What matters when?

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What matters when? – An integrative literature review on decision criteria in different stages of the adaptive reuse process

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ABSTRACT

Despite the significant growth of the literature on adaptive reuse, little is known about the specific criteria unfolding throughout the different phases of the adaptive reuse decision-making process. To address this gap this paper aims to provide a comprehensive, state-of-the-art overview of the decision criteria for adaptive reuse throughout the adaptive reuse process. Through an integrative literature review with a systematic search strategy, three phases are substantiated: pre-project phase, preparation phase, and post-completion phase. This paper finds that despite the similarities between the different phases, with a predominant repetition of economic and architectural categories, more specific environmental decision criteria are still overlooked. The findings underscore the necessity for additional research on circularity within the adaptive reuse process, emphasizing the significance of the often overlooked implementation phase, crucial for practices like disassembly. By offering a novel process perspective on AR decision-making, this study contributes to the growing discourse on adaptive reuse and provides a basis for further enhancement of AR decision-making frameworks.

1. Introduction

The average lifetime of a building is only 34 years, with the most common reason for building demolition being functional obsolescence (Liu et al., 2014). At the same time buildings worldwide account for 40 percent of the world's waste, 40 percent of material resource use, and 33 percent of all human-induced emissions (Layke et al., 2016). To cope with these environmental impacts and to extend the functional lifetime of buildings, adaptive reuse has become a well-established strategy (Langston et al., 2008). Adaptive Reuse (AR) is defined as *"the process of extending the useful life of historic, old, obsolete, and derelict buildings, by seeking to maximize the reuse and retention of existing structures and fabrics"* (Shahi et al., 2020). The term adaptive reuse emerged in the 21st century and has its roots in the combination of 'ad' (to) and 'aptare' (fit) which can be translated to: "the process of fitting" (Douglas, 2006). The classic definition focuses on the change in use; a process of converting a building for a new use, different from the initial aim of its construction (Douglas, 2006). Adaptive reuse therefore differs from other building adaptation practices like refurbishment, renovation, and restoration where the focus lies on extending the functional lifetime of the building for the same use (Shahi et al., 2020).

The adaptive reuse of buildings has many social, environmental, and economic benefits. By adaptively reusing a building embodied energy is preserved (Kumari et al., 2020), and the further use of operational energy is reduced (Langston et al., 2008). Preventing demolition through the reuse of buildings results in environmental advantages including reducing construction waste, consuming fewer natural resources and raw materials (Conejos et al., 2013), emitting fewer greenhouse gases (Yung and Chan, 2012), and controlling urban sprawl (Sanchez et al., 2019). Other social advantages of adaptive reuse include improved safety, quality of living, occupant health, and help restore and maintain the identity of a building (Shen and Langston, 2010; Aigwi et al., 2018). When it comes to economic advantages, adaptive reuse can lead to the increase of property value of the building and other surrounding buildings (Sanchez et al., 2019), and the generation of jobs on the site and in its vicinity (Chan et al., 2015).

A growing trend of adaptive reuse literature has been observed recently (Li et al., 2021; Nadkarni and Puthuvayi, 2020; Owojori et al., 2021). Owojori et al. (2021) reviewed the global research developments in adaptive reuse according to journal articles from 2006 to 2022 and found that the number of published articles has grown exponentially during the reviewed period. Earlier scientific work between 2010 and

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2017 focused on the concept of adaptive reuse in the light of historical preservation and sustainable development (Li et al., 2021). This first period of scholarly work saw the emergence of publications relating to; the assessment of building reuse (Wilkinson, 2014), adaptive reuse potential (Langston et al., 2008), and design principles for adaptive reuse (Conejos et al., 2014). In the most current period, the focus has shifted towards more publications on strategic approaches such as: 'multi--criteria analyses' (Haroun et al., 2019), 'decision-making processes' (Nadkarni and Puthuvayi, 2020), 'design strategies' (Hamida et al., 2023), 'human engineering' (Li et al., 2021), etc.

Especially multi-criteria decision-making (MCDM) models have become increasingly popular in recent years for the evaluation of adaptive reuse projects (Nadkarni and Puthuvayi, 2020), as they provide a structured approach to assess and compare alternative solutions, taking into account these multiple criteria (Belton and Stewart, 2002; Mardani et al., 2015). Multi-criteria decision-making (MCDM) exists to help decision-makers systematically navigate the complexities of evaluating alternatives with multiple conflicting objectives (Keeney and Raiffa, 1976). The decision-making process in adaptive reuse projects is often complex, involving multiple and conflicting criteria, such as economic feasibility, environmental sustainability, cultural significance, technical feasibility (Wilkinson et al., 2014), and the inclusion of many stakeholders (Douglas, 2006; Bullen and Love, 2011; Wilkinson et al., 2009). These models can help improve the efficiency and effectiveness of various facets of decision-making by considering all relevant factors, and by integrating various forms of data and expert knowledge (Greco et al., 2016; Love et al., 2023). There is, however, no clear consensus on the decision criteria and the decision support tool when it comes to adaptive reuse (Mısırlısoy and Günçe, 2016; Arfa et al., 2022a; Unver et al., 2022).

A wide range of different MCDM methods are used in the adaptive reuse literature (Nadkarni and Puthuvayi, 2020). The method, stakeholders, and criteria used in the multi-criteria decision-making process for adaptive reuse are dependent on the aim and context of the application (Li et al., 2021). When determining an alternative new use for a building, different decision criteria and stakeholders are involved, compared to when AR projects are evaluated post-completion (Nadkarni and Puthuvayi, 2020; Arfa et al., 2022a). The type of decisions and the decision criteria per phase in the adaptive reuse process can therefore differ, which is understudied in the adaptive reuse literature. Deciding on whether to reuse the building in the first place, might require different decision criteria compared to when deciding on the best option for adaptive reuse. An extensive body of literature looked into the decision criteria for deciding on the new use of a building (Haroun et al., 2019; Bottero et al., 2019; Chen et al., 2018; Dell'Ovo et al., 2021). Assessing the building on its adaptive reuse or adaptability potential to decide between demolition, renovation, or adaptive reuse, has also been subject to many publications (Wilkinson, 2014; Bansal and Chhabra, 2022; Langston, 2014a; Langston and Shen, 2007; Sharifi and Farahinia, 2020). However, studies that look into the different decisions that are made throughout the adaptive reuse process, and the interrelationships and contrasts between the corresponding decision criteria, are lacking. Many publications on decision-making in adaptive reuse have focussed on specific decisions within a distinct phase (Nadkarni and Puthuvayi, 2020), but few have considered the process as a whole (Arfa et al., 2022a). The idea of considering adaptive reuse from a process perspective, rather than merely an architectural design intervention, has been put forward before (Lanz and Pendlebury, 2022) but is not reflected in the decision-making literature. Approaching building and construction management in a 'phased' manner can effectively guide engineering practices by providing a deepened understanding of organizational management across different project stages (Wang et al., 2023). Arfa et al. (2022a) do consider adaptive reuse from a process perspective but take a broader approach, coming up with a conceptual model for the general AR process, while not focusing on the decision-making process. The evaluation of the adaptive reuse academic literature in the domain of decision-making, demonstrates that there is a lack of understanding of: 'What matters when?', in adaptive reuse processes. This lack of understanding in the decision-making process could hinder the execution of adaptive reuse projects. Slow decision-making is already an important factor for the delay in construction projects (Carvalho et al., 2021), and a lack of understanding regarding the appropriate decisions and decision criteria could further delay the process.

No literature currently exists that systematically looks at the similarities and differences between relevant criteria in the various phases of the adaptive reuse decision-making process. This lack of publications, and the need to holistically approach the AR process as a whole (Arfa et al., 2022a; Lanz and Pendlebury, 2022), based on the different phases of the AR process, provides the knowledge gap for this paper. Considering the aforementioned research gaps in the decision-making literature for adaptive reuse projects, this study aims to address the following research questions: (i) What decisions are made in the different phases of the AR process? (ii) What are the criteria in decision-making for the adaptive reuse of buildings during the different phases of the AR process?

The objectives of this paper are threefold: to provide a comprehensive, state-of-the-art overview of the decision criteria for adaptive reuse throughout the adaptive reuse process, to identify the similarities and differences between these criteria in the various phases, and to identify potential areas for future research, thereby contributing to the growing discourse on adaptive reuse decision-making. This study's novelty lies in its approach; to the best of our knowledge, this is the first literature review that takes a process perspective focusing on specific phases of adaptive reuse, while systematically looking at the interrelationships and distinctions between decision criteria across the different phases. Through an integrative literature review following the structured approach outlined by Toronto & Remington (Toronto and Remington, 2020) and Whittemore & Knafl (Whittemore and Knafl, 2005), relevant decision criteria for adaptive reuse per phase are identified that can be used as a basis for further enhancement of AR decision-making frameworks, and help stakeholders of adaptive reuse projects in structuring their decision-making process.

The research design of this study is shown in Fig. 1. The research process is summarized according to the steps of writing an integrative review by Toronto & Remington (Toronto and Remington, 2020) and Whittemore & Knafl (Whittemore and Knafl, 2005). In the next section, we elaborate on the design of the integrative literature review that we conducted to underpin our results. Then, we present the decision criteria in adaptive reuse projects, found for the different stages in the AR process. Subsequently, the interrelationships and contrasts of the decision criteria between different phases are analyzed. Lastly, the limitations of this study and the suggestions for future research are discussed.

2. Materials and methods

2.1. The integrative review approach

There are several types of literature reviews, such as qualitative review, meta-analysis, systematic review, and integrative review (Whittemore and Knafl, 2005). For this particular study, an integrative literature review was utilized as a research methodology to identify relevant decision criteria for various phases in the adaptive reuse process. The integrative review stands apart from other review types, playing a distinct and crucial role in advancing scientific knowledge through evidence-based insights (Elsbach et al., 2020).

According to Post et al. (2020), integrative reviews are characterized as articles that contribute to theory by analyzing and synthesizing existing research to generate novel perspectives on a given field or phenomenon, rather than simply reporting on previous literature. Integrative reviews incorporate the strengths of other review methods, describing research topics like traditional reviews, collecting and evaluating literature like systematic reviews, and assessing article

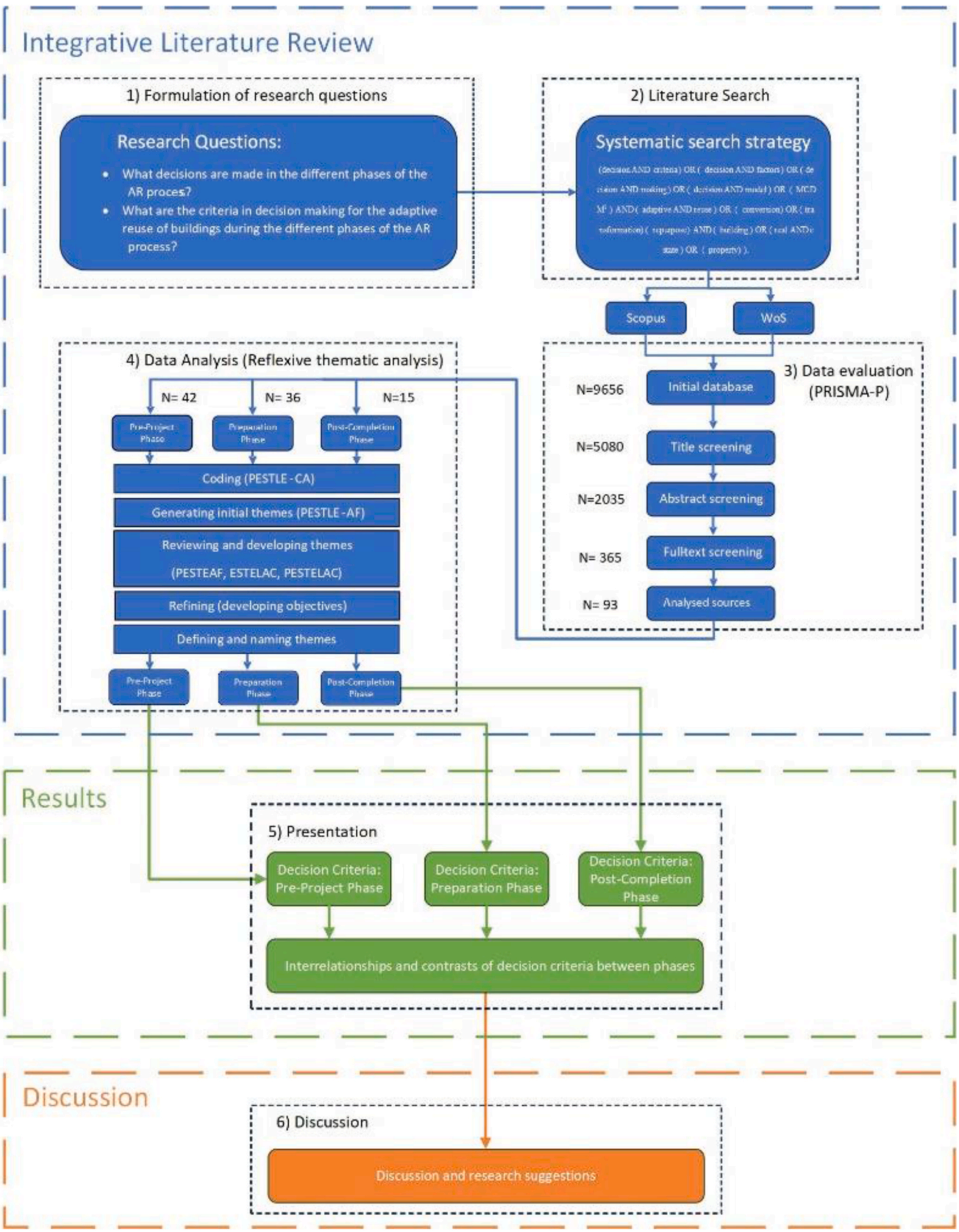

Fig. 1. The flowchart of the study.

conclusions on specific topics like meta-analysis (Post et al., 2020). Other studies looking into the benefits and challenges of adaptive reuse (Aigwi et al., 2023), success factors affecting adaptive reuse (Vafaie et al., 2023) and vacancy of adaptive reuse (Armstrong et al., 2023) have used the more traditional systematic literature review (SLR) approach. The rationale for adopting the SLR is its ability to provide access to current significant trends in the relevant literature on the research topic under investigation in an organized and transparent way (Aigwi et al., 2023). Other studies looking into visitors' perception of adaptive reuse (Vardopoulos, 2022, 2023), and the transformation of heritage buildings (Vardopoulos et al., 2023), have deployed empirical methods like surveys and case studies for collecting data. Although both methods are effective for understanding contemporary phenomena like adaptive reuse, its findings may be context-specific and not universally applicable to other contexts (Vardopoulos et al., 2023). For this study, the integrative review approach is deemed appropriate, as the aim is not only to examine existing literature but also to advance novel knowledge concerning decision-making processes in adaptive reuse projects across different stages. Notably, integrative reviews have the potential to create new frameworks and viewpoints on specific subjects (Scully-Russ and Torraco, 2020; Torraco, 2016). An integrative literature review presents several advantages over both user surveys and systematic literature reviews in the context of exploring decision-making in adaptive reuse projects. The integrative literature review allows for a more flexible and holistic approach (Post et al., 2020). While user surveys offer direct insights from stakeholders, they are often limited by sample bias, resource constraints, and the challenge of capturing the full spectrum of perspectives and experiences (Babbie, 2020). Conversely, systematic literature reviews, though rigorous in methodology, may overlook valuable insights from diverse sources and fail to accommodate the nuanced complexities of the decision-making process (Babbie, 2020). Unlike the rigid structure of a systematic review, which typically employs strict inclusion criteria, an integrative review accommodates various study designs, methodologies, and conceptual frameworks (Post et al., 2020). Given the interdisciplinary and novel nature of the topic and the need to provide an overview of differences between phases, an integrative approach offers the versatility required to address the intricacies of the adaptive reuse decision-making process.

The procedure of the integrative review suggested by: Toronto & Remington (Toronto and Remington, 2020) and Whittemore & Knafl (Whittemore and Knafl, 2005), was followed, which consists of the following steps: formulation of review questions, literature search, data evaluation, analysis and synthesis, and presentation and discussion.

