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Adaptive Reuse Potential (ARP) Model for Age-Friendly Social Housing: a Systematic Literature Review

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***Abstract*— This systematic literature review examines the Adaptive Reuse Potential (ARP) Model and its application in developing age-friendly social housing. The study synthesizes research on the ARP Model's components, benefits, and variations, focusing on its relevance to repurposing existing buildings for social housing. Our findings reveal that the ARP Model offers a robust framework for assessing buildings' suitability for adaptive reuse, with significant potential for promoting sustainable urban development and creating age-friendly living environments. The model's consideration of multiple obsolescence factors allows for a comprehensive evaluation of a building's adaptive reuse potential. Variations of the model, including the Green Adaptive Reuse Model and the Adaptive Sustainable Reuse Model, further enhance its applicability to age-friendly social housing development by incorporating additional sustainability and decision-making criteria. By critically analyzing existing literature, we highlight the model's strengths in addressing complex urban regeneration challenges and meeting the evolving needs of aging populations. The ARP Model demonstrates particular efficacy in bridging architectural preservation with contemporary social housing requirements, offering a nuanced approach to repurposing underutilized urban spaces. This comprehensive evaluation underscores the importance of interdisciplinary considerations in adaptive reuse strategies, integrating architectural, social, and environmental perspectives. This review concludes that the ARP Model and its variations provide valuable tools for decision-making in adaptive reuse projects, particularly in addressing the growing demand for age-friendly social housing. However, there is scope for further development of the model to more explicitly incorporate age-friendly design principles.**

Keywords*— *adaptive reuse potential (ARP) model, age-friendly housing, social housing, building obsolescence.

I. Introduction

The adaptive reuse of existing buildings has emerged as a sustainable solution to address the increasing demand for social housing, particularly for aging populations. This approach not only provides much-needed housing but also contributes to urban conservation efforts by minimizing urban sprawl and preserving cultural heritage [1]–[3]. As cities worldwide grapple with the dual challenges of housing shortages and aging populations, the concept of adaptive reuse has gained significant traction among urban planners, architects, and policymakers.

The Adaptive Reuse Potential (ARP) Model, developed by [4]–[7], offers a structured approach to evaluating the potential of existing buildings for adaptive reuse. This model provides a quantitative framework for assessing a building's suitability for repurposing, considering various factors that influence its potential for successful adaptation. As such, the ARP Model has become an invaluable tool in the field of urban regeneration and sustainable development.

The growing interest in age-friendly social housing adds another dimension to the application of the ARP Model. With the global population aging rapidly, there is

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an urgent need for housing solutions that cater to the specific needs of older adults while promoting social integration and community well-being. The adaptive reuse of existing buildings for age-friendly social housing presents an opportunity to address this need while simultaneously preserving urban heritage and promoting sustainable development.

This systematic literature review aims to explore the ARP Model's components, benefits, and variations, with a specific focus on its application in developing age-friendly social housing. By synthesizing existing research on the ARP Model and its applications, this review seeks to provide a comprehensive understanding of the model's potential for guiding adaptive reuse projects in the context of age-friendly social housing development.

The review addresses the following research questions:

1. What are the key components and principles of the ARP Model?
2. How effective is the ARP Model in assessing buildings for adaptive reuse?
3. What variations of the ARP Model have been developed, and how do they contribute to its application?
4. How can the ARP Model be applied to the development of age-friendly social housing?

By addressing these questions, this review aims to contribute to the growing body of knowledge on adaptive reuse and age-friendly housing. It seeks to provide valuable insights for researchers, urban planners, architects, and policymakers involved in the development of sustainable and inclusