoning plan permits modification	Zoning plan, policy of municipality		
	9 No serious public health risk (pollution, noise, odour)	Estate agent or on site inspection		
VETO CRITERIA BUILDING				
8 Dimensions of skeleton	10 Free ceiling height > 2.60	Estate agent or on site inspection		
		RESULT QUICK SCAN:	**0**	**0**

Figure 7. Conversion meter, step 1, quick scan with veto criteria (Geraedts *et al.*, 2017)

Table 6. Conversion meter, step 1, quick scan with veto criteria (Geraedts *et al.*, 2017)

Characteristic	Description
Year	2017
Towards	Assessment of conversion risks and benefits
Type of criteria	Quantitative/Qualitative
Stage	Phase 1, Phase 2
For	Experts
Categories	Location and physical features across functional, cultural, technical and legal categories
Hierarchy	Yes
Inspired by	Transformation meter
Developed in	Netherlands

incorporating the political category, heritage values and authentic features (Mehr and Wilkinson, 2023), as illustrated in Figure 8 and summarized in Table 7. The initial step in this model involves the recognition and assessment of significant authentic features and heritage values of a building (key-values). The subsequent stage considers assessing the economic viability of adaptive reuse heritage buildings, with technical and legal aspects taken into account. The political category, to some extent, overlaps with the economic category concerning government support and political ownership and is therefore given comparable consideration within the economic category. The locational, physical and environmental challenges are not considered in the model. Except for the consideration of important authentic features and heritage values, the sequence of the model does not indicate the importance of categories.

4.2.7 TOBUS. TOBUS (Caccavelli and Gugerli, 2002) is a decision-making computer-based tool proposed specifically for office building upgrading solutions, created by a team of researchers from various European countries (Table 8). It helps generate refurbishment scenarios and calculates a cost-efficient investment budget during the early stages of the refurbishment process. The TOBOS method is primarily applied in the initial decision-making process, which may ultimately lead to refurbishment. TOBUS is divided into four subject areas: the physical state of building degradation, functional obsolescence of building services, indoor environmental quality and energy consumption. Although the model provides solutions for multidisciplinary and professional issues, it only focuses on the conversion of office buildings. The model brings energy and indoor environmental quality to the heart of decision-making process. While the model addresses multidisciplinary issues, it focuses solely on office building conversions and does not prioritize historic buildings or consider socio-cultural, legal and environmental factors in the decision-making process. Nevertheless, it assists in identifying potential interventions and estimating costs.

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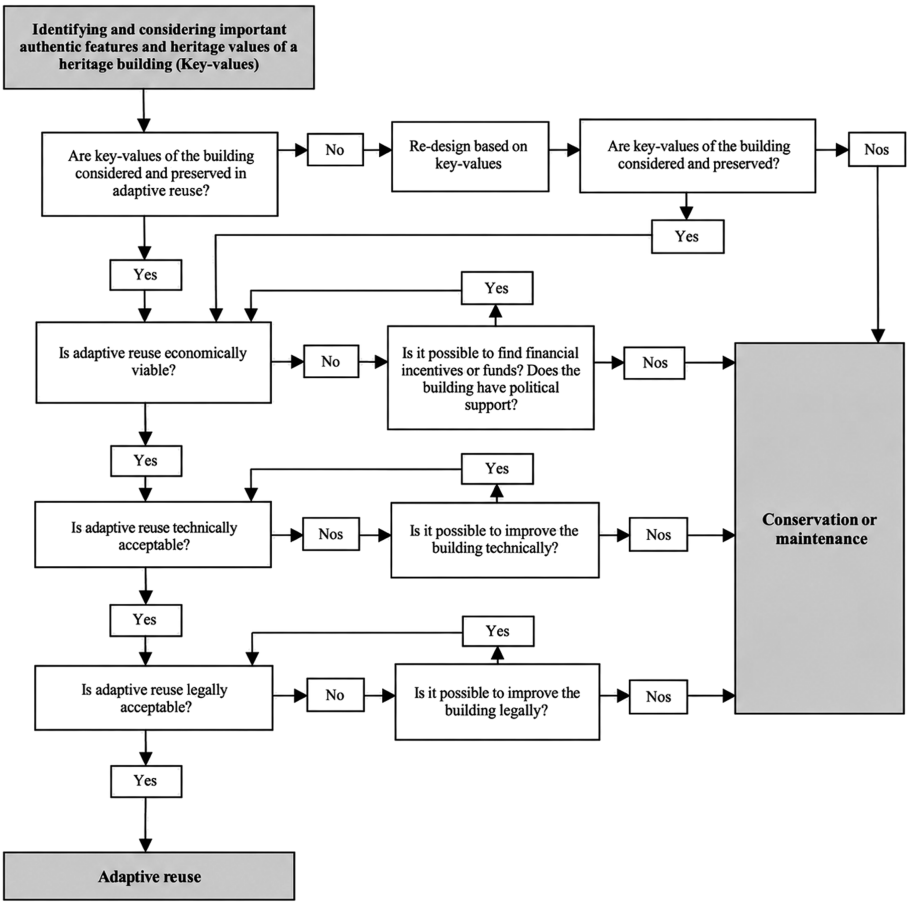


Figure 8. Adaptive reuse assessment model (ARAM) for heritage buildings by Mehr and Wilkinson (2023)

Table 7. ARAM for heritage buildings by Mehr and Wilkinson (2023)

Characteristic	Description
Year	2021
Towards	Adaptability Evaluation
Type of criteria	Qualitative
Stage	Phase 1
For	Non experts/Experts
Categories	Environmental, Social, Economic, Legal, Political, Physical, Locational, Technical
Hierarchy	YES
Inspired by	Chudley, PAAM
Developed in	Australia

4.2.8 ABD (adaptable building design) framework. The adaptable building design (ABD) framework (Allahaim *et al.*, 2010) provides a design tool that enhances a building's adaptability and extends its lifespan by using predictive uncertainty modeling, probabilistic simulations and

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Table 8. TOBUS decision model

Characteristic	Description
Year	2002
Towards	Refurbishment Scenarios
Type of criteria	Qualitative/Quantitative
Stage	Phase 1, Phase 2
For	Experts(Architects, Engineers)
Categories	Physical, Functional, Energy Consumption, Indoor Environment
Hierarchy	NO
Inspired by	. . .
Developed in	Europe

Real Options Analysis (ROA). The framework is divided into four phases: Phase 1 identifies potential future uncertainties such as technological, policy, climate and market changes; Phase 2 analyzes and integrates flexibility options into building systems; Phase 3 applies a mathematical decision-making model to define design rules for these flexibility options; and Phase 4 uses ROA to assess the economic value and adaptability of the project. ABD supports initial design and can be used in redesigns to determine optimal strategies for future adaptation and covering the building lifecycle. Table 9 summarizes some important parameters of the ABD.

4.2.9 Additional adaptive reuse frameworks. Building upon this understanding of decision-making approaches, there exist several adaptive reuse frameworks that, while valuable, differ in scope and purpose and therefore are not included in the main comparative analysis. These frameworks primarily serve as strategic guides or grading tools rather than comprehensive decision-making models with explicit input criteria and structured evaluation processes.

For example, the adaptive reuse decision-making model by Bullen and Love (2011) emphasizes three key factors – capital investment, asset condition and regulation – integrated with sustainability principles. However, it functions more as a conceptual framework derived from stakeholder interviews rather than a structured decision-support tool.

Similarly, Dutta and Husain (2009) present a MCDM-based grading system for heritage sites that enhances transparency and stakeholder involvement but is focused specifically on prioritization rather than full decision processes.

Misirlisoy and Gunce's (2016) qualitative model proposes a stepwise strategy development approach based on comprehensive analyses and interviews. While applicable across contexts, it is better understood as a strategic framework guiding adaptive reuse rather than a formalized decision-making model.

These frameworks provide important perspectives and complementary insights into adaptive reuse but fall outside the defined criteria for decision-making models central to this

Table 9. ABD decision model

Characteristic	Description
Year	2010
Towards	Extending Buildings Lifespan
Type of criteria	Qualitative/Quantitative
Stage	Phase 1, Phase 2
For	Experts
Categories	Technical/performance, legal and policies, finance and market, climate conditions
Hierarchy	No
Inspired by	. . .
Developed in	Europe

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research. Future studies could explore integrating such frameworks with decision-support models to enrich adaptive reuse planning.

4.3 Relationship between adaptive reuse phases and decision-making models

The mapping and linkage between the decision-making models analysed in this research and the phases of adaptive reuse were established through multiple approaches, as the original studies rarely specify the exact phase in which their models are intended to be applied. However, by examining the purpose of each model and the context in which it is applied, it was possible to determine the phase of adaptive reuse to which it is most relevant. In addition, the key terms and keywords used in the original papers to describe the model, its applicability and its structure – as well as the model's name – provided direct or indirect indications of the phase to which the model is most closely associated, which is discussed in more detail in this section.

As mentioned in the introduction, one of the gaps in this study is the lack of sufficient research providing a comprehensive definition of adaptive reuse phases and their clear division in practice. A review of existing research and decision-making models in the field shows that these models do not always explicitly indicate the specific phase of adaptive reuse to which they apply, and instead primarily focus on describing the overall purpose of the model itself. However, it is evident that many of the reviewed models are designed to analyse and evaluate the potential of buildings for adaptive reuse, which is a key activity of Phase 1. In other words, the majority of multi-criteria decision-making models in this domain fall under the "alternate use/adaptive reuse selection" category. For example, based on its name, the ARP model by Langston *et al.* (2008) primarily focuses on the "assessment of potential adaptive reuse projects" and "identifying buildings' suitability for adaptive reuse," as stated in the original research paper. These activities correspond to Phase 1 of adaptive reuse, according to the definitions of this phase in Figure 1. A similar approach can be observed in the PAAM by Wilkinson (2014), which focuses on the "preliminary assessment of adaptation potential." It clearly addresses the evaluation of a building's suitability for adaptation as an initial step, placing it within Phase 1. Although the main purpose of PAAM lies in Phase 1, it also discusses "alterations and extension-level of adaptation" and includes some considerations related to design and the surrounding environment, which are associated with Phase 2 activities of adaptive reuse. However, it is important to note that, as stated in the original paper, PAAM is intended as an initial screening tool for assessing adaptation potential. In addition to ARP and PAAM, the ARAM by Mehr and Wilkinson (2023), as reflected in its name, also focuses on assessing the building's potential for adaptability. Notably, ARAM places greater emphasis on heritage buildings compared to other models, making it a more suitable option for initial assessment in cases involving heritage structures. All of these models, as reflected in their names and stated objectives, primarily focus on the assessment and evaluation of the potential of buildings for adaptation. The final step of these models typically involves determining whether the adaptive reuse approach should be considered or whether alternative options are more appropriate. Accordingly, they are mainly associated with Phase 1 of adaptive reuse and its related activities, such as "analysis and research of the building's potential for reuse," "assessment of monumental status," "development of initial scenarios and forms of development" and "definition of initial ideas and project purposes." All of these activities fall under the category of Phase 1 of adaptive reuse. The Conversion Meter (Geraedts *et al.*, 2017), described in the original research paper as a "Conversion Potential assessment tool" also focuses on evaluating the potential of buildings for reuse within Phase 1 through a quick scan based on yes/no and veto criteria for conversion. However, it extends beyond this initial assessment by including a feasibility scan, "detailed analysis of structural layout," some "financial calculation," "determination of extension possibilities" and "identification of risks and risks management." These activities are largely associated with Phase 2 of adaptive reuse, namely "preparation and design development." In this regard, the IconCUR model (Langston and Smith, 2012) determines adaptation potential based on the relationship between the existing physical condition and the utilization of the building, as

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well as alternative scenarios such as "preserve" and "extend." These aspects place the model within the activities of Phase 1. However, it also goes further; as indicated in the study presenting the model, the IconCUR model demonstrates the ability to map design criteria and sub-criteria, for example, "stakeholders interest," with attributes such as "design standard" and "regulatory compliance," which are all activities under the category of Phase 2 of adaptive reuse, "preparation and design development." Another point to consider is that the model adopts a prospective view by defining short-term perspective (first 5 years), medium-term perspective (15 years) and long-term perspective (remaining useful life). It also introduces the concept of "Maintained service level," which refers to the level of upkeep and includes aspects such as regular repair. This component can be related to activities such as "starting regular maintenance cycles and maintenance plan" and establishing a "conservation management plan," both of which fall under Phase 4 of adaptive reuse, "Post Execution Maintenance," as referred to in Figure 1. Similarly, the TOBUS model consists of two stages: first, assessing the property status of office buildings, and second, determining the type of intervention based on potential costs, energy considerations and interior comfort. Accordingly, the first stage relates to activities such as "analysis of the building's potential for reuse" and budget analysis in the initial design stage, corresponding to Phase 1. The second stage, which involves cost evaluation, financial calculations and possible intervention scenarios, is associated with Phase 2 of adaptive reuse. Like many other models, this one does not elaborate on the implementation phase of adaptive reuse (Nedeljkovic *et al.*, 2023).

On the other hand, the AdaptSTAR model, which is specifically designed to assess the future adaptation potential of new buildings, stands out as one of the few models focusing on the "design criteria" of new structures. As stated in the original paper, the application and use of the AdaptSTAR model depend on the willingness of design practitioners and other allied professionals to use the tool throughout the design process, from pre-design and concept decision-making to project implementation. Accordingly, the AdaptSTAR model (Conejos *et al.*, 2012) is most applicable across multiple phases of adaptive reuse, from the initial phase of "initial analysis and project definition" to the second phase, "preparation and design development" and the third phase, "execution and implementation." Among the models discussed in the results section, the ABD model (Allahaim *et al.*, 2010) also focuses on the design of future buildings with adaptive potential. Based on the authors' description, the adaptable buildings design (ABD) framework aims to support the design of buildings that can adapt to change and thereby increase their longevity. As noted in the paper, the process begins with recognizing uncertainties, which involves "analysis and research of the building and its potential for adaptability," corresponding to the first phase of adaptive reuse, "initial analysis and project definition." Furthermore, as reflected in its design-oriented approach, the ABD framework also contributes to Phase 2, "preparation and design development," by proposing strategies for creating buildings capable of adapting to change.

In summary, most decision-making models are designed to assess the potential of a building or asset for adaptive reuse, primarily focusing on the initial stages, particularly the decision point of whether to adapt, demolish, or take no action. Furthermore, some of these models generally do not support the subsequent stages of the adaptive reuse process, nor do they clearly identify which factors or categories are applicable in these later phases.

5. Discussion

5.1 Decision-making models comparison

5.1.1 Heritage and non-heritage considerations. There is a clear distinction not only between the decision-making processes and phases of new buildings and adaptive reuse projects, but also in the decision-making for the adaptive reuse of heritage buildings. In other words, the heritage status of a building, whether listed or unlisted, directly affects the prioritization of decision-making processes, factors, categories and their classifications from the initial stages of a project (Vafaie *et al.*, 2025). This aspect has, however, received insufficient

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attention in the existing models of decision-making in this field. A quick glance at the titles of research papers proposing these models and Table 10 reveals that only the ARAM decision model explicitly mentions "A model for assessing adaptability in heritage buildings" with its categories designed based on the value-representative characteristics of heritage buildings. Additionally, a framework of adaptive reuse strategies for heritage buildings by Mısırlısoy and Günç (2016) tends to focus more on guidelines without quantitative measurements, offering flexibility for various scenarios in the adaptive reuse process. Besides some other decision models that consider aspects of heritage value and authenticity in certain inputs, these factors are only indirectly mentioned under broader categories, such as socio-cultural, rather than being listed as separate, distinct factors or categories. This issue has also been pointed out in the literature. For instance, Hong and Chen (2017) suggested that the AdaptSTAR model does not fully account for the unique characteristics of historic buildings, where the relative factors in this model, such as socio-cultural value, can outweigh other factors. In this context, research comparing the Transformation Meter and IconCur indicated that potential improvements could be achieved by incorporating additional factors, such as assigning greater weight to intangible values, like heritage, in order to more accurately reflect real-world conditions (Baker *et al.*, 2017). In the PAAM decision model, the physical category is prioritized, and if a building's current physical condition does not meet the criteria, the adaptation process fails. However, this approach should not be applied to heritage buildings, as a high architectural or cultural-historical value, along with designation as a monument, will hinder demolition and stimulate adaptive reuse, as Benraad and Remøy (2007) also mentioned.

Furthermore, decision-making for heritage buildings involves not only the consideration of specific factors and their categories but also how these categories are prioritized relative to one another, particularly when comparing heritage to non-heritage buildings, including both listed and non-listed structures.

5.1.2 Categories/criteria. Typically, adaptive reuse decision-making models and frameworks encompass a range of categories, each including a list of relevant criteria or factors that guide the decision-making models to meet their purposes. The identification, classification and listing of these factors within their categories have been the focus of several studies over the past decades (Douglas, 2006; Langston *et al.*, 2008; Conejos *et al.*, 2012). Vafaie *et al.* (2023), through a comprehensive systematic literature review of numerous articles, identified and summarized the key categories involved in the decision-making process of adaptive reuse projects and their successful outcomes. These categories include: architectural (physical), structural (technical), socio-cultural, economic, environmental, energy, authenticity, legal, management (decision-making) and functional. The number and nature of these criteria can differ across decision-making models due to differences in authors' research scopes, data collection approaches and disciplinary focus. This is further emphasized by Unver *et al.* (2022), who pointed out that each adaptive reuse decision model incorporates different dependent matrices but also a set of common criteria/factors often exists in the process of analysing adaptability across different frameworks and models. For instance, in the ARP model, the categories include physical, economic, functional, technological, social and legal factors. Building on ARP, the AdaptSTAR model incorporates all these categories and introduces an additional one – political – as seen in the use of the conversion meter. Similarly, IconCUR, which focuses not only on the reuse potential of buildings but also on the level of intervention required, places greater emphasis on physical aspects over functional parameters. On the other hand, PAAM does not directly include a category titled "physical," although some of the related variables might be defined under the category of "technical." However, it clearly highlights the functional category, which is an important aspect of adaptive reuse within heritage buildings. In this regard, ARAM, as a model titled for assessing adaptability in heritage buildings, does not directly contain a functional category; however, in its first stage, it assesses authentic features and historic values as the first fundamental aspect, and in general it includes physical, technological, economic, social, legal and political categories.

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These decision models, along with their associated categories and factors, often complement and build upon one another, contributing to the development of more comprehensive models or even the creation of new frameworks.

5.1.3 Hierarchy. Prioritizing factors and their relevant categories over one another depends on variables such as the building typology, intended function, the purpose of the decision-making tool and stakeholders' willingness to preserve the building (Askar *et al.*, 2022). For example, in the ARAM decision model, social, political and economic factors are prioritized over physical aspects for heritage buildings. This prioritization comes from the recognition that adaptive reuse often depends on political support to address the high costs involved, emphasizing the early consideration of economic and political factors (Mehr and Wilkinson, 2023). However, a question arises here whether these aspects should come before technical parameters, especially considering the role of structural safety in old buildings – a matter that remains debatable.

On the other hand, in the PAAM decision-making model, the significance of the building's physical conditions in the initial stages can exert a direct influence on subsequent steps, determining whether the process ultimately leads to the adaptive reuse of the building. In the iconCUR model, there is also a hierarchical approach between the indicators within the criteria (established by their percentage share); however, not all decision-making models follow the same approach. Models like adaptSTAR adopt a different method, assigning higher importance to each category – such as the physical category with 16.08% – based on specific ratios collected through expert interviews, rather than relying on the sequence of different stages. In contrast, the ARP model does not imply a hierarchy between criteria, instead treating all criteria as equally weighted, with the building's physical life determined collectively through these factors. Similarly, the TOBUS model does not include hierarchical structures, but in general the main focus of the model is on the energy category and internal comfort of the building.