2.2. Formulation of review questions

The first step in the procedure of the integrative literature review is the formulation of review questions. In the literature review the following research questions are addressed.

- What decisions are made in the different phases of the AR process?
- What are the criteria in decision-making for the adaptive reuse of buildings during the different phases of the AR process?

2.3. Literature search

The literature search was conducted in the Web of Science and Scopus databases. For the literature search, the systematic search approach by Bramer et al. (2018) was used as a search strategy. This approach was chosen as it follows a clear 15-step methodology, that includes reiterating the keywords based on initial results (Bramer et al., 2018). The search string was optimized according to earlier results, and the additional keywords were chosen based on synonyms that were found in the literature. To retrieve sources that are relevant to the research context (buildings), three linking terms were added (Building, Real Estate, Property). This resulted in the final search string:

(decision AND criteria) OR (decision AND factors) OR (decision AND making) OR (decision AND model) OR (MCDM) AND (adaptive AND reuse) OR (conversion) OR (transformation) (repurpose) AND (building) OR (real AND estate) OR (property)).

The strings were searched as the title, abstract, and keywords. There was no temporal limit to the literature search. The document type was peer-reviewed journal papers, conference papers, and book chapters, and the language of the articles was English. The literature search was conducted on November 24th, 2022. The multiple searches in the two different databases resulted in an initial database containing 9656 publications.

2.4. Data evaluation

Through an extensive screening process, the total number of publications was brought back to 93. The screening of papers was done in accordance with the PRISMA-P method and comprised 4 different rounds of data evaluation (Moher et al., 2015). In the first round duplicate sources were removed, eliminating 4576 sources. In the second round sources were excluded based on the screening of titles, which eliminated 3045 articles. In this round, we excluded articles that are irrelevant to buildings or the built environment. The third round focussed on abstract screening and eliminated 1670 articles. In this round articles that look at adaptive reuse on district/neighborhood or material/component level were excluded. Articles that did not include criteria for decision-making were also excluded. To guide this exclusion decision a broader definition of criteria was used: *"a principle or standard by which something may be judged or decided"* (Oxford University Press, 2023), as the definition of the term can differ based on the phase in the adaptive reuse process. In the post-completion phase, the function of the criteria is more evaluative of nature, whereas, in the pre-project and preparation phase, the criteria are used to make an ex-ante decision. Although the post-completion phase in adaptive reuse is more evaluative of nature, compared to the more ex-ante decision-making in pre-completion phases, 'evaluation' may bring up the need for further intervention of the building and consequently new decisions (Vandesande K van B and Aziliz, 2018). Using a broader definition of 'decision criteria' during data evaluation ensured that no important publications were missed.

In the last round 272 articles were excluded after a full-text screening. We excluded articles that did not fit the scope of the research such as articles that focus only on the lifetime extension of the building without changing the function. The following definition was used to guide this exclusion decision: *"Adaptive reuse is known as the process of converting the function of an existing building into another, which is substantially different from that function, in which the building was originally designed for"* (Douglas, 2006).

2.5. Analysis and synthesis

The eligible articles were reviewed with respect to decision criteria used, and the main decisions that are made during the adaptive reuse process. The reviewed articles were then categorized according to their application in the adaptive reuse process. For this categorization, the AR Process model by Arfa et al. (2022a) was used, in which 4 distinct phases in the AR process are distinguished: pre-project phase, preparation phase, implementation phase, and post-completion phase. Although the implementation phase is considered an important aspect of the adaptive reuse process (Vervloed, 2013), we excluded it in the analysis part of the literature review because none of the included papers corresponded to this phase. The implementation phase is described as: "*The third phase of the AR process consists of implementing the agreed design strategies, which may involve the removal, preservation, or addition of a specific part to an existing building*" (Arfa et al., 2022a). A plausible explanation could be that the implementation phase is characterized by the implementation

of the agreed-on design strategies (Arfa et al., 2022a), and important decisions are therefore already made in the previous phases. Articles were categorized according to the three remaining phases, based on the following rules.

- **Pre-project phase:** Articles in which decision criteria are presented for the decision on starting the adaptive reuse process. This phase focuses on the decision to: '*preserve, reuse or demolish a building*' (Arfa et al., 2022a). In this phase, the decision to pursue adaptive reuse has not yet been made, and the decision criteria are used to guide this decision.
- **Preparation phase:** Articles in which decision criteria are presented for the decision of choosing between different adaptive reuse options. The decision to pursue adaptive reuse has been made, and decision criteria are used to decide on the best new function, alternative, design strategy, or intervention action (Arfa et al., 2022a).
- **Post-completion phase:** Articles in which decision criteria are used to evaluate the AR projects post-completion, or make decisions regarding maintenance or conservation actions (Arfa et al., 2022a). In this phase, AR projects are completed. Although criteria in this phase are more evaluative of nature, evaluation' may bring up the need for further intervention of the building and consequently new decisions (Vandesande K van B and Aziliz, 2018).

Initially, the publications were also categorized within the different phases according to 'building type'. However, after an initial analysis, no significant differences in decision criteria between different building typologies were noticed, and we decided to not include this categorization in further analysis.

2.6. Reflexive thematic analysis

After the articles were categorized according to the three different phases, a reflexive thematic analysis through a semantic approach was used to conceptually cluster the criteria into main categories using Miro (Braun and Clarke, 2012). The reflexive approach to thematic analysis highlights the researcher's active role in knowledge production (Braun and Clarke, 2019). Codes are utilized to symbolize the researcher's understanding of meaningful patterns throughout the dataset. The semantic approach refers to the process of coding and theme development. Semantic codes are identified through the explicit or surface meanings of the data, instead of attempting to identify hidden meanings or underlying assumptions (Byrne, 2022). For a reflexive thematic analysis, themes are not predefined to 'find' codes. Instead, themes are produced by organizing codes around a 'central organizing concept', that the researcher interprets from the data (Braun and Clarke, 2019). We have chosen the reflexive thematic analysis through a semantic approach in this study because it provides flexibility to reiterate the themes according to research findings (Byrne, 2022). This approach differs from other thematic analyses like coding reliability TA (thematic analysis), in which themes are developed before the analysis, and coding is used to: search for evidence within themes, instead of being the building blocks for themes (Byrne, 2022). The flexible and iterative nature of the reflexive thematic analysis complements the idea behind the integrative analysis in which novel ideas and perspectives are generated rather than simply reporting on previous literature (Snyder, 2019). The reflexive thematic analysis was used following the six stages of Braun & Clarke (Braun and Clarke, 2012): familiarisation; coding; generating initial themes; reviewing and developing themes; refining, defining, and naming themes; and writing up.

For the initial coding, the extended PESTLE-CA framework by Ikiz Kaya et al. (Ikiz et al., 2021a) was used to categorize the decision criteria into the following categories: Political, Economic, Technological, Legal, Environmental, Cultural, and Administrative. For these initial themes, the definitions of Ikiz Kaya et al. were used for the categorization (Ikiz et al., 2021a), but after iteration two extra categories were added: Functional and Architectural/physical, and one was omitted: Administrative. For the coding of decision criteria into the: "Functional" and "Architectural/physical" themes, the definitions used in Conejos et al. (2013) were adopted. The classification of existing decision criteria was performed based on the classification of the original studies. For example, some studies proposed a list of decision criteria divided over the PESTLE-CA categories, which was useful for classifying the specific criteria within the proposed themes.

After the initial coding into the above-mentioned categories, the focus shifted from the interpretation of individual data items within the dataset to the interpretation of aggregated meaning and meaningfulness across the dataset (Byrne, 2022). Based on the thematic coding of the criteria across the above-stated categories, sub-themes and themes were created based on over-arching narratives of the decision criteria (Byrne, 2022). The themes are based on the initial coding categories from Ikiz Kaya et al. (Ikiz et al., 2021a), complemented with the two added themes of Functional, and Architectural/physical. The sub-themes take the form of objectives and are developed based on overarching interpretations of the decision criteria, following an analytical write-up approach in which objectives are contextualized in relation to the literature (Clarke and Braun, 2013; Terry et al., 2017). A bottom-up approach (Xu and Zammit, 2020), was used for structuring the decision tree in which decision criteria were grouped into themes, and within those themes, sub-themes (objectives) were formulated based on over-arching narratives (Byrne, 2022).

2.7. Presentation and discussion

The publications that are reviewed are organized according to the AR process model by Arfa et al. (2022a). Most publications are related to the pre-project phase (42) and fewer are concerned with the post-completion phase (15). In the following section, the main decisions per phase in the AR process are explained, followed by an integrative list of decision criteria for this phase. Subsequently, the interrelationships and contrasts of the decision criteria for the different phases are discussed.

3. Results

3.1. Pre-project phase

In the pre-project phase, the decision focuses on preserving reusing, or demolishing a building (Wilkinson et al., 2014). The decision to adaptively reuse the buildings has not yet been made and the phase is characterized by defining the scope of the project, as well as mapping the potential for adaptation and adaptive reuse (Arfa et al., 2022a). Geraedts & van der Voordt (Geraedts et al., 2007) identified: financial, functional, technical, cultural, and legal criteria to determine whether an office building is suitable for transformation into residential housing. The "TransformationMeter" is developed as a QuickScan to determine whether an office building has enough potential to be transformed, with the decision outcomes being "Go"; the transformation is feasible, and "No-Go" if no immediate action should be taken (Geraedts et al., 2007).

The decision between adaptive reuse "Go" and doing nothing "No-Go", is found in many other publications in this phase (Mohamed and Alauddin, 2016a, 2021; Djebbour and Biara, 2020). The decision in this case is a yes or no question, with no other alternative options being considered. The decision to go for adaptive reuse or do "nothing", ultimately leads to new decisions, such as how to pursue adaptive reuse, or what strategies are suitable to do this. Langston et al. (2008) came up with a model that measures the adaptive reuse potential based on the estimation of physical, economic, functional, technological, social, legal, and political obsolescence. To evaluate the embedded physical life of a building the present age and projected physical life are needed to determine the 7 obsolescence factors. In the model, obsolescence acts as a discount factor to discount the expected physical life of the building to

arrive at the useful life of the building. This model supports the decision between reusing a building and demolishing and rebuilding (Langston et al., 2008). This decision is also central in other works (Sfakianaki and Moutsatsou, 2015; Samaranayake et al., 2019; Bullen and Love, 2010).

The decision to demolish or adapt the building is found in the work of Baker (2020), Wilkinson (2014), Teo & Lin (Teo and Lin, 2012), Bansal & Chabra (Bansal and Chhabra, 2022), Mehr & Wilkinson (Mehr and Wilkinson, 2021), and Wang & Liu (Wang and Liu, 2021), in which adaptation is considered more broadly then merely adaptive reuse, but also the decision for "within-use adaptation" is considered. Other decisions that are mentioned in this phase are; the decision between demolition, maintenance, or adaptive reuse (Liu et al., 2014), the decision between adaptive reuse and 'redevelopment' (Yang et al., 2022), and the decision for adaptive refurbishment (Vizzarri and Fatiguso, 2019). Following the reflexive thematic analysis 65 criteria, and 29 objectives were identified in the pre-project phase. This resulted in the following list of decision criteria (see Fig. 2 and Table 1).

3.2. Preparation phase

The reviewed publications in the preparation phase are mostly concerned with multi-criteria decision-making models for the selection of the best adaptive reuse alternative. In this phase, the decision to adaptively reuse the buildings has been made, and decision criteria are used to compare different options and decide on the best new use or design alternative. These alternatives can take shape in various ways. Haroun et al. (2019) and Bottero et al. (2019) use an MCDM to find the best alternative use for (industrial) heritage buildings, whereas Vizzari et al. (Vizzarri et al., 2021) and Dabouh & El Shazly (Dabouh and Shazly, 2020) compare specific design scenarios using an MCDM model. Langston (2012) compares general intervention scenarios for adaptive reuse (Langston, 2012), whereas Aigwi et al. (2022) compare buildings suitable for adaptive reuse using an MCDM method (Miloševi et al., 2020). The publications in this phase are all characterized by the decision between different alternatives (Pavlovskis et al., 2019), adaptive reuse strategies (Della Spina, 2021), new use (Vehbi et al., 2021), scenarios (Morgante et al., 2022), or other options.

The thematic analysis in the preparation phase resulted in 64 criteria divided over 24 objectives (see Fig. 3 and Table 2).

3.3. Post-completion phase

For the post-completion phase, publications that focus on evaluating adaptive reuse projects after the conversion were considered. This phase

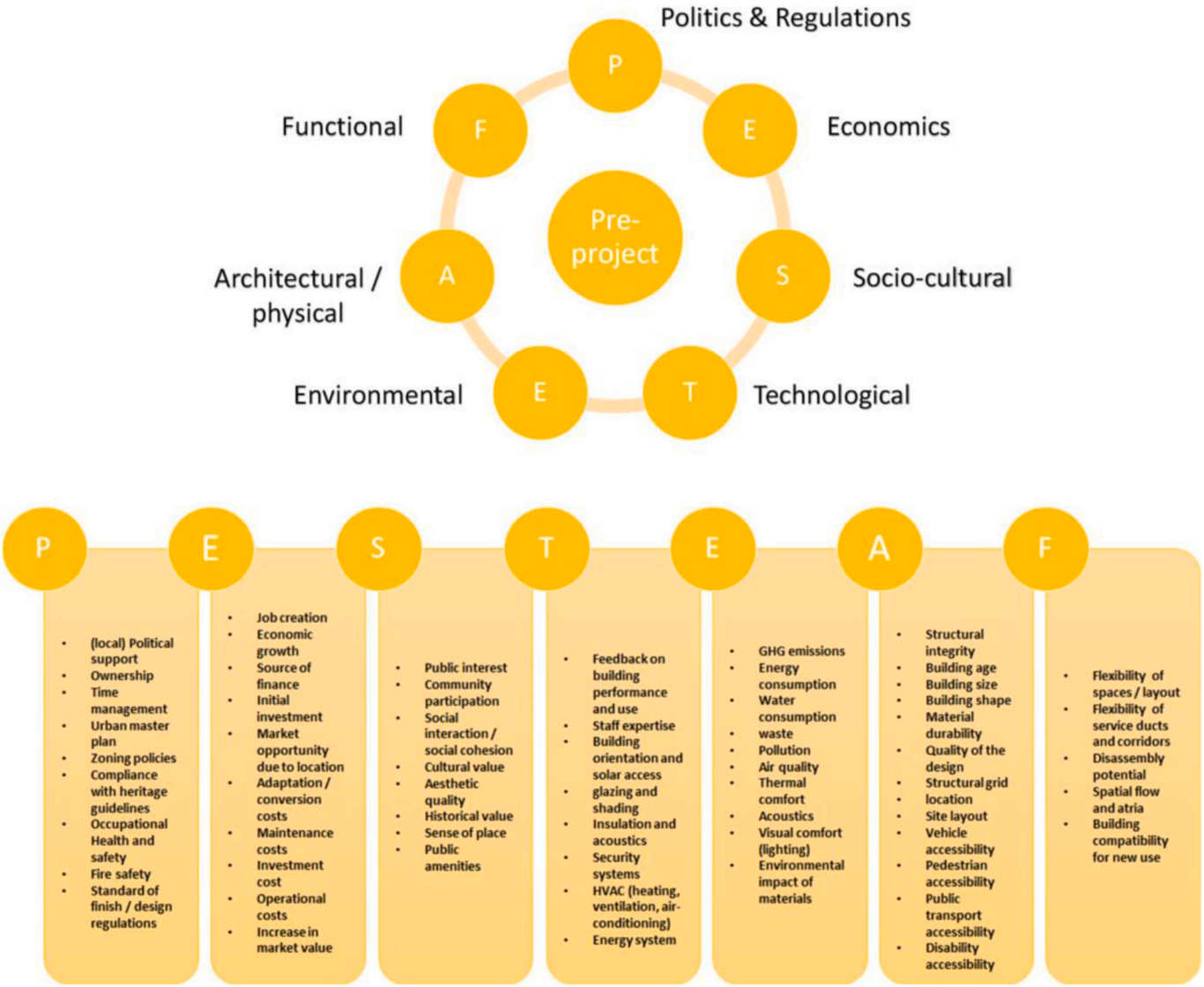

Fig. 2. The decision criteria for adaptive reuse in the pre-project phase.

Table 1
The decision criteria for adaptive reuse in the pre-project phase.

Themes	Objectives	Criteria	Literature
Politics and Regulations	To increase political support To successfully manage the adaptive reuse process To comply with urban master plans and zoning regulations To comply with heritage regulations To comply with the local building codes and regulations	• (local) political support • Ownership • Time management • Urban master plan • Zoning policies • Compliance with heritage guidelines • Occupational health and safety • Fire safety • Standard of finish/design regulations	(Langston et al., 2008; Bansal and Chhabra, 2022; Langston, 2014a; Langston and Shen, 2007; Sharifi and Farahinia, 2020; Ikiz et al., 2021a; Djebbour and Biara, 2020; Bullen and Love, 2010; Mehr and Wilkinson, 2021; Yang et al., 2022; Vizzarri and Fatiguso, 2019; Yoon and Lee, 2019; Remø et al., 2014; Hanafi et al., 2019; Gravagnuolo et al., 2017) (Conejos et al., 2013; Wilkinson et al., 2014; Bullen and Love, 2010, 2011; Langston, 2014a; Ikiz et al., 2021a; Geraedts et al., 2007; Mohamed and Alauddin, 2016a, 2021; Djebbour and Biara, 2020; Mehr and Wilkinson, 2021; Hanafi et al., 2019; Gravagnuolo et al., 2017; De et al., 2019; Ragheb and Naguib, 2021) (Djebbour and Biara, 2020; Teo and Lin, 2012; Mehr and Wilkinson, 2021; Vizzarri and Fatiguso, 2019; Aigwi et al., 2020; Hanafi et al., 2018) (Conejos et al., 2013; Bullen and Love, 2011; Langston, 2014a; Mohamed and Alauddin, 2016a, 2021; Samaranayake et al., 2019; Teo and Lin, 2012; Mehr and Wilkinson, 2021; Yang et al., 2022; Vizzarri and Fatiguso, 2019; Remø et al., 2014; De et al., 2019; Aigwi et al., 2020; Hanafi et al., 2018; Ragheb, 2021; Abdullah et al., 2020) (Conejos et al., 2013; Wilkinson, 2014; Bullen and Love, 2010, 2011; Bansal and Chhabra, 2022; Langston, 2014a; Mohamed and Alauddin, 2016a, 2021; Samaranayake et al., 2019; Teo and Lin, 2012; Mehr and Wilkinson, 2021; Yang et al., 2022; Vizzarri and Fatiguso, 2019; Remø et al., 2014; De et al., 2019; Aigwi et al., 2020; Hanafi et al., 2018; Abdullah et al., 2020) (Conejos et al., 2013; Wilkinson, 2014; Bullen and Love, 2011; Langston, 2014a; Mohamed and Alauddin, 2021; Samaranayake et al., 2019; Yang et al., 2022; Vizzarri and Fatiguso, 2019; Yoon and Lee, 2019; De et al., 2019; Aigwi et al., 2020; Hanafi et al., 2018; Kavinda and Jayalath, 2019) (Conejos et al., 2013; Wilkinson, 2014; Bullen and Love, 2011; Langston, 2014a; Samaranayake et al., 2019; Baker, 2020; Teo and Lin, 2012; Yang et al., 2022; Vizzarri and Fatiguso, 2019; Yoon and Lee,

Table 1 (*continued*)

Themes	Objectives	Criteria	Literature
			2014; Bullen and Love, 2010, 2011; Bansal and Chhabra, 2022; Langston, 2014a; Mohamed and Alauddin, 2016a, 2021; Samaranayake et al., 2019; Teo and Lin, 2012; Mehr and Wilkinson, 2021; Yang et al., 2022; Vizzarri and Fatiguso, 2019; Remø et al., 2014; De et al., 2019; Aigwi et al., 2020; Hanafi et al., 2018; Abdullah et al., 2020) (Conejos et al., 2013; Wilkinson, 2014; Bullen and Love, 2010, 2011; Bansal and Chhabra, 2022; Langston, 2014a; Mohamed and Alauddin, 2016a, 2021; Samaranayake et al., 2019; Teo and Lin, 2012; Mehr and Wilkinson, 2021; Yang et al., 2022; Vizzarri and Fatiguso, 2019; Remø et al., 2014; De et al., 2019; Aigwi et al., 2020; Hanafi et al., 2018; Abdullah et al., 2020) (Conejos et al., 2013; Wilkinson, 2014; Bullen and Love, 2011; Langston, 2014a; Mohamed and Alauddin, 2021; Samaranayake et al., 2019; Yang et al., 2022; Vizzarri and Fatiguso, 2019; Yoon and Lee, 2019; De et al., 2019; Aigwi et al., 2020; Hanafi et al., 2018; Kavinda and Jayalath, 2019) (Conejos et al., 2013; Wilkinson, 2014; Bullen and Love, 2011; Langston, 2014a; Samaranayake et al., 2019; Baker, 2020; Teo and Lin, 2012; Yang et al., 2022; Vizzarri and Fatiguso, 2019; Yoon and Lee,

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Table 1 (*continued*)

Themes	Objectives	Criteria	Literature
			2019; De et al., 2019; Aigwi et al., 2020; Hanafi et al., 2018; Kavinda and Jayalath, 2019) (Conejos et al., 2013; Wilkinson, 2014; Bullen and Love, 2010, 2011; Bansal and Chhabra, 2022; Langston, 2014a; Mohamed and Alauddin, 2016a, 2021; Samaranayake et al., 2019; Teo and Lin, 2012; Mehr and Wilkinson, 2021; Yang et al., 2022; Vizzarri and Fatiguso, 2019; Remø et al., 2014; De et al., 2019; Aigwi et al., 2020; Hanafi et al., 2018; Abdullah et al., 2020)
Economic	To have a positive impact on the local economy To minimize financial risk To increase market potential To reduce costs To increase economic returns	• Job creation • Economic growth • Source of finance • Initial investment • Market opportunity due to location • Adaptation/ conversion costs • Maintenance costs • Investment cost • Operational costs • Increase in market value	(Liu et al., 2014; Ikiz et al., 2021a; Yoon and Lee, 2019; Gravagnuolo et al., 2017; Ragheb and Naguib, 2021; Aigwi et al., 2020; Vardopoulos, 2019) (Liu et al., 2014; Chen et al., 2018; Ikiz et al., 2021a; Djebbour and Biara, 2020; Bullen and Love, 2010; Baker, 2020; Yoon and Lee, 2019; Remø et al., 2014; Gravagnuolo et al., 2017; Ragheb and Naguib, 2021; Vardopoulos, 2019; Parpas and Savvides, 2018; Mısırlısoy, 2021; Bullen, 2007a; Hsueh et al., 2013) (Bullen and Love, 2010, 2011; Chen et al., 2018; Ikiz et al., 2021a; Mohamed and Alauddin, 2016a, 2021; Djebbour and Biara, 2020; Baker, 2020; Teo and Lin, 2012; Mehr and Wilkinson, 2021; De et al., 2019; Ragheb and Naguib, 2021; Hanafi et al., 2018; Abdullah et al., 2020;

Table 1 (*continued*)

Themes	Objectives	Criteria	Literature
			Vardopoulos, 2019) (Wilkinson, 2014; Chen et al., 2018; Ikiz et al., 2021a; Mohamed and Alauddin, 2016a; Baker, 2020; Mehr and Wilkinson, 2021; Remø et al., 2014; De et al., 2019; Hanafi et al., 2018) (Liu et al., 2014; Langston et al., 2008; Conejos et al., 2013; Bullen and Love, 2011; Bansal and Chhabra, 2022; Langston, 2014a; Langston and Shen, 2007; Sharifi and Farahinia, 2020; Ikiz et al., 2021a; Geraedts et al., 2007; Mohamed and Alauddin, 2021; Mohamed and Alauddin, 2016a; Djebbour and Biara, 2020; Samaranayake et al., 2019; Bullen and Love, 2010; Baker, 2020; Teo and Lin, 2012; Mehr and Wilkinson, 2021; Yang et al., 2022; Yoon and Lee, 2019; Remø et al., 2014; De et al., 2019; Ragheb and Naguib, 2021; Hanafi et al., 2018; Abdullah et al., 2020; Kavinda and Jayalath, 2019; Vardopoulos, 2019; Parpas and Savvides, 2018; Mısırlısoy, 2021; Sharifi and Farahinia, 2021; Langston, 2014b) (Wilkinson, 2014; Ikiz et al., 2021a; Mohamed and Alauddin, 2021; Sfakianaki and Moutsatsou, 2015; Baker, 2020; Teo and Lin, 2012; Mehr and Wilkinson, 2021; Vizzarri and Fatiguso, 2019; Remø et al., 2014; Ragheb and Naguib, 2021; Aigwi et al., 2020; Kavinda and Jayalath, 2019; Parpas and

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Themes	Objectives	Criteria	Literature
			Savvides, 2018; Hsueh et al., 2013) (Mohamed and Alauddin, 2021; Sfakianaki and Moutsatsou, 2015; Bullen and Love, 2010; Baker, 2020; Teo and Lin, 2012; Vizzarri and Fatiguso, 2019; De et al., 2019; Ragheb and Naguib, 2021; Kavinda and Jayalath, 2019; Parpas and Savvides, 2018; Mısırlısoy, 2021) (Sfakianaki and Moutsatsou, 2015; Baker, 2020; Mehr and Wilkinson, 2021; Vizzarri and Fatiguso, 2019; Remø et al., 2014; Remø et al., 2014, 2014; Ragheb and Naguib, 2021; Kavinda and Jayalath, 2019; Parpas and Savvides, 2018) (Ikiz et al., 2021a; Sfakianaki and Moutsatsou, 2015; Baker, 2020; Vizzarri and Fatiguso, 2019; De et al., 2019; Ragheb and Naguib, 2021; Parpas and Savvides, 2018) (Wilkinson, 2014; Chen et al., 2018; Geraedts et al., 2007; Mohamed and Alauddin, 2021; Mohamed and Alauddin, 2021; Djebbour and Biara, 2020; Sfakianaki and Moutsatsou, 2015; Samaranayake et al., 2019; Bullen and Love, 2010; Baker, 2020; Teo and Lin, 2012; Remø et al., 2014; Gravagnuolo et al., 2017; Abdullah et al., 2020; Vardopoulos, 2019; Mısırlısoy, 2021; Hong and Chen, 2017)
Socio-Cultural	To increase social impact To preserve the historical image of the building To retain a sense of place/identity	• Social interaction/ social cohesion • Cultural value • Aesthetic quality • Historical value • Sense of place • Public amenities	(Chen et al., 2018; Bansal and Chhabra, 2022; Ikiz et al., 2021a; Mohamed and Alauddin, 2016a; Teo and Lin, 2012; Yang et al., 2022;

Table 1 (*continued*)

Themes	Objectives	Criteria	Literature
	To improve public amenities		Yoon and Lee, 2019; Gravagnuolo et al., 2017; De et al., 2019; Aigwi et al., 2020; Abdullah et al., 2020; Vardopoulos, 2019; Mısırlısoy, 2021) (Conejos et al., 2013; Wilkinson, 2014; Chen et al., 2018; Ikiz et al., 2021a; Mohamed and Alauddin, 2021; Mohamed and Alauddin, 2016a; Djebbour and Biara, 2020; Sfakianaki and Moutsatsou, 2015; Samaranayake et al., 2019; Bullen and Love, 2010; Gravagnuolo et al., 2017; Ragheb and Naguib, 2021; Hanafi et al., 2018; Mısırlısoy, 2021; Hsueh et al., 2013; Hong and Chen, 2017; Bullen, 2007b) (Conejos et al., 2013; Wilkinson, 2014; Chen et al., 2018; Langston, 2014a; Sfakianaki and Moutsatsou, 2015; Samaranayake et al., 2019; Bullen and Love, 2010; Teo and Lin, 2012; Mehr and Wilkinson, 2021; Yang et al., 2022; Yoon and Lee, 2019; Remø et al., 2014; Gravagnuolo et al., 2017; Ragheb and Naguib, 2021; Aigwi et al., 2020; Hanafi et al., 2018; Kavinda and Jayalath, 2019; Vardopoulos, 2019; Mısırlısoy, 2021; Bullen, 2007a; Hong and Chen, 2017) (Conejos et al., 2013; Wilkinson, 2014; Chen et al., 2018; Langston, 2014a; Sfakianaki and Moutsatsou, 2015; Samaranayake et al., 2019; Yang et al., 2022; Yoon and Lee, 2019; Remø et al., 2014; Gravagnuolo et al.,

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Table 1 (*continued*)

Themes	Objectives	Criteria	Literature
			2017; Ragheb and Naguib, 2021; Aigwi et al., 2020; Hanafi et al., 2018; Kavinda and Jayalath, 2019; Vardopoulos, 2019; Mısırlısoy, 2021; Bullen, 2007a) (Wilkinson, 2014; Chen et al., 2018; Ikiz et al., 2021a; Mohamed and Alauddin, 2021; Djebbour and Biara, 2020; Samaranayake et al., 2019; Yoon and Lee, 2019; Gravagnuolo et al., 2017; Aigwi et al., 2020; Abdullah et al., 2020; Kavinda and Jayalath, 2019; Vardopoulos, 2019; Mısırlısoy, 2021; Mohamed and Alauddin, 2016b) (Conejos et al., 2013; Wilkinson, 2014; Chen et al., 2018; Ikiz et al., 2021a; Geraedts et al., 2007; Djebbour and Biara, 2020; Samaranayake et al., 2019; Yoon and Lee, 2019; Gravagnuolo et al., 2017; Aigwi et al., 2020; Hanafi et al., 2018; Abdullah et al., 2020; Vardopoulos, 2019; Hsueh et al., 2013; Langston, 2014b; Hong and Chen, 2017)
Technological	To increase knowledge and expertise To improve building services	• Feedback on building performance and use • Staff expertise • Building orientation and solar access • glazing and shading • Insulation and acoustics • Security systems • HVAC • Energy system	(Conejos et al., 2013; Djebbour and Biara, 2020; Yang et al., 2022; Langston, 2014b) (Langston et al., 2008; Conejos et al., 2013; Bansal and Chhabra, 2022; Langston, 2014a; Langston and Shen, 2007; Djebbour and Biara, 2020; Mehr and Wilkinson, 2021; Gravagnuolo et al., 2017; De et al., 2019; Ragheb and Naguib, 2021; Hanafi et al., 2018; Mısırlısoy, 2021; Sharifi and Farahinia, 2021;

Table 1 (*continued*)

Themes	Objectives	Criteria	Literature
			Langston, 2014b) (Conejos et al., 2013; Langston, 2014a; Geraedts et al., 2007; Yang et al., 2022; Vizzarri and Fatiguso, 2019; Aigwi et al., 2020; Hanafi et al., 2018; Kavinda and Jayalath, 2019; Bullen, 2007a) (Conejos et al., 2013; Langston, 2014a; Yang et al., 2022; Vizzarri and Fatiguso, 2019; Hanafi et al., 2018; Kavinda and Jayalath, 2019) (Conejos et al., 2013; Langston, 2014a; Geraedts et al., 2007; Teo and Lin, 2012; Yang et al., 2022; Vizzarri and Fatiguso, 2019; Hanafi et al., 2018; Kavinda and Jayalath, 2019) (Teo and Lin, 2012; Mehr and Wilkinson, 2021; Vizzarri and Fatiguso, 2019; Gravagnuolo et al., 2017; Ragheb and Naguib, 2021; Hanafi et al., 2018; Abdullah et al., 2020; Mohamed and Alauddin, 2016b) (Conejos et al., 2013; Langston, 2014a; Geraedts et al., 2007; Sfakianaki and Moutsatsou, 2015; Teo and Lin, 2012; Mehr and Wilkinson, 2021; Vizzarri and Fatiguso, 2019; Remø et al., 2014; Gravagnuolo et al., 2017; Ragheb and Naguib, 2021; Hanafi et al., 2018; Abdullah et al., 2020; Mohamed and Alauddin, 2016b) (Geraedts et al., 2007; Teo and Lin, 2012; Mehr and Wilkinson, 2021; Yang et al., 2022; Vizzarri and Fatiguso, 2019; Gravagnuolo et al., 2017; Ragheb and Naguib, 2021; Hanafi et al., 2018;