In general, most adaptive reuse decision-making models follow a hierarchical structure, shaped by the model's purpose and the approach to data collection, while some others apply equally weighted categories. However, the order and importance of these steps or categories may vary across models. Elements such as the significance level of each category, the relationships between categories, and the relative importance of individual components within a category can all influence the structure and sequence of steps within a decision-making framework.

It should be emphasized that not all decision-making models fully address these complexities. The challenge becomes especially noticeable when categorizations are not specifically designed to distinguish between listed (heritage) and non-listed buildings, leaving the impact of heritage value on decision-making steps or the overall framework insufficiently explored. Nevertheless, as ICOMOS Australia (2013) emphasizes, in the adaptive reuse of heritage buildings, adaptation priorities are clearly focused on preserving the building's intrinsic heritage value, which sets these processes apart from strategies used for non-heritage structures.

5.2 Relationship between adaptive reuse decision models (evolution and validation)

There are a number of decision models and frameworks in the field of adaptive reuse that build upon earlier models, offering more complete versions. For example, the design criteria in the AdaptSTAR model, which are organized into seven overarching dimensions – physical, economic, functional, technological, social, legal and political – align with the seven obsolescence categories identified in the ARP model, providing a solid foundation for direct comparison (Conejos *et al.*, 2013). In this context, the Conversion Meter is another decision-making tool, serving as an updated version of the Transformation Meter, designed to assess the adaptation potential of vacant office buildings. Additionally, both the first and second versions of the PAAM decision-making model are largely based on the work of Chudley (1981), who proposed a sequence of steps to be considered during the initial assessment of building adaptation.

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By drawing upon proven frameworks and adapting them to contemporary challenges, researchers can build on established knowledge while ensuring that the models remain contextually relevant and robust. This approach not only enhances the validity of new models but also promotes continuity and innovation in the field of adaptive reuse, as long as the models are focused on specific purposes and relevant contexts. The relationship between decision models goes beyond their evolutionary process; several decision-making models and tools, such as the ARP and AdaptSTAR models, have been thoroughly tested and validated through case studies in various contexts (Langston *et al.*, 2013; Sharifi and Farahinia, 2020a). Additionally, some models have been validated through comparison with other models. For example, Langston (2012) assessed the level of agreement between the ARP and IconCUR evaluations based on twelve case studies, revealing notable correlations between the two models. The findings indicated that if the ARP is conducted first and a project achieves an ARP score exceeding 50%, it should proceed to the second stage, involving evaluation using IconCUR. Similarly, Conejos *et al.* (2013) compared the AdaptSTAR and ARP models, validating the AdaptSTAR model through comparison with the ARP model across multiple case studies. The relationship between these models suggests that the success of an adaptive reuse project is associated with a higher AdaptSTAR score. While IconCUR identifies the types of actions to be considered, the Transformation Meter focuses specifically on the adaptation potential of the building. Despite these differences, both tools offer relevant insights regarding the suitability of adapting or demolishing a building within the context of assessing a portfolio of building assets (Baker *et al.*, 2017). The question of whether older buildings should be demolished and replaced has long been a controversial issue among both the public and government authorities (Ashworth, 2011; Ariffin *et al.*, 2020).

5.3 Applicability of decision-making models

Each model reviewed in this study possesses its own distinct purpose, characteristics and specific structure. Although these decision-support models were systematically examined and compared, one of the main limitations of this study lies in the act of comparison itself. This is primarily due to the fundamentally different natures of the models. For instance, some models are quantitative, whereas others are qualitative; some operate within three-dimensional frameworks, while others are limited to two-dimensional representations.

Furthermore, the scope of application varies significantly among the models. Certain models, such as TOBUS, ABD and Conversion Meter, primarily focus on specific types of conversions, particularly the transformation of office buildings into residential use. In contrast, models like IconCUR do not concentrate on a specific building typology but instead adopt a broader perspective.