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Themes	Objectives	Criteria	Literature
			Abdullah et al., 2020; Mohamed and Alauddin, 2016b)
Environmental	To reduce the environmental impact To reduce waste and pollution To safeguard the indoor environmental quality To reduce material consumption	• GHG emissions • Energy consumption • Water consumption • waste • Pollution • Air quality • Thermal comfort • Acoustics • Visual comfort (lighting) • Environmental impact of materials	(Chen et al., 2018; Langston, 2014a; Ikiz et al., 2021a; Mohamed and Alauddin, 2021; Bullen and Love, 2010; Baker, 2020; Ragheb and Naguib, 2021; Hanafi et al., 2018; Abdullah et al., 2020; Vardopoulos, 2019; Bullen, 2007b) (Conejos et al., 2013; Chen et al., 2018; Langston, 2014a; Ikiz et al., 2021a; Bullen and Love, 2010; Baker, 2020; Teo and Lin, 2012; Yang et al., 2022; Ragheb and Naguib, 2021; Hanafi et al., 2018; Abdullah et al., 2020; Kavinda and Jayalath, 2019; Vardopoulos, 2019; Bullen, 2007b) (Chen et al., 2018; Mohamed and Alauddin, 2021; Bullen and Love, 2010; Baker, 2020; Teo and Lin, 2012; Hanafi et al., 2018; Abdullah et al., 2020; Vardopoulos, 2019; Bullen, 2007b) (Ikiz et al., 2021a; Bullen and Love, 2010; Baker, 2020; Teo and Lin, 2012; Hanafi et al., 2018; Kavinda and Jayalath, 2019; Vardopoulos, 2019) (Wilkinson, 2014; Chen et al., 2018; Geraedts et al., 2007; Mohamed and Alauddin, 2016a, 2021; Bullen and Love, 2010; Baker, 2020; Teo and Lin, 2012; Vizzarri and Fatiguso, 2019; Gravagnuolo et al., 2017; Hanafi et al., 2018; Kavinda and Jayalath, 2019; Vardopoulos, 2019) (Conejos et al., 2013; Wilkinson,

Table 1 (*continued*)

Themes	Objectives	Criteria	Literature
			2014; Langston, 2014a; Geraedts et al., 2007; Teo and Lin, 2012; Yang et al., 2022; Vizzarri and Fatiguso, 2019; Aigwi et al., 2020; Hanafi et al., 2018; Kavinda and Jayalath, 2019) (Conejos et al., 2013; Langston, 2014a; Geraedts et al., 2007; Teo and Lin, 2012; Yang et al., 2022; Vizzarri and Fatiguso, 2019; Hanafi et al., 2018; Kavinda and Jayalath, 2019) (Conejos et al., 2013; Langston, 2014a; Geraedts et al., 2007; Teo and Lin, 2012; Yang et al., 2022; Vizzarri and Fatiguso, 2019; Hanafi et al., 2018; Kavinda and Jayalath, 2019) (Conejos et al., 2013; Conejos et al., 2013; Langston, 2014a; Langston, 2014a; Geraedts et al., 2007; Sfakianaki and Moutsatsou, 2015; Teo and Lin, 2012; Yang et al., 2022; Vizzarri and Fatiguso, 2019; Remø et al., 2014; Aigwi et al., 2020; Hanafi et al., 2018; Kavinda and Jayalath, 2019) (Langston, 2014a; Ikiz et al., 2021a; Sfakianaki and Moutsatsou, 2015; Bullen and Love, 2010; Mehr and Wilkinson, 2021; Yang et al., 2022; Gravagnuolo et al., 2017; Ragheb and Naguib, 2021; Hanafi et al., 2018; Abdullah et al., 2020; Vardopoulos, 2019; Hsueh et al., 2013; Hong and Chen, 2017; Bullen, 2007b)
Architectural/ Physical	To safeguard the structural integrity of the building The physical character of the building allows	• Structural integrity • Building age • Building size • Building shape • Material durability	(Liu et al., 2014; Langston et al., 2008; Conejos et al., 2013; Wilkinson, 2014; Bullen and Love, 2011; Langston,

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Themes	Objectives	Criteria	Literature
	for adaptive reuse To improve the durability of the materials To preserve the aesthetic quality of the building The location and site of the building allow for adaptive reuse To improve the accessibility	• Quality of the design • Structural grid • location • Site layout • Vehicle accessibility • Pedestrian accessibility • Public transport accessibility • Disability accessibility	2014a, 2014b; Langston and Shen, 2007; Mohamed and Alauddin, 2016b, 2021; Samaranayake et al., 2019; Baker, 2020; Yang et al., 2022; Vizzarri and Fatiguso, 2019; Yoon and Lee, 2019; Remø et al., 2014; De et al., 2019; Ragheb and Naguib, 2021; Hanafi et al., 2018; Abdullah et al., 2020; Kavinda and Jayalath, 2019; Sharifi and Farahinia, 2021; Miloševi et al., 2020) (Liu et al., 2014; Langston et al., 2008; Wilkinson, 2014; Bullen and Love, 2011; Ikiz et al., 2021a; Geraedts et al., 2007; Sfakianaki and Moutsatsou, 2015; Samaranayake et al., 2019; Baker, 2020; Teo and Lin, 2012; Vizzarri and Fatiguso, 2019; Yoon and Lee, 2019; Remø et al., 2014; De et al., 2019; Abdullah et al., 2020; Kavinda and Jayalath, 2019; Parpas and Savvides, 2018; Sharifi and Farahinia, 2021; Langston, 2014b; Miloševi et al., 2020) (Liu et al., 2014; Langston et al., 2008; Wilkinson, 2014; Bullen and Love, 2011; Langston, 2014a, 2014b; Langston and Shen, 2007; Ikiz et al., 2021a; Geraedts et al., 2007; Samaranayake et al., 2019; Baker, 2020; Teo and Lin, 2012; Vizzarri and Fatiguso, 2019; Yoon and Lee, 2019; Remø et al., 2014; De et al., 2019; Hanafi et al., 2018; Abdullah et al., 2020; Kavinda and

Table 1 (*continued*)

Themes	Objectives	Criteria	Literature
			Jayalath, 2019; Sharifi and Farahinia, 2021; Mohamed and Alauddin, 2016b; Miloševi et al., 2020) (Liu et al., 2014; Langston et al., 2008; Wilkinson, 2014; Bullen and Love, 2011; Langston, 2014a, 2014b; Langston and Shen, 2007; Geraedts et al., 2007; Djebbour and Biara, 2020; Samaranayake et al., 2019; Baker, 2020; Teo and Lin, 2012; Vizzarri and Fatiguso, 2019; Yoon and Lee, 2019; Remø et al., 2014; De et al., 2019; Ragheb and Naguib, 2021; Hanafi et al., 2018; Abdullah et al., 2020; Mohamed and Alauddin, 2016b; Miloševi et al., 2020) (Conejos et al., 2013; Wilkinson, 2014; Langston, 2014a; Geraedts et al., 2007; Sfakianaki and Moutsatsou, 2015; Baker, 2020; Yang et al., 2022; Vizzarri and Fatiguso, 2019; De et al., 2019; Aigwi et al., 2020; Hanafi et al., 2018; Abdullah et al., 2020; Kavinda and Jayalath, 2019; Parpas and Savvides, 2018) (Wilkinson, 2014; Bullen and Love, 2010; Mehr and Wilkinson, 2021; Yang et al., 2022; Gravagnuolo et al., 2017; Ragheb and Naguib, 2021; Hanafi et al., 2018; Abdullah et al., 2020; Kavinda and Jayalath, 2019; Mısırlısoy, 2021; Hong and Chen, 2017; Miloševi et al., 2020) (Liu et al., 2014; Conejos et al., 2013; Langston, 2014a; Samaranayake et al., 2019; Yang et al., 2022;

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Themes	Objectives	Criteria	Literature
			Vizzarri and Fatiguso, 2019; Remø et al., 2014; Hanafi et al., 2018; Abdullah et al., 2020; Hong and Chen, 2017) (Liu et al., 2014; Langston et al., 2008; Conejos et al., 2013; Wilkinson, 2014; Bullen and Love, 2011; Langston, 2014a; Sharifi and Farahinia, 2020; Sharifi and Farahinia, 2020; Ikiz et al., 2021a; Geraedts et al., 2007; Mohamed and Alauddin, 2021; Mohamed and Alauddin, 2016a; Samaranayake et al., 2019; Teo and Lin, 2012; Mehr and Wilkinson, 2021; Yang et al., 2022; Yoon and Lee, 2019; Remø et al., 2014; Ragheb and Naguib, 2021; Hanafi et al., 2018; Abdullah et al., 2020; Kavinda and Jayalath, 2019; Parpas and Savvides, 2018; Mısırlısoy, 2021; Hong and Chen, 2017) (Liu et al., 2014; Conejos et al., 2013; Wilkinson, 2014; Bullen and Love, 2010, 2011; Langston, 2014a; Ikiz et al., 2021a; Geraedts et al., 2007; Mohamed and Alauddin, 2016b, 2021; Samaranayake et al., 2019; Teo and Lin, 2012; Vizzarri and Fatiguso, 2019; Yoon and Lee, 2019; Remø et al., 2014; Ragheb and Naguib, 2021; Hanafi et al., 2018; Abdullah et al., 2020; Kavinda and Jayalath, 2019; Hong and Chen, 2017; Miloševi et al., 2020) (Wilkinson, 2014; Bansal and Chhabra, 2022; Langston, 2014a; Ikiz et al., 2021a;

Table 1 (*continued*)

Themes	Objectives	Criteria	Literature
			Geraedts et al., 2007; Yang et al., 2022; Vizzarri and Fatiguso, 2019; Remø et al., 2014; Ragheb and Naguib, 2021; Hanafi et al., 2018; Hong and Chen, 2017) (Wilkinson, 2014; Bansal and Chhabra, 2022; Langston, 2014a; Ikiz et al., 2021a; Vizzarri and Fatiguso, 2019; Yoon and Lee, 2019; Ragheb and Naguib, 2021; Hanafi et al., 2018; Hong and Chen, 2017) (Wilkinson, 2014; Bansal and Chhabra, 2022; Langston, 2014a; Ikiz et al., 2021a; Geraedts et al., 2007; Samaranayake et al., 2019; Bullen and Love, 2010; Vizzarri and Fatiguso, 2019; Yoon and Lee, 2019; Ragheb and Naguib, 2021; Hanafi et al., 2018; Hong and Chen, 2017) (Langston, 2014a; Samaranayake et al., 2019; Baker, 2020; Mehr and Wilkinson, 2021; Vizzarri and Fatiguso, 2019; De et al., 2019; Ragheb and Naguib, 2021)
Functional	To improve the flexibility and adaptability of the building To improve the disassembly potential of the building To safeguard the suitability of the building for a new use	• Flexibility of spaces/layout • Flexibility of service ducts and corridors • Disassembly potential • Spatial flow and atria • Building compatibility for new use	(Conejos et al., 2013; Wilkinson, 2014; Bullen and Love, 2011; Langston, 2014a; Geraedts et al., 2007; Mohamed and Alauddin, 2021; Djebbour and Biara, 2020; Samaranayake et al., 2019; Baker, 2020; Teo and Lin, 2012; Mehr and Wilkinson, 2021; Yang et al., 2022; Remø et al., 2014; De et al., 2019; Ragheb and Naguib, 2021; Aigwi et al., 2020; Hanafi et al., 2018; Kavinda and Jayalath, 2019; Parpas and

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Table 1 (*continued*)

Themes	Objectives	Criteria	Literature
			Savvides, 2018; Bullen, 2007a; Hsueh et al., 2013; Miloševi et al., 2020)
			(Conejos et al., 2013; Wilkinson, 2014; Langston, 2014a; Geraedts et al., 2007; Djebbour and Biara, 2020; Baker, 2020; Teo and Lin, 2012; Mehr and Wilkinson, 2021; Yang et al., 2022; Remø et al., 2014; De et al., 2019; Hanafi et al., 2018; Kavinda and Jayalath, 2019; Bullen, 2007a)
			(Conejos et al., 2013; Wilkinson, 2014; Langston, 2014a; Djebbour and Biara, 2020; Yang et al., 2022; Remø et al., 2014; Hanafi et al., 2018; Kavinda and Jayalath, 2019)
			(Conejos et al., 2013; Langston, 2014a; Yang et al., 2022; Hanafi et al., 2018; Kavinda and Jayalath, 2019)
			(Langston et al., 2008; Langston and Shen, 2007; Geraedts et al., 2007; Mohamed and Alauddin, 2021; Djebbour and Biara, 2020; Baker, 2020; Teo and Lin, 2012; Mehr and Wilkinson, 2021; Yoon and Lee, 2019; Remø et al., 2014; Aigwi et al., 2020; Abdullah et al., 2020; Kavinda and Jayalath, 2019; Parpas and Savvides, 2018; Mısırlısoy, 2021; Sharifi and Farahinia, 2021; Langston, 2014b; Hong and Chen, 2017; Mohamed and Alauddin, 2016b)

is considered the final step of the AR process. The evaluation in this final stage tries to identify successes and failures to provide feedback for future projects (Arfa et al., 2022a). The aim of the publications assigned to the post-completion phase roughly consists of three parts: 1) assessing the building on future adaptation, based on adaptive reuse projects, 2) evaluation/assessment of the adaptive reuse project, and 3) determining whether or not the new use is appropriate.

The adaptSTAR framework developed by Conejos et al. (2015) takes the form of a checklist and evaluates an adaptive reuse project on a list of design criteria for future adaptive reuse. The adaptSTAR model has been previously used to evaluate adaptive reuse projects post-completion, to determine future building adaptive reuse design (Sharifi and Farahinia, 2020). The central decision then is whether or not a completed adaptive reuse project is suitable for future adaptation. Günçe & Mısırlısoy (Günç et al., 2019) assess adaptive reuse projects in Nicosia based on user experiences. The study questions the appropriateness of the new functions that have been assigned to the projects. The decision; of whether or not the new function of the building is appropriate is also found in the holistic framework of Mısırlısoy & Günçe (Mısırlısoy and Günçe, 2016) and the work of Nasr & Khalil (Nasr and Khalil, 2022). Most publications in this phase evaluate the adaptive reuse projects, to determine the contribution to achieving sustainability (Alavi et al., 2022; Djebbour and Biara, 2019; Vardopoulos et al., 2021; Parpas and Savvides, 2020). The thematic analysis in the post-completion phase resulted in 61 criteria divided over 8 main themes and 30 objectives (see Fig. 4 & Table 3) (see Fig. 5).

3.4. Interrelationships and contrasts of decision criteria between phases

Through a reflexive thematic analysis, three lists of decision criteria for adaptive reuse were constructed for the three phases of the adaptive reuse process. A comparative analysis between the different lists of decision criteria indicated some notable similarities and differences that are further explained below.

In general, the decision criteria for different phases of adaptive reuse identified in this review show a lot of similarities. For all three phases, economic and architectural/physical aspects seem to be consistent across the reviewed literature. One of the most repeated categories of decision criteria throughout the different phases is the 'Economic' category. This is in line with the work of Mohamed & Alauddin (Mohamed and Alauddin, 2021) and Mısırlısoy & Günçe (Mısırlısoy and Günçe, 2016), who also regard the economic dimension as the most vital part of an adaptive reuse project. In all three phases, the cost of the adaptive reuse project is mentioned as one of the criteria, with a distinction between different types of costs such as adaptation costs (Aigwi et al., 2020; Dabouh and Shazly, 2020; Alavi et al., 2022), maintenance costs (Mısırlısoy, 2021; Vizzarri et al., 2021; Elsorady, 2020), and cost of materials (Tan et al., 2018). The post-completion phase differs from the pre-project phase and the preparation phase pertaining to investment risk. The financial risk of the project and the source of finance are often mentioned criteria in the first two phases (Mehr and Wilkinson, 2021; Vehbi et al., 2021; Shehada et al., 2015), but are not mentioned in the post-completion phase. An explanation for this could be that in the post-completion phase, the adaptive reuse project has finished, and the financial risk is therefore of less importance. An aspect that is found in all three phases is the positive impact of the project in a wider economic sense (Vardopoulos, 2019; Pavlovskis et al., 2019; Nasr and Khalil, 2022). Frequently mentioned criteria are job creation and local economic growth. The financial or economic returns of the adaptive reuse project are also mentioned in all three phases (Ikiz et al., 2021a; Hong and Chen, 2017; Bottero et al., 2022). Criteria that correspond to this include return on investment (Vardopoulos et al., 2021) and increase in property value (Bottero et al., 2019). The market opportunity/potential due to the location of the building, is an often mentioned criterion in the pre-project and preparation phase (Bansal and Chhabra, 2022; Abdullah et al., 2020; Bonci et al., 2018; Hsu and Juan, 2016), but is less mentioned in the post-completion phase.

Social criteria mentioned in the preparation and post-completion phase are mostly concerned with community engagement (Abastante et al., 2022; Alavi et al., 2022), socio-economic conditions (Haroun et al., 2019; Arfa et al., 2022b), and public amenities (Giuliani et al.,

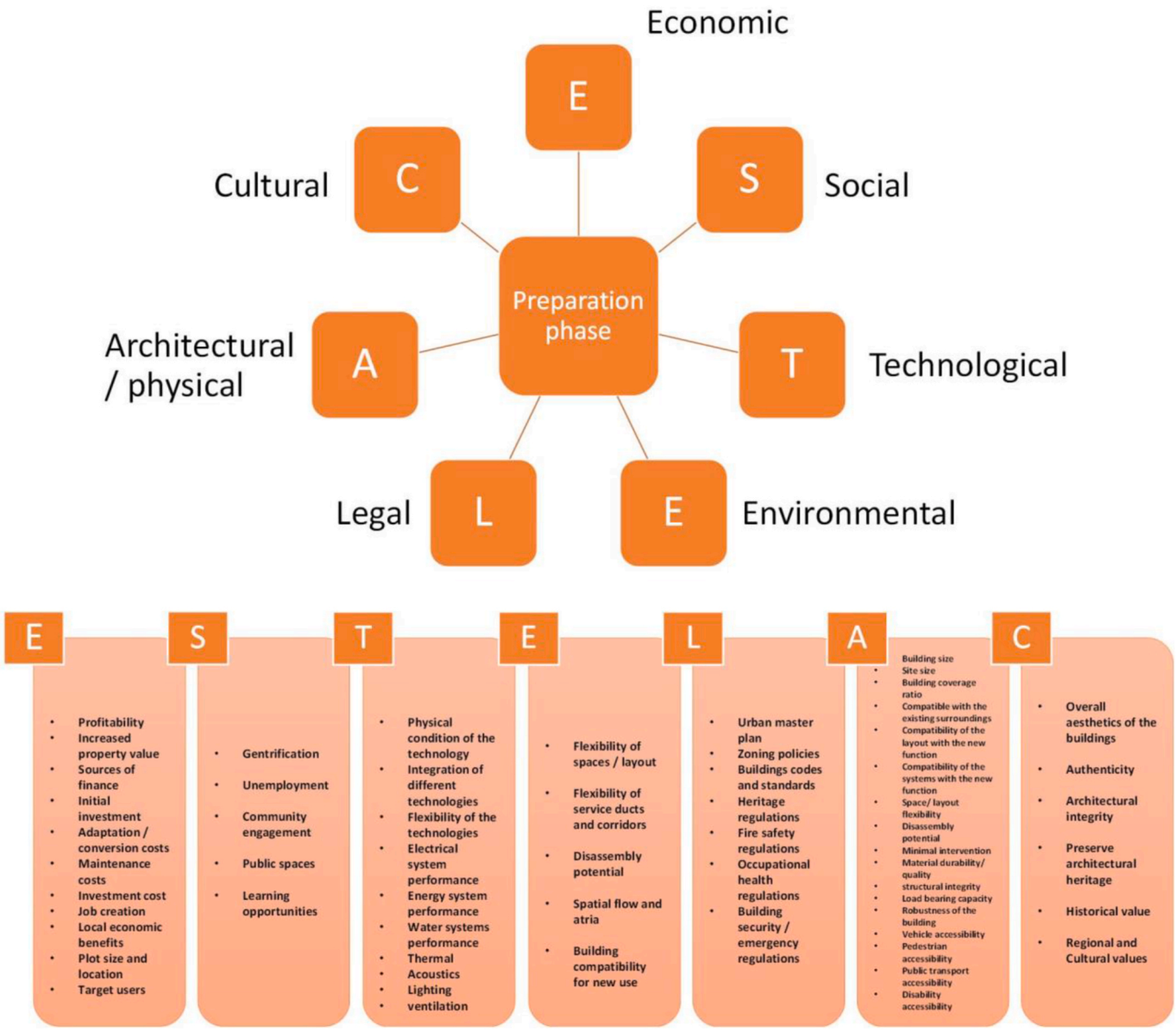

Fig. 3. Decision criteria for adaptive reuse in the preparation phase.

2018; Conejos et al., 2015), and cultural criteria are concerned with historic, architectural, and cultural values (Hanafi et al., 2019; Shehada et al., 2015). In the pre-project phase these aspects are mentioned under both the social and cultural categories and often combined into one category: socio-cultural (Aigwi et al., 2020; Mısırlısoy, 2021).

In the post-completion phase, there seems to be a clear distinction between legal aspects (aspects considering regulations, standards, urban master plans, etc.) and political aspects: aspects considering political support and project management (project timeline and planning, etc.). In the pre-project phase however political and legal criteria are often interchangeably used under the same category (Mohamed and Alaaddin, 2016a; Aigwi et al., 2020), and are therefore combined into the category: Politics and regulations. For the preparation phase, mostly legal aspects are mentioned (building regulations etc.), and political aspects are missing entirely.

The technological category is less mentioned in all three phases compared to the economic and architectural categories. Building systems and services are considered under the technological category. In the post-completion phase, the technological criteria are more broadly considered compared to the pre-project and preparation phase. In the post-completion phase, three general building systems are considered as criteria: mechanical, electrical, and plumbing, whereas in the pre-project phase, there is a distinction of 6 sub-criteria for building services: building orientation and solar access, glazing and shading, insulation and acoustics, security systems, HVAC, and energy system. For the preparation phase, indoor environmental quality is considered more from a technical perspective, including thermal, acoustics, lighting, and ventilation in the technological category (Sharifi and Farahinia, 2020), whereas for the pre-project phase, it is mentioned in the environmental category (Teo and Lin, 2012), and in the post-completion phase it is considered under the legal aspect (Conejos et al., 2015).

For the preparation phase, the environmental category is more broadly considered. Besides environmental impact, ecological quality and climate adaptation are also considered (Bonci et al., 2018; Juan et al., 2016). For the post-completion and pre-project phases the environmental category is more concerned with the environmental impact (Djebbour and Biara, 2019, 2020), pollution (Hanafi et al., 2018; Tan et al., 2018), and waste (Ikiz et al., 2021a; Nasr and Khalil, 2022). For the pre-project phase also indoor environmental quality is taken into account for the environmental category (Teo and Lin, 2012).

Table 2
The decision criteria for adaptive reuse in the preparation phase.

Themes	Objectives	Criteria	Literature
Economic	To increase financial returns To minimize financial risk To reduce costs To increase wider economic benefits To increase market potential	• Profitability • Increased property value • Sources of finance • Initial investment • Adaptation/ conversion costs • Maintenance costs • Investment cost • Job creation • Local economic benefits • Plot size and location • Target users	(Sharifi and Farahinia, 2020; Vizzarri et al., 2021; Aigwi et al., 2022; Della Spina, 2020, 2021; Vehbi et al., 2021; Morgante et al., 2022; Bottero et al., 2022; Abastante et al., 2020; Fedorczak-Cisak et al., 2020; Bonci et al., 2018; Oppio et al., 2017; Shehada et al., 2015; Tan et al., 2014; Hsu and Juan, 2016; Wang and Zeng, 2010) (Bottero et al., 2019; Aigwi et al., 2022; Pavlovskis et al., 2019; Abastante et al., 2020; Della Spina, 2020; Bonci et al., 2018; Shehada et al., 2015; Ś ladowski et al., 2021) (Sharifi and Farahinia, 2020; Ragheb, 2021; Vehbi et al., 2021; Della Spina, 2020; Bonci et al., 2018; Shehada et al., 2015; Tan et al., 2014; Hsu and Juan, 2016; Wang and Zeng, 2010; Torrieri et al., 2019; Huang and Wey, 2019; Giuliani et al., 2018; Langston, 2013) (Vehbi et al., 2021; Morgante et al., 2022; Bottero et al., 2022; Della Spina, 2020; Bonci et al., 2018; Oppio et al., 2017; Shehada et al., 2015; Wang and Zeng, 2010; Torrieri et al., 2019; Yau, 2009) (Haroun et al., 2019; Ragheb, 2021; Dabouh and Shazly, 2020; Morgante et al., 2022; Bottero et al., 2022; Bonci et al., 2018; Torrieri et al., 2019; Giuliani et al., 2018; Yau, 2009; Shahi et al., 2018) (Ragheb, 2021; Vizzarri et al., 2021; Vehbi et al., 2021; Bottero et al., 2022; Abastante et al., 2020; Bonci et al., 2018; Wang and Zeng, 2010; Giuliani et al., 2018; Yau, 2009; Shahi et al., 2018) (Dell'Ovo et al., 2021; Ragheb, 2021; Aigwi et al., 2022; Pavlovskis et al., 2019; Della Spina, 2021; Morgante et al., 2022; Bottero et al., 2022; Bonci et al., 2018; Oppio et al., 2017; Wang and Zeng, 2010; Giuliani et al., 2018; Yau, 2009; Shahi et al., 2018; Abastante et al., 2022) (Dell'Ovo et al., 2021; Sharifi and Farahinia, 2020; Aigwi et al., 2022; Pavlovskis et al., 2019; Della Spina, 2021; Morgante et al., 2022; Bottero et al., 2022; Bonci et al., 2018; Hsu and Juan, 2016; Torrieri et al., 2019; Huang and Wey, 2019; Ferretti et al., 2014; Della Spina, 2019; Ribera et al., 2020) (Haroun et al., 2019; Bottero et al., 2019; Ragheb, 2021; Vizzarri et al., 2021; Dabouh and Shazly, 2020; Pavlovskis et al., 2019; Morgante et al., 2022; Fedorczak-Cisak et al., 2020; Bonci et al., 2018; Ś ladowski et al., 2021; Śladowski et al., 2021; Torrieri et al., 2019; Huang and Wey, 2019; Giuliani et al., 2018; Yau, 2009; Abastante et al., 2022; Ferretti et al., 2014; Della Spina, 2019; Ribera et al., 2020) (Bottero et al., 2019; Dell'Ovo et al., 2021; Sharifi and Farahinia, 2020; Aigwi et al., 2022; Vehbi et al., 2021; Della Spina, 2020; Bonci et al.,

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Table 2 (*continued*)

Themes	Objectives	Criteria	Literature
			2018; Shehada et al., 2015; Tan et al., 2014; Hsu and Juan, 2016; Wang and Zeng, 2010; Torrieri et al., 2019; Langston, 2013) (Sharifi and Farahinia, 2020; Aigwi et al., 2022; Della Spina, 2019, 2021; Vehbi et al., 2021; Bottero et al., 2022; Bonci et al., 2018; Shehada et al., 2015; Tan et al., 2014; Hsu and Juan, 2016; Wang and Zeng, 2010; Torrieri et al., 2019; Huang and Wey, 2019)
Social	To improve socio-economic conditions To increase community engagement To improve public amenities	• Gentrification • Unemployment • Community engagement • Public spaces • Learning opportunities	(Haroun et al., 2019; Vizzarri et al., 2021; Aigwi et al., 2022; Morgante et al., 2022; Bottero et al., 2022; Huang and Wey, 2019) (Haroun et al., 2019; Morgante et al., 2022; Huang and Wey, 2019; Ribera et al., 2020) (Haroun et al., 2019; Dell'Ovo et al., 2021; Sharifi and Farahinia, 2020; Dabouh and Shazly, 2020; Della Spina, 2021; Vehbi et al., 2021; Bonci et al., 2018; Oppio et al., 2017; Shehada et al., 2015; Tan et al., 2014; Hsu and Juan, 2016; Wang and Zeng, 2010; Torrieri et al., 2019; Huang and Wey, 2019; Giuliani et al., 2018; Langston, 2013; Abastante et al., 2022; Della Spina, 2019; Ribera et al., 2020) (Bottero et al., 2019; Dell'Ovo et al., 2021; Sharifi and Farahinia, 2020; Vizzarri et al., 2021; Dabouh and Shazly, 2020; Aigwi et al., 2022; Pavlovskis et al., 2019; Bottero et al., 2022; Bonci et al., 2018; Ś ladowski et al., 2021; Huang and Wey, 2019; Giuliani et al.,

Table 2 (*continued*)

Themes	Objectives	Criteria	Literature
			2018) (Bottero et al., 2019; Pavlovskis et al., 2019; Bottero et al., 2022; Shehada et al., 2015; Hsu and Juan, 2016; Wang and Zeng, 2010; Ś ladowski et al., 2021; Huang and Wey, 2019; Della Spina, 2019)
Technological	To increase the quality of the technology in the building To provide appropriate electrical and water systems for the new use To safeguard healthy indoor environmental quality	• Physical condition of the technology • Integration of different technologies • Flexibility of the technologies • Electrical system performance • Energy system performance • Water systems performance • Thermal • Acoustics • Lighting • ventilation	(Haroun et al., 2019; Bottero et al., 2019; Sharifi and Farahinia, 2020; Fedorczak-Cisak et al., 2020; Hsu and Juan, 2016; Wang and Zeng, 2010; Langston, 2013; Costa et al., 2019; Turskis et al., 2013) (Haroun et al., 2019; Sharifi and Farahinia, 2020; Giuliani et al., 2018; Langston, 2013; Costa et al., 2019; Turskis et al., 2013; Cerreta et al., 2020) (Haroun et al., 2019; Sharifi and Farahinia, 2020; Aigwi et al., 2022; Della Spina, 2020; Giuliani et al., 2018; Langston, 2013; Costa et al., 2019; Turskis et al., 2013; Cerreta et al., 2020) (Haroun et al., 2019; Sharifi and Farahinia, 2020; Fedorczak-Cisak et al., 2020; Giuliani et al., 2018; Langston, 2013; Yau, 2009; Shahi et al., 2018; Juan et al., 2016) (Aigwi et al., 2022; Morgante et al., 2022; Fedorczak-Cisak et al., 2020; Giuliani et al., 2018; Langston, 2013; Yau, 2009; Shahi et al., 2018; Juan et al., 2016) (Giuliani et al., 2018; Langston, 2013; Yau, 2009; Shahi et al., 2018; Juan et al., 2016) (Fedorczak-Cisak et al., 2020; Giuliani et al., 2018; Langston, 2013; Shahi et al., 2018; Juan et al.,

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Table 2 (*continued*)