In terms of functionality, the models also demonstrate notable differences. For example, IconCUR primarily focuses on "the management of existing built facilities," whereas models such as ARP emphasize aspects such as "Best timing of intervention." Therefore, the applicability of these models is best understood in relation to the specific objectives of a given project. In particular, their usefulness depends on whether the model aligns with the project's purpose – whether for validation of completed projects or for providing recommendations for future developments.

Figure 9 serves as a guide for researchers and practitioners seeking decision-support models applicable to specific phases of adaptive reuse, indicating which models are most suitable at each stage. In addition, since the purpose of each model reflects its functionality, it is essential to identify overlaps between the intended use of the model within a project and the predefined purposes of the models throughout the adaptive reuse process.

All of this information is synthesized in Table 10, which presents a comparative analysis of the reviewed decision-making models and their key characteristics. This table supports decision-makers in selecting appropriate models based on factors such as their intended purpose, type of criteria, whether the building already exists or is to be developed in the future and their overall applicability.

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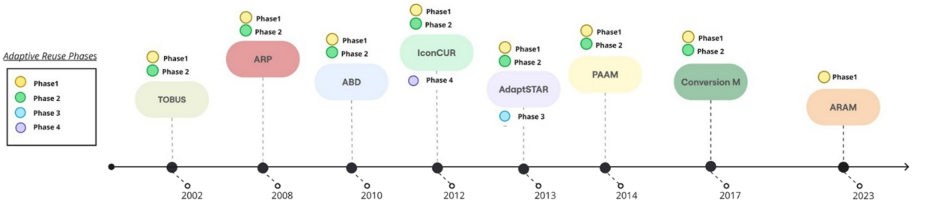


Figure 9. Decision-making models and adaptive reuse phases

Table 10. Comparative analysis of decision-making models

	ARP	ARAM	PAAM	Conversion M	TOBUS	IconCUR	ABD	AdaptSTAR
Categories	Physical Economic Functional Technological Social Legal	Environmental Social Economic Legal Political Physical Locational Technical	Physical Social Economic Environmental Legal Technological	physical functional technological economic legal social political	Physical Functional Energy Consumption Indoor environment	feasibility: Physical, location, financial and categories: technical legal cultural categories	Technical/performance legal and policies finance and market climate conditions	Physical Technological Economic Functional Social Legal Political
Building Typology	Overall	Overall/Heritage	office/commercial	Office/Residential	Office	Overall	office/commercial	Overall
Hierarchy	NO	YES	YES	YES	NO	YES	YES	NO
Type of Criteria	Qualitative/Quantitative	Qualitative	Qualitative	Quantitative	Qualitative/Quantitative	Qualitative/Quantitative	Qualitative/Quantitative	Qualitative
New or Existing	Existing building	Existing building	Existing building	Existing building	Existing building	Existing building	New building	Existing/New Building
Purpose	A model to assess useful life and adaptation potentials	A model of evaluation for heritage buildings	A preliminary assessment model	A tool for the assessment of risks and opportunities	A software tool for adaptation possibilities	The 3D model for building's adaptability performance	A design support tool	A multi-criteria design decision tool

Although these decision models were primarily developed and their data collection was conducted in developed contexts, such as ARP, AdaptSTAR, IconCUR and PAAM in Australia, the Conversion Meter in the Netherlands and TOBUS through a collaboration among several European countries, some of them have also demonstrated applicability internationally and in emerging markets. For example, the ARP model was tested and applied in Hong Kong (Langston and Shen, 2007), Australia (Shehata *et al.*, 2022), Iran (Sharifi and Farahinia, 2020b) and Iraq (Mustafa, 2023). Similarly, AdaptSTAR has been applied in Australia (Conejos *et al.*, 2013), Hong Kong (Conejos *et al.*, 2017) and Iran (Tavakoli *et al.*, 2026). Apart from the different economic circumstances between developed and emerging markets, their potential applicability appears to be more international than context-based.