Themes	Objectives	Criteria	Literature
			2016) (Bottero et al., 2019; Fedorczak-Cisak et al., 2020; Giuliani et al., 2018; Langston, 2013; Shahi et al., 2018; Costa et al., 2019; Juan et al., 2016) (Sharifi and Farahinia, 2020; Aigwi et al., 2022; Fedorczak-Cisak et al., 2020; Giuliani et al., 2018; Langston, 2013; Shahi et al., 2018; Juan et al., 2016) (Sharifi and Farahinia, 2020; Fedorczak-Cisak et al., 2020; Giuliani et al., 2018; Langston, 2013; Shahi et al., 2018; Juan et al., 2016)
Environmental	To reduce the environmental impact To improve the quality of the landscape To improve climate adaptation measures	• Environmental impact • Water quality • Air quality • Ecological quality • Quality of the public landscape • Climate adaptation measures	(Dell'Ovo et al., 2021; Vizzarri et al., 2021; Pavlovskis et al., 2019; Morgante et al., 2022; Fedorczak-Cisak et al., 2020; Bonci et al., 2018; Tan et al., 2014;Śladowski et al., 2021; Yau, 2009; Shahi et al., 2018; Juan et al., 2016) (Dell'Ovo et al., 2021; Yau, 2009; Juan et al., 2016) (Dell'Ovo et al., 2021; Aigwi et al., 2022; Yau, 2009; Juan et al., 2016) (Dell'Ovo et al., 2021; Vehbi et al., 2021; Morgante et al., 2022; Bottero et al., 2022; Bonci et al., 2018; Shehada et al., 2015; Tan et al., 2014; Wang and Zeng, 2010; Langston, 2013; Costa et al., 2019; Juan et al., 2016) (Bottero et al., 2019; Dell'Ovo et al., 2021; Sharifi and Farahinia, 2020; Vizzarri et al., 2021; Pavlovskis et al., 2019; Vehbi et al., 2021; Bottero et al., 2022; Della Spina, 2020; Bonci et al., 2018; Shehada

Table 2 (*continued*)

Themes	Objectives	Criteria	Literature
			et al., 2015; Tan et al., 2014; Wang and Zeng, 2010; Ferretti et al., 2014; Juan et al., 2016) (Dell'Ovo et al., 2021; Sharifi and Farahinia, 2020; Pavlovskis et al., 2019; Bottero et al., 2022; Della Spina, 2020; Bonci et al., 2018; Śladowski et al., 2021; Costa et al., 2019; Juan et al., 2016)
Legal	To comply with urban master plan and zoning To comply with building codes and regulations To comply with health, safety, and security regulations	• Urban master plan • Zoning policies • Building codes and standards • Heritage regulations • Fire safety regulations • Occupational health regulations • Building security/ emergency regulations	(Sharifi and Farahinia, 2020; Dabouh and Shazly, 2020; Aigwi et al., 2022; Bonci et al., 2018; Shehada et al., 2015; Tan et al., 2014; Wang and Zeng, 2010; Langston, 2013) (Haroun et al., 2019; Sharifi and Farahinia, 2020; Dabouh and Shazly, 2020; Aigwi et al., 2022; Bonci et al., 2018; Shehada et al., 2015; Tan et al., 2014; Wang and Zeng, 2010; Langston, 2013) (Ragheb, 2021; Dabouh and Shazly, 2020; Aigwi et al., 2022; Bonci et al., 2018; Shehada et al., 2015; Tan et al., 2014; Wang and Zeng, 2010; Langston, 2013) (Dabouh and Shazly, 2020; Aigwi et al., 2022; Bonci et al., 2018; Shehada et al., 2015; Tan et al., 2014; Wang and Zeng, 2010; Langston, 2013) (Sharifi and Farahinia, 2020; Aigwi et al., 2022; Bonci et al., 2018; Oppio et al., 2017; Hsu and Juan, 2016; Giuliani et al., 2018; Langston, 2013) (Sharifi and Farahinia, 2020; Aigwi et al., 2022; Bonci et al., 2018; Langston, 2013; Juan et al., 2016) (Vizzarri et al., 2021; Aigwi et al., 2022; Bonci et al., 2018; Oppio et al., 2017; Śladowski et al., 2021;

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Table 2 (*continued*)

Themes	Objectives	Criteria	Literature
			Giuliani et al., 2018; Langston, 2013)
Architectural/ Physical	To increase the size of the building To be compatible with the new function To be flexible and adaptable to future needs To improve the physical quality of the building To improve the accessibility	• Building size • Site size • Building coverage ratio • Compatible with the existing surroundings • Compatibility of the layout with the new function • Compatibility of the systems with the new function • Space/layout flexibility • Disassembly potential • Minimal intervention • Material durability/ quality • structural integrity • Load bearing capacity • Robustness of the building • Vehicle accessibility • Pedestrian accessibility • Public transport accessibility • Disability accessibility	(Bottero et al., 2019; Vizzarri et al., 2021; Pavlovskis et al., 2019; Shehada et al., 2015; Hsu and Juan, 2016; Wang and Zeng, 2010; Langston, 2013) (Bottero et al., 2019; Dell'Ovo et al., 2021; Sharifi and Farahinia, 2020; Della Spina, 2020; Shehada et al., 2015; Hsu and Juan, 2016; Langston, 2013; Yau, 2009) (Shehada et al., 2015; Hsu and Juan, 2016; Costa et al., 2019) (Haroun et al., 2019; Dell'Ovo et al., 2021; Sharifi and Farahinia, 2020; Ragheb, 2021; Vizzarri et al., 2021; Dabouh and Shazly, 2020; Pavlovskis et al., 2019; Della Spina, 2021; Vehbi et al., 2021; Bottero et al., 2022; Abastante et al., 2020; Bonci et al., 2018; Oppio et al., 2017; Shehada et al., 2015; Tan et al., 2014; Hsu and Juan, 2016; Langston, 2013; Yau, 2009; Ferretti et al., 2014; Ribera et al., 2020; Turskis et al., 2013) (Haroun et al., 2019; Dell'Ovo et al., 2021; Ragheb, 2021; Vizzarri et al., 2021; Dabouh and Shazly, 2020; Pavlovskis et al., 2019; Della Spina, 2021; Vehbi et al., 2021; Bonci et al., 2018; Oppio et al., 2017; Śladowski et al., 2021; Giuliani et al., 2018; Langston, 2013; Yau, 2009; Ribera et al., 2020; Turskis et al., 2013) (Haroun et al., 2019; Ragheb, 2021; Vizzarri et al., 2021; Dabouh and Shazly,

Table 2 (*continued*)

Themes	Objectives	Criteria	Literature
			2020; Della Spina, 2021; Vehbi et al., 2021; Bonci et al., 2018; Oppio et al., 2017; Śladowski et al., 2021; Giuliani et al., 2018; Langston, 2013) (Bottero et al., 2019; Sharifi and Farahinia, 2020; Ragheb, 2021; Vizzarri et al., 2021; Vehbi et al., 2021; Della Spina, 2020; Bonci et al., 2018; Oppio et al., 2017; Hsu and Juan, 2016; Wang and Zeng, 2010; Śladowski et al., 2021; Langston, 2013; Ferretti et al., 2014; Costa et al., 2019; Cerreta et al., 2020) (Sharifi and Farahinia, 2020; Vehbi et al., 2021; Hsu and Juan, 2016; Śladowski et al., 2021; Shahi et al., 2018) (Sharifi and Farahinia, 2020; Della Spina, 2021; Bottero et al., 2022; Ferretti et al., 2014; Ribera et al., 2020; Cerreta et al., 2020) (Bottero et al., 2019; Sharifi and Farahinia, 2020; Vehbi et al., 2021; Oppio et al., 2017; Shehada et al., 2015; Hsu and Juan, 2016; Wang and Zeng, 2010; Langston, 2013) (Haroun et al., 2019; Sharifi and Farahinia, 2020; Dabouh and Shazly, 2020; Vehbi et al., 2021; Shehada et al., 2015; Hsu and Juan, 2016; Wang and Zeng, 2010; Giuliani et al., 2018; Langston, 2013; Juan et al., 2016) (Haroun et al., 2019; Sharifi and Farahinia, 2020; Dabouh and Shazly, 2020; Shehada et al., 2015; Giuliani et al., 2018; Langston, 2013) (Sharifi and Farahinia, 2020; Abastante et al.,

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Themes	Objectives	Criteria	Literature
			2020; Giuliani et al., 2018; Langston, 2013; Cerreta et al., 2020) (Haroun et al., 2019; Bottero et al., 2019; Dell'Ovo et al., 2021; Sharifi and Farahinia, 2020; Ragheb, 2021; Vizzarri et al., 2021; Dabouh and Shazly, 2020; Aigwi et al., 2022; Bonci et al., 2018; Langston, 2013; Yau, 2009; Ferretti et al., 2014; Della Spina, 2019) (Haroun et al., 2019; Bottero et al., 2019; Dell'Ovo et al., 2021; Ragheb, 2021; Vizzarri et al., 2021; Dabouh and Shazly, 2020; Aigwi et al., 2022; Langston, 2013; Ferretti et al., 2014; Della Spina, 2019; Costa et al., 2019) (Haroun et al., 2019; Bottero et al., 2019; Dell'Ovo et al., 2021; Ragheb, 2021; Vizzarri et al., 2021; Bonci et al., 2018; Hsu and Juan, 2016; Langston, 2013; Ferretti et al., 2014; Della Spina, 2019; Costa et al., 2019) (Dabouh and Shazly, 2020; Aigwi et al., 2022)
Cultural	To preserve the architectural value of the building To preserve the cultural value of the building	• Overall aesthetics of the buildings • Authenticity • Architectural integrity • Preserve architectural heritage • Historical value • Regional and Cultural values	(Haroun et al., 2019; Bottero et al., 2019; Sharifi and Farahinia, 2020; Vizzarri et al., 2021; Aigwi et al., 2022; Oppio et al., 2017; Shehada et al., 2015; Langston, 2013; Yau, 2009; Turskis et al., 2013) (Haroun et al., 2019; Bottero et al., 2019; Pavlovskis et al., 2019; Vehbi et al., 2021; Abastante et al., 2020; Shehada et al., 2015; Wang and Zeng, 2010; Langston, 2013; Turskis et al., 2013) (Bottero et al., 2019; Vizzarri et al., 2021; Vehbi et al., 2021; Oppio et al., 2017; Shehada et al., 2015; Wang and Zeng, 2010; Langston, 2013; Yau, 2009; Turskis et al., 2013) (Haroun et al., 2019; Bottero et al., 2019; Sharifi and Farahinia, 2020; Ragheb, 2021; Dabouh and Shazly, 2020; Aigwi et al., 2022; Bottero et al., 2022; Fedorczak-Cisak et al., 2020; Oppio et al., 2017; Shehada et al., 2015; Śladowski et al., 2021; Yau, 2009; Ferretti et al., 2014; Ribera et al., 2020; Turskis et al., 2013) (Sharifi and Farahinia, 2020; Ragheb, 2021; Dabouh and Shazly, 2020; Aigwi et al., 2022; Pavlovskis et al., 2019; Vehbi et al., 2021; Fedorczak-Cisak et al., 2020; Della Spina, 2020; Bonci et al., 2018; Shehada et al., 2015; Hsu and Juan, 2016; Wang and Zeng, 2010; Śladowski et al., 2021; Langston, 2013; Yau, 2009; Turskis et al., 2013) (Sharifi and Farahinia, 2020; Aigwi et al., 2022; Pavlovskis et al., 2019; Della Spina, 2021; Fedorczak-Cisak et al., 2020; Bonci et al., 2018; Shehada et al., 2015; Hsu and Juan, 2016; Śladowski et al., 2021; Langston, 2013; Della Spina, 2019; Turskis et al., 2013)

In the pre-project phase, there is a lot of emphasis on the physical and architectural decision criteria for adaptive reuse. Although aspects of functionality like flexibility, and building suitability are mentioned in all three phases, in the pre-project phase these criteria are often categorized separately under the "Functional" category (Yang et al., 2022; Vizzarri and Fatiguso, 2019; Remø et al., 2014), whereas for the other two phases, they are mostly mentioned under the "Architectural/physical" category. In the preparation and post-completion phases the compatibility of the building with the local environment, is a frequently repeated aspect (Haroun et al., 2019; Alavi et al., 2022). With a focus on

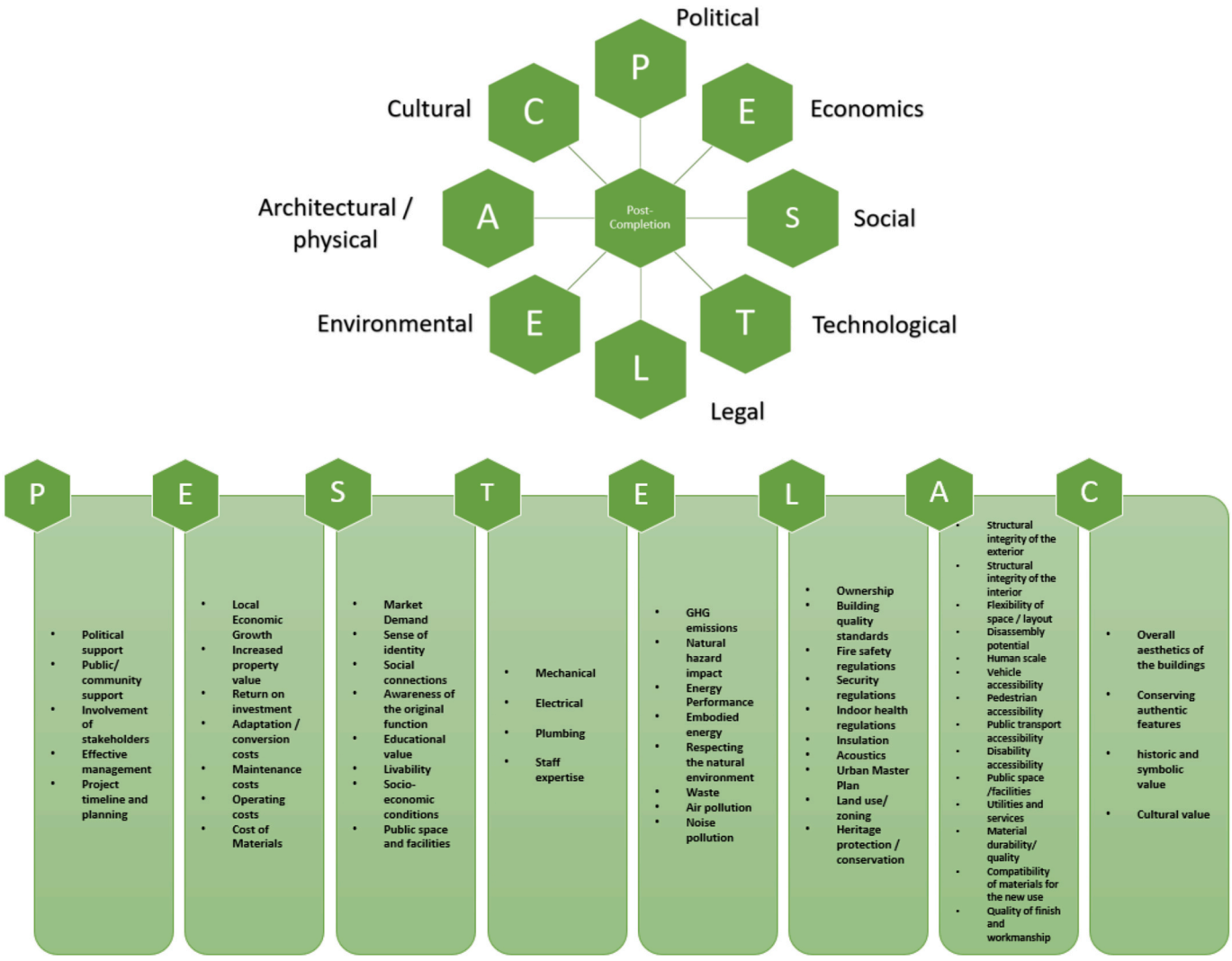

Fig. 4. The decision criteria for adaptive reuse in the post-completion phase.

being compatible with the local surroundings (Vizzarri et al., 2021), public spaces and facilities (Tan et al., 2018), and the local utilities and services (Giuliani et al., 2018). In the pre-project phase, there is more emphasis on whether the physical character of the building allows for adaptive reuse. The compatibility of the building with the local surroundings is more generally mentioned in the pre-project phase, with a focus on whether the location and site layout do not hinder adaptive reuse (Geraedts et al., 2007; Hong and Chen, 2017). An aspect that is mentioned repeatedly throughout the AR process is the accessibility of the building (Vizzarri and Fatiguso, 2019; Aigwi et al., 2022; Günç et al., 2019). For all three phases, a distinction is made between four types of accessibility: vehicle accessibility, pedestrian accessibility, public transport accessibility, and disability access.

In summary, the decision criteria for adaptive reuse show great similarities between different phases. Some subtle differences between phases are inherent to the aim of the decision in the different phases. In the post-completion phase the investment risk, source of finance, and market potential of the location are of less importance because the adaptive reuse project has already been completed. In the preparation phase, the lack of political criteria might be inherent to the fact that the decision for adaptive reuse has already been made, and political support has been dealt with in the pre-project phase. In the pre-project phase, the social and cultural criteria showed considerable overlap and were therefore combined. The same was done for the political and legal criteria in the pre-project phase. For the preparation phase, criteria related to indoor environmental quality were considered from a more technical standpoint and categorized in the "Technological" category. These same criteria for environmental quality were considered from two different standpoints for the pre-project and post-completion phases.

4. Discussion and recommendations for further research

In structuring the reviewed publications according to the different phases in the adaptive reuse process, the four phases defined by Arfa et al. (2022a) were used. During the analysis part of the literature review, the implementation phase was however omitted due to a lack of publications corresponding to this phase. This phase is characterized by the execution of previously agreed-on design strategies, which may explain the lack of decisions made during this phase. The duration of the implementation phase shows a high correlation with the duration of the preparation phase highlighting that; the more detailed the preparation phase, the shorter and less complex the implementation phase (Kurul, 2007). However, Kurul (2007) argues that in adaptive reuse projects, the complexity increases where there is a higher variance in the type of activities undertaken. Slow decision-making in the implementation phase is already mentioned as an important factor for the delay in construction projects (Carvalho et al., 2021), but with the rise of circular design strategies such as: design-for-disassembly (DfD) and modular design (Ganiyu et al., 2020), one could argue that the complexity in the implementation phase only increases (Rios et al., 2015). The lack of

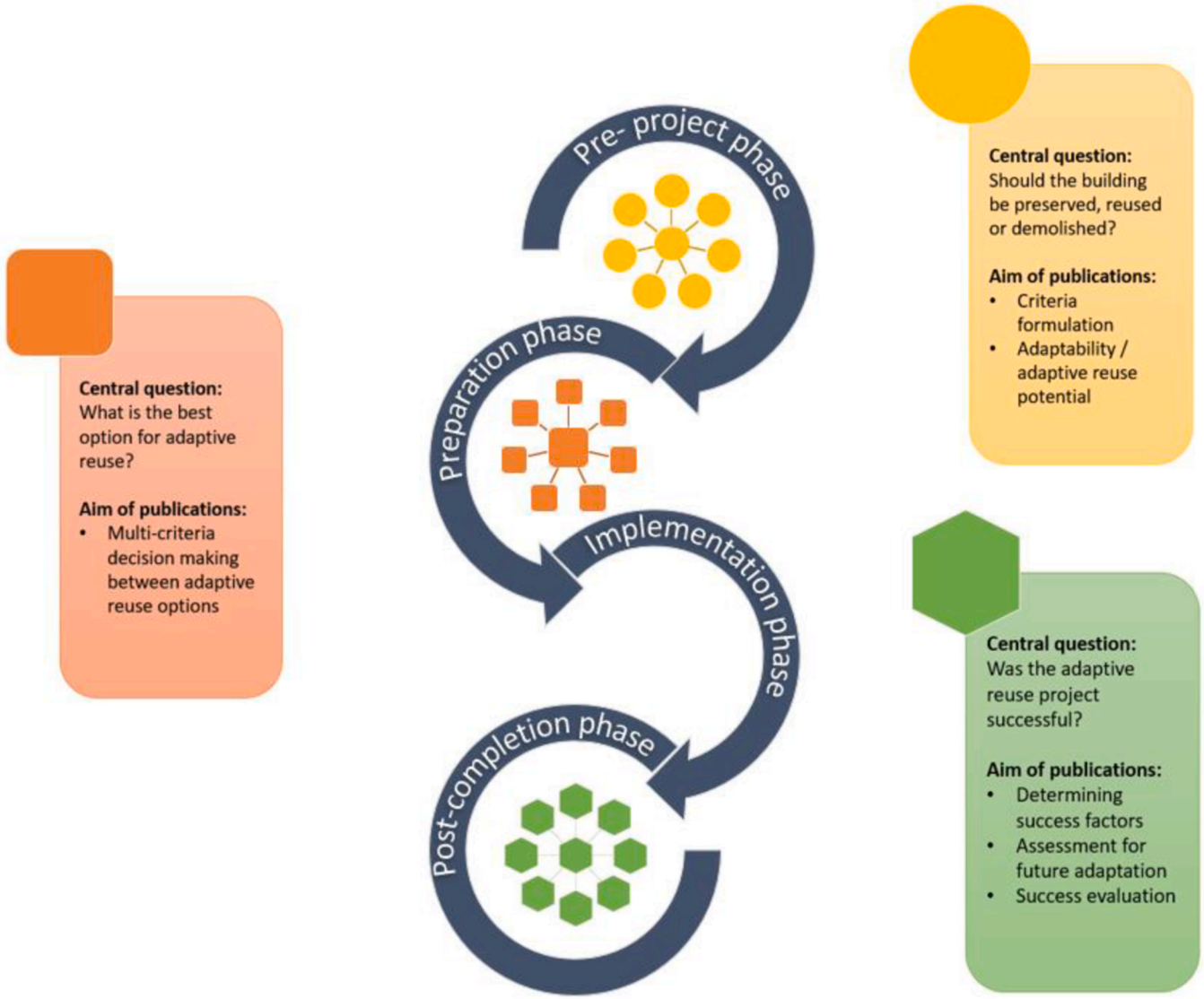

Fig. 5. The aim of the reviewed literature with regards to the different phases in the adaptive reuse decision making process.

decision criteria for adaptive reuse in the implementation phase together with the increasing complexity of decisions in this phase in the future, highlights the need for more research into the decision criteria in this phase. With an increasing complexity in the implementation phase, policymakers can proactively avoid delays by: streamlining permitting processes, providing regulatory flexibility for innovative and circular practices, and offering technical or financial assistance to overcome potential barriers or challenges associated with the adoption of circular practices like design-for-disassembly (DfD) (AlJaber et al., 2023).

After an initial analysis, we decided to not make a distinction between building types, when analyzing the decision criteria for different phases. In this study, a process perspective was taken regarding the decision-making process, but future studies could take a 'building segmentation' perspective, in which differences between building typologies could be better understood.

Although the differences in decision criteria between the different phases seem minimal, the way to measure these criteria may greatly differ depending on the phase in the adaptive reuse process. How to measure the criteria is an important step in the multi-criteria decision-making process (Brugha, 2004). The performance according to the criteria can be measured through multiple measurement scales such as nominal, ordinal, interval, and ratio, both qualitative and quantitative (Cinelli et al., 2020). The measurement scale and the way to evaluate the criteria are dependent on the data and information available as well as the context of the project. In the post-completion phase data on costs and local economic growth might be evaluated more quantitatively compared to the pre-project phase, because after the project is finished, quantitate data is available in detail. How to evaluate and measure the criteria is also dependent on the aim of the decision in the corresponding phase. In the preparation phase, different scenarios for adaptive reuse are compared to each other, which may require a more ordinal measurement scale, compared to the post-completion phase where the success of the adaptive reuse project is measured in a broader sense. More research into how to evaluate the decision criteria per phase in the AR process is therefore recommended.

How the decision criteria are measured and evaluated is also dependent on the importance of the criteria concerning the phase of the AR process. Investment risk and political support might be of more importance in the pre-project and preparation phase, whereas criteria like: "project management and planning" could be more important in the post-completion phase. The difference in weighting of the decision criteria between different phases was outside the scope of this literature review but nonetheless deserves more attention in future research.

Most decision models reviewed in this article use decision criteria to

Table 3
The decision criteria of adaptive reuse in the post-completion phase.

Themes	Objectives	Criteria	Literature
Political	The adaptive reuse intervention was broadly supported by the public Stakeholders and citizens participated throughout the adaptive reuse process The adaptive reuse project was well-managed	• Political support • Public/ community support • Involvement of stakeholders • Effective management • Project timeline and planning	(Mısırlısoy and Günçe, 2016; Conejos et al., 2015; Vardopoulos et al., 2021) (Mısırlısoy and Günçe, 2016; Conejos et al., 2015; Günç et al., 2019; Elsorady, 2020; Hamida et al., 2020) (Conejos et al., 2015; Djebbour and Biara, 2019; Elsorady, 2020; Arfa et al., 2022b) (Wang and Liu, 2021; Hanafi et al., 2019; Conejos et al., 2015; Nasr and Khalil, 2022; Alavi et al., 2022; Djebbour and Biara, 2019; Elsorady, 2020; Hamida et al., 2020) (Hanafi et al., 2019; Elsorady, 2020; Hamida et al., 2020; Tan et al., 2018)
Economic	The adaptive reuse project had a positive impact on the local economy The adaptive reuse project was financially feasible and profitable The costs of the adaptive reuse project were minimized There is a clear market demand for the adaptive reuse project	• Local economic growth • Increased property value • Return on investment • Adaptation/ conversion costs • Maintenance costs • Operating costs • Cost of materials • Market demand	(Mısırlısoy and Günçe, 2016; Günç et al., 2019; Nasr and Khalil, 2022; Djebbour and Biara, 2019; Vardopoulos et al., 2021; Arfa et al., 2022b) (Mısırlısoy and Günçe, 2016 Günç et al., 2019) (Mısırlısoy and Günçe, 2016 Wang and Liu, 2021; Hanafi et al., 2019; Günç et al., 2019; Nasr and Khalil, 2022; Djebbour and Biara, 2019; Vardopoulos et al., 2021; Elsorady, 2020; Hamida et al., 2020; Tan et al., 2018; Bottero et al., 2020) (Nasr and Khalil, 2022; Alavi et al., 2022; Parpas and Savvides, 2020; Hamida et al., 2020; Tan et al., 2018) (Vardopoulos et al., 2021; Parpas and Savvides, 2020; Elsorady, 2020; Bottero et al., 2020) (Conejos et al., 2015; Nasr and Khalil, 2022; Parpas and Savvides, 2020; Bottero et al., 2020) (Parpas and Savvides, 2020; Tan et al., 2018) (Mısırlısoy and Günçe, 2016 Hanafi et al., 2019; Conejos et al., 2015; Elsorady, 2020; Tan et al., 2018)
Social	The adaptive reuse project preserves the local identity The adaptive reuse project had a positive impact on community building The adaptive reuse project contributed to raising social awareness and education The adaptive reuse project contributed to improving the quality of life for the local residents	• Sense of identity • Social connections • Awareness of the original function • Educational value • Liveability • Socio-economic conditions • Public space and facilities	(Wang and Liu, 2021; Conejos et al., 2015; Günç et al., 2019; Nasr and Khalil, 2022; Djebbour and Biara, 2019; Arfa et al., 2022b; Bottero et al., 2020) (Conejos et al., 2015; Nasr and Khalil, 2022; Alavi et al., 2022; Djebbour and Biara, 2019; Arfa et al., 2022b) (Mısırlısoy and Günçe, 2016; Wang and Liu, 2021; Hanafi et al., 2019; Günç et al., 2019; Nasr and Khalil, 2022; Alavi et al., 2022; Djebbour and Biara, 2019; Hamida et al., 2020; Arfa et al., 2022b; Tan et al., 2018; Bottero et al., 2020) (Mısırlısoy and Günçe, 2016; Nasr and Khalil, 2022; Djebbour and Biara, 2019; Arfa et al., 2022b) (Mısırlısoy and Günçe, 2016; Alavi et al., 2022; Vardopoulos et al., 2021; Arfa et al., 2022b) (Mısırlısoy and Günçe, 2016; Wang and Liu, 2021; Nasr and Khalil, 2022; Alavi et al., 2022; Djebbour and Biara, 2019; Arfa et al., 2022b) (Mısırlısoy and Günçe, 2016; Wang and Liu,

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Themes	Objectives	Criteria	Literature
			2021; Conejos et al., 2015; Arfa et al., 2022b)
Technological	The building systems are appropriate for the new use The people involved in the adaptive reuse project possessed the necessary skills and knowledge	• Mechanical • Electrical • Plumbing • Staff expertise	(Hanafi et al., 2019; Conejos et al., 2015; Vardopoulos et al., 2021; Hamida et al., 2020; Tan et al., 2018) (Hanafi et al., 2019; Conejos et al., 2015; Vardopoulos et al., 2021; Hamida et al., 2020; Tan et al., 2018) (Hanafi et al., 2019; Conejos et al., 2015; Vardopoulos et al., 2021; Hamida et al., 2020; Tan et al., 2018) (Hanafi et al., 2019; Vardopoulos et al., 2021; Elsorady, 2020; Hamida et al., 2020; Arfa et al., 2022b; Tan et al., 2018)
Environmental	The environmental impact of the adaptive reuse project was minimized The operational energy of the building is minimized The embodied energy of the building (materials) is minimized The adaptive reuse project had a positive impact on nature The waste and pollution relating to the adaptive reuse project is minimized	• GHG emissions • Natural hazard impact • Energy performance • Embodied energy • Respecting the natural environment • Waste • Air pollution • Noise pollution	(Mısırlısoy and Günçe, 2016; Wang and Liu, 2021; Hanafi et al., 2019; Vardopoulos et al., 2021; Elsorady, 2020; Hamida et al., 2020; Arfa et al., 2022b; Tan et al., 2018) (Hanafi et al., 2019; Conejos et al., 2015; Nasr and Khalil, 2022; Elsorady, 2020) (Mısırlısoy and Günçe, 2016; Hanafi et al., 2019; Conejos et al., 2015; Djebbour and Biara, 2019; Vardopoulos et al., 2021; Hamida et al., 2020; Arfa et al., 2022b; Tan et al., 2018) (Wang and Liu, 2021; Hanafi et al., 2019; Conejos et al., 2015; Nasr and Khalil, 2022; Djebbour and Biara, 2019; Vardopoulos et al., 2021; Arfa et al., 2022b; Tan et al., 2018) (Mısırlısoy and Günçe, 2016; Wang and Liu, 2021; Hanafi et al., 2019; Conejos et al., 2015; Günç et al., 2019; Nasr and Khalil, 2022; Alavi et al., 2022; Arfa et al., 2022b) (Hanafi et al., 2019; Nasr and Khalil, 2022; Tan et al., 2018) (Wang and Liu, 2021; Hanafi et al., 2019; Vardopoulos et al., 2021; Tan et al., 2018) (Wang and Liu, 2021; Hanafi et al., 2019; Vardopoulos et al., 2021; Tan et al., 2018)
Legal	The ownership status of the building did not hinder the adaptive reuse project The adaptive reuse project complied with the building regulations and standards The adaptive reuse project suited to the urban master plan and zoning regulations	• Ownership • Building quality standards • Fire safety regulations • Security regulations • Indoor health regulations • Insulation • Acoustics • Urban master plan • Land use/ zoning • Heritage protection/ conservation	(Hanafi et al., 2019; Conejos et al., 2015; Vardopoulos et al., 2021; Hamida et al., 2020; Tan et al., 2018; Bottero et al., 2020) (Conejos et al., 2015; Vardopoulos et al., 2021; Elsorady, 2020; Hamida et al., 2020; Tan et al., 2018; Bottero et al., 2020) (Conejos et al., 2015; Nasr and Khalil, 2022; Nasr and Khalil, 2022, 2022; Alavi et al., 2022; Tan et al., 2018) (Hanafi et al., 2019; Conejos et al., 2015; Vardopoulos et al., 2021; Hamida et al., 2020; Tan et al., 2018) (Mısırlısoy and Günçe, 2016; Hanafi et al., 2019; Conejos et al., 2015; Vardopoulos et al., 2021; Hamida et al., 2020; Arfa et al., 2022b) (Wang and Liu, 2021; Hanafi et al., 2019; Conejos et al.,