5.4 Practical implications

Regarding the practical implications of this study, this research is beneficial to stakeholders and decision-makers involved in adaptive reuse projects in three ways. First, it helps architects, developers, heritage advisors, public sector representatives and other stakeholders understand the phases of adaptive reuse projects in real-world practice, the sequence of steps to follow, the activities that should be considered, and any aspects that may be missing or require further attention. Second, by reviewing the existing adaptive reuse decision-making models, together with their purposes, characteristics and application contexts, this study enables practitioners to identify the most relevant decision-making model according to the purpose and context of their projects and to understand how these models can be applied. Although gaps and challenges still exist in adaptive reuse decision-making and further research is being undertaken to

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address them, implementing and benefiting from these models, particularly those that have been validated in practice, can facilitate the decision-making process. Third, this study contributes to the discussion on the relevance of existing decision-making models to the different phases of adaptive reuse and identifies the phases in which these models are most applicable to support improved decision-making for the adaptive reuse of existing and heritage buildings.

6. Conclusion

The decision-making processes involved in adaptive reuse projects, particularly concerning heritage buildings, are inherently complex and multifaceted. Existing literature on decision-making models for adaptive reuse often lacks a comprehensive analysis of the relevance of these models to the different phases of the adaptive reuse process, the exploration of internal categorizations and criteria, the consideration of authentic value for heritage buildings and the significance or hierarchy of various factors within each model. While both academic and practical research on this topic has progressed, there remains a noticeable gap in comprehensive comparative analyses of these decision-making models.

As a first step in analyzing how models incorporate phases, we conducted a focus group to gather diverse perspectives on the actual phases of adaptive reuse in real-world projects. This approach aimed to enhance the limited existing literature by helping define each phase and identify the key activities and decisions associated with them in practice. While focus groups often face challenges related to limited diversity, considerable attention was given to including representatives from both the public and private sectors, and from a range of perspectives within the field. All participants were actively involved in adaptive reuse projects and contributed valuable insights based on their practical experience, helping ensure that a broad range of viewpoints was represented. The results of the data were categorized into four key phases: Phase 1 – Initial Analysis and Project Definition, Phase 2 – Preparation and Design Development, Phase 3 – Execution and Implementation and Phase 4 – Post-Execution Evaluation and Maintenance. Our analysis shows that most decision-making models for adaptive reuse primarily focus on assessing a building's potential during the early stages of the process. However, the extent to which this initial assessment contributes to the success of the project as a whole remains unclear. Moreover, these models often do not extend to the later stages of adaptive reuse, nor do they clarify which factors or categories may be relevant during those phases. It is therefore crucial to recognize which categories and internal criteria should be considered at each specific phase. The majority of these decision-making models focus on office buildings, although some claim general applicability. Notably, aside from the model by ARAM, no existing decision-making framework explicitly prioritizes aspects related to heritage buildings and their unique factors. While some models show alignment with existing frameworks, further research is needed to refine and incorporate a comprehensive categorization of success factors into decision-making models for adaptive reuse. This study proposes a decision-making model that tailored to the assessment of adaptive reuse in existing (heritage) buildings – one that requires a clear understanding of the key challenges that significantly influence this process.

This study applied a consistent set of comparative criteria – categories addressed, building typology, hierarchy, type of criteria, applicability and overall purpose – to evaluate existing models. Using these criteria highlighted key strengths and gaps, such as the lack of attention to later phases and heritage-specific needs. Framing the conclusions around these criteria emphasizes the need for future models to be more comprehensive, adaptable and connected to the real adaptive reuse phases of existing (heritage) buildings. Moreover, this research addresses an important gap in the literature on adaptive reuse by linking decision-making models to distinct phases of adaptive reuse, an area that has not been extensively explored before. In terms of practical implications, the study helps decision-makers in adaptive reuse

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projects gain a clearer overview and understanding of existing decision-making models, as well as where and when these models are applicable across different phases of the adaptive reuse process. Overall, this study contributes to facilitating the decision-making process in adaptive reuse projects for practitioners.

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