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Themes	Objectives	Criteria	Literature
			2015; Vardopoulos et al., 2021; Arfa et al., 2022b; Tan et al., 2018) (Wang and Liu, 2021; Hanafi et al., 2019; Conejos et al., 2015; Vardopoulos et al., 2021; Arfa et al., 2022b; Tan et al., 2018) (Hanafi et al., 2019; Conejos et al., 2015; Vardopoulos et al., 2021; Parpas and Savvides, 2020; Elsorady, 2020; Hamida et al., 2020; Tan et al., 2018) (Hanafi et al., 2019; Conejos et al., 2015; Vardopoulos et al., 2021; Parpas and Savvides, 2020; Elsorady, 2020; Hamida et al., 2020; Tan et al., 2018) (Mısırlısoy and Günçe, 2016; Wang and Liu, 2021; Hanafi et al., 2019; Conejos et al., 2015; Günç et al., 2019; Nasr and Khalil, 2022; Alavi et al., 2022; Elsorady, 2020; Arfa et al., 2022b; Tan et al., 2018; Bottero et al., 2020)
Architectural/ physical	The building's structural integrity was appropriate for the new use The new use/ function of the adaptive reuse project is appropriate for the physical structure of the building The building after intervention is accessible The adaptive reuse project is physically compatible with the existing surroundings The building materials are durable and qualitatively appropriate The quality of the	• Structural integrity of the exterior • Structural integrity of the interior • Flexibility of space/layout • Disassembly potential • Human scale • Vehicle accessibility • Pedestrian accessibility • Public transport accessibility • Disability accessibility • Public space/ facilities • Utilities and services	(Wang and Liu, 2021; Hanafi et al., 2019; Conejos et al., 2015; Nasr and Khalil, 2022; Alavi et al., 2022; Vardopoulos et al., 2021; Hamida et al., 2020; Arfa et al., 2022b; Tan et al., 2018) (Wang and Liu, 2021; Hanafi et al., 2019; Conejos et al., 2015; Nasr and Khalil, 2022; Alavi et al., 2022; Vardopoulos et al., 2021; Hamida et al., 2020; Arfa et al., 2022b; Tan et al.,

Table 3 (*continued*)

Themes	Objectives	Criteria	Literature
	building after interventions is maximized	• Material durability/ quality • Compatibility of materials for the new use • Quality of finish and workmanship	2018) (Mısırlısoy and Günçe, 2016; Wang and Liu, 2021; Hanafi et al., 2019; Conejos et al., 2015; Günç et al., 2019; Nasr and Khalil, 2022; Djebbour and Biara, 2019; Hamida et al., 2020; Arfa et al., 2022b; Tan et al., 2018; Bottero et al., 2020) (Wang and Liu, 2021; Hanafi et al., 2019; Conejos et al., 2015; Alavi et al., 2022; Djebbour and Biara, 2019; Hamida et al., 2020; Arfa et al., 2022b; Tan et al., 2018) (Wang and Liu, 2021; Hanafi et al., 2019; Conejos et al., 2015; Günç et al., 2019; Nasr and Khalil, 2022; Djebbour and Biara, 2019; Parpas and Savvides, 2020; Arfa et al., 2022b) (Mısırlısoy and Günçe, 2016; Wang and Liu, 2021; Conejos et al., 2015; Günç et al., 2019; Alavi et al., 2022; Tan et al., 2018; Bottero et al., 2020) (Mısırlısoy and Günçe, 2016; Wang and Liu, 2021; Conejos et al., 2015; Günç et al., 2019; Alavi et al., 2022; Arfa et al., 2022b; Tan et al., 2018; Bottero et al., 2020) (Wang and Liu, 2021; Conejos et al., 2015; Alavi et al., 2022; Tan et al., 2018; Bottero et al., 2020) (Mısırlısoy and Günçe, 2016; Hanafi et al., 2019; Conejos et al., 2015; Arfa et al., 2022b) (Mısırlısoy and Günçe, 2016;

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Themes	Objectives	Criteria	Literature
			Wang and Liu, 2021; Hanafi et al., 2019; Conejos et al., 2015; Günç et al., 2019; Nasr and Khalil, 2022; Parpas and Savvides, 2020; Arfa et al., 2022b; Tan et al., 2018) (Mısırlısoy and Günçe, 2016; Wang and Liu, 2021; Hanafi et al., 2019; Conejos et al., 2015; Arfa et al., 2022b; Tan et al., 2018; Bottero et al., 2020) (Wang and Liu, 2021; Hanafi et al., 2019; Conejos et al., 2015; Vardopoulos et al., 2021; Parpas and Savvides, 2020; Hamida et al., 2020; Arfa et al., 2022b; Tan et al., 2018) (Mısırlısoy and Günçe, 2016; Wang and Liu, 2021; Günç et al., 2019; Alavi et al., 2022; Djebbour and Biara, 2019; Elsorady, 2020; Hamida et al., 2020; Arfa et al., 2022b; Tan et al., 2018) (Mısırlısoy and Günçe, 2016; Hanafi et al., 2019; Conejos et al., 2015; Günç et al., 2019; Nasr and Khalil, 2022; Parpas and Savvides, 2020; Elsorady, 2020; Arfa et al., 2022b; Tan et al., 2018)
Cultural	The architectural values of the building are preserved The historic values of the building are preserved The cultural values of the building are preserved	• Overall aesthetics of the buildings • Conserving authentic features • historic and symbolic value • Cultural value	(Wang and Liu, 2021; Hanafi et al., 2019; Günç et al., 2019; Arfa et al., 2022b; Tan et al., 2018) (Mısırlısoy and Günçe, 2016 Wang and Liu, 2021; Hanafi et al., 2019; Conejos et al., 2015; Günç et al., 2019; Nasr and Khalil, 2022; Alavi et al., 2022; Elsorady, 2020; Arfa et al., 2022b;

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Themes	Objectives	Criteria	Literature
			Bottero et al., 2020) (Wang and Liu, 2021; Hanafi et al., 2019; Conejos et al., 2015; Günç et al., 2019; Nasr and Khalil, 2022; Alavi et al., 2022; Elsorady, 2020; Arfa et al., 2022b; Tan et al., 2018) (Mısırlısoy and Günçe, 2016; Wang and Liu, 2021; Hanafi et al., 2019; Conejos et al., 2015; Günç et al., 2019; Nasr and Khalil, 2022; Alavi et al., 2022; Djebbour and Biara, 2019; Vardopoulos et al., 2021; Elsorady, 2020; Arfa et al., 2022b; Tan et al., 2018)

determine what the best new use or intervention action is for the adaptive reuse project. The decision options for these models are either really broad (functional use) (Haroun et al., 2019), or really specific (pre-defined design options) (Vizzarri et al., 2021). The IconCUR model does take into account general property management interventions but takes a broader approach looking beyond adaptive reuse alone (Langston and Smith, 2011). The results from this literature review reveal that general holistic intervention options specifically focussed on adaptive reuse, incorporating design principles are currently missing in the literature. This is supported by various authors who also state the need for creating general typologies for adaptive reuse scenarios (Pieczka and Wowrzeczka, 2021; Cleempoel, 2019).

Although adaptive reuse itself is considered a circular strategy, other circularity aspects seem to be lacking in adaptive reuse projects (Bosone et al., 2021). The work by Ikiz Kaya et al. (Ikiz et al., 2021b) shows that there is still a weak connection and awareness among relevant stakeholders regarding adaptive heritage reuse and the circularity framework in adaptive reuse projects in the Netherlands (Ikiz et al., 2021b). In their research, the circularity performance of adaptive reuse projects is assessed from the perspective of stakeholders, based on 23 circularity indicators. Through a cluster analysis, it was revealed that stakeholders of adaptive reuse projects only weakly recognize the correlation between the adaptive reuse projects and the circularity framework (Ikiz et al., 2021b). Most of the circularity performance indicators used in their study are repeatedly found in this literature review throughout all phases of the adaptive reuse process. This indicates a possible discrepancy between circular decision criteria for adaptive reuse found throughout the adaptive reuse process and the actual circularity performance of adaptive reuse projects. Whilst circularity might be embedded in the decision criteria and decision models for adaptive reuse, it does not transfer to actual circular strategies being implemented in adaptive reuse projects. This highlights the need for more research into the actual circularity performance of adaptive reuse projects, as well as ways to incorporate circularity strategies into adaptive reuse projects. A good starting point for this could be the work of Foster (2020), who came up with a comprehensive framework for circular strategies for adaptive reuse throughout the building's life cycle. These

strategies could be incorporated with general adaptive reuse scenarios to give decision-makers in adaptive reuse projects tangible intervention options that increase the overall circularity performance. This might bridge the gap between circular intentions in the adaptive reuse decision-making process, and actual circular actions. By mandating or prioritizing concrete circularity and environmental principles at the outset of adaptive reuse projects, such as through: Green Building Rating Systems (GBRS) (Awadh, 2017), policymakers can incentivize project developers to incorporate circularity into both their decision-making process and translate it into tangible, concrete outcomes.

The results from this literature review are also in line with the results from Foster & Kreinin (Foster and Kreinin, 2020), whose study highlights that environmental indicators are rarely applied in cultural heritage adaptive reuse projects, pointing out a gap between common circularity indicators and specific indicators aimed at demonstrating the environmental advantages of adaptive reuse. In their work four environmental indicator groups are synthesized resulting in the following four clusters: 1. Indicators of direct reductions to new natural materials extraction due to the adaptive reuse; 2. Indicators of direct reductions to energy use due to the adaptive reuse; 3. Indicators of direct environmental improvements due to the adaptive reuse; and 4. Indicators of indirect reductions to energy use or pollution due to the adaptive reuse. The four environmental indicator groups by Foster & Krenin (Foster and Kreinin, 2020) are all found in this literature review as decision criteria for adaptive reuse throughout the different phases. However, looking at specific criteria some gaps can be identified. Although reduction in Greenhouse Gas emissions and energy consumption are found in all three phases, the focus on direct environmental improvement is somewhat lacking. Biodiversity and climate adaptation are only found in the preparation phase, whereas soil quality is not mentioned throughout the phases. Health and well-being are partly integrated into the three lists under indoor environmental quality aspects like air and noise quality, but a holistic focus on health is missing for all three phases. This corresponds to the work of Bosone et al. (2021), who looked at indicators of cultural heritage adaptive reuse impacts in the post-completion phase, and also found the absence of health and well-being indicators. Only few publications have looked at the relationship between health and heritage regeneration (Carone et al., 2017), which indicates a new interesting research intersection. In line with Foster & Krenin (Foster and Kreinin, 2020) and Bosone et al. (2021), this research illustrates a need for more adequate and specific environmental decision criteria for adaptive reuse, including a more holistic approach to health and well-being criteria.

While this literature review meticulously analyses and categorizes decision criteria across various phases, it's imperative to underscore the significance of adhering to the three fundamental conditions of criteria when applying them in a multi-criteria decision-making (MCDM) context. As outlined by Roy (1996) the conditions of exhaustiveness, non-redundancy, and cohesiveness serve as guiding principles to ensure the validity and effectiveness of the decision-making process. Adhering to these conditions facilitates the rigorous evaluation and comparison of alternatives, enabling decision-makers to make informed and robust choices amidst complex and conflicting objectives (Roy, 1996). Therefore, while the identification and organization of criteria are essential, their application must be grounded in these fundamental conditions to yield meaningful and actionable insights in practical decision-making applications.

While this paper aims to offer a comprehensive overview of decision criteria throughout the adaptive reuse process, several limitations and constraints must be acknowledged. Firstly, the reliance on existing literature, although extensive, may have introduced biases inherent in the selection and interpretation of sources. The limitations of this study can be linked to the subjective interpretations of the decision criteria during the thematic reflexive analysis. Although the subjective interpretation of the author is considered a strong point of the reflexive thematic analysis (Braun and Clarke, 2012), it can also lead to inconsistency and a lack of coherence when developing themes from the data. It is important to state that this review is only one possible set of analyses of the literature. Moreover, while the integrative literature review approach offers a comprehensive synthesis, it may not fully capture emerging perspectives or innovative approaches outside the existing body of literature. The predominance of economic and architectural decision criteria across all phases may suggest a bias towards traditional considerations, possibly neglecting the evolving importance of environmental factors, particularly in the implementation phase. Therefore, future studies could benefit from incorporating diverse methodologies, such as empirical case studies or stakeholder interviews, to complement and validate the findings of this paper in a real-life context.

4.1. Recommendations for further research

Based on the research findings the following recommendations for further research are provided to advance the literature on decision criteria for adaptive reuse.

- More research is needed on the differences in weighting and importance of the decision criteria of adaptive reuse between the different phases of the AR process.
- More research is needed on the differences in evaluating and measuring the decision criteria per phase in the AR process.
- The implementation phase is largely overlooked with regard to adaptive reuse decision criteria. Due to the arrival of circular design practices such as design-for-disassembly (DfD), the complexity of decisions in the implementation phase will only increase in the future, highlighting the need for more research into the decision criteria in this phase.
- The findings of this research could be validated in future studies through empirical methods like case studies or stakeholder interviews. This approach would address the limitations of relying solely on existing literature by providing firsthand insights from practitioners and stakeholders involved in adaptive reuse projects.
- Future studies could take a 'building segmentation' perspective when looking at the decision-making process, further diving into the differences in decision criteria for different building typologies.
- Alternatives and options considered in the multi-criteria decision-making models for adaptive reuse should consist of more holistic scenarios that provide a general overview of what is possible when pursuing adaptive reuse. Alternatives and options that are currently used in MCDM models are either really specific (specific design options), or really broad (functional use).
- Environmental decision criteria should be considered from a broader perspective looking at biodiversity, climate adaptation, soil quality, and health and well-being. More research is needed on the correlation between these aspects and adaptive reuse.

Finally, as stated at the beginning of the article, AR can contribute to, and is therefore very much in line with CE ambitions. It is very interesting to note therefore there is a gap between theory and practice when it comes to circularity performance and adaptive reuse (Ikiz et al., 2021b). Although circularity aspects are embedded in the decision criteria for adaptive reuse, this is not translated into the actual circularity performance of adaptive reuse projects. More research is needed into the circularity performance of adaptive reuse projects, and the inclusion of circular strategies in holistic adaptive reuse scenarios.

5. Conclusion

The decision-making process in adaptive reuse projects is often complex, involving multiple and conflicting criteria, and diverse stakeholders. Despite the significant growth of the literature on adaptive reuse, no literature currently exists that systematically looks at the

similarities and differences between relevant criteria in the various phases of the adaptive reuse decision-making process. Therefore this study aims to provide a state-of-the-art overview of the decision criteria for adaptive reuse throughout the AR process and, to identify areas for future research. Through an integrative literature review with a systematic search strategy three phases where decision criteria can be used in the adaptive reuse process were substantiated, and three lists of decision criteria were established. The decision criteria for adaptive reuse have been categorized and discussed in relation to these phases. In the pre-project phase, decisions focus on preserving, reusing, or demolishing buildings, often guided by financial, functional, technical, cultural, and legal criteria. The preparation phase involves selecting the best adaptive reuse alternative through multi-criteria decision-making models, considering factors like economic viability, community engagement, and cultural significance. In the post-completion phase, evaluations assess project success and future adaptability, emphasizing sustainability and user satisfaction. While decision criteria exhibit similarities across phases, differences emerge in their focus and application, reflecting the evolving needs and objectives throughout the adaptive reuse process. The results show a predominant repetition of economic and architectural categories, but more specific environmental decision criteria, especially in the implementation phase, are still largely overlooked. Based on the research findings 8 recommendations for further research are provided to advance the literature on decision criteria for adaptive reuse. The proposed lists of decision criteria per phase in the AR process provide stakeholders with a state-of-the-art overview of relevant factors to consider throughout the whole adaptive reuse decision-making process. The results can also serve as a resource when considering which criteria to include in comprehensive multi-criteria decision-making approaches for adaptive reuse.

CRediT authorship contribution statement

Brian van Laar: Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Angela Greco:** Writing – original draft, Validation, Supervision, Methodology, Conceptualization. **Hilde Remøy:** Writing – original draft, Validation, Supervision, Project administration, Funding acquisition, Conceptualization. **Vincent Gruis:** Writing – original draft, Validation, Supervision, Project administration, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Brian van Laar reports financial support was provided by the: EUROPEAN HEALTH AND DIGITAL EXECUTIVE AGENCY (HADEA), under grant number: 101056773.

Data availability

No data was used for the research described in the article.

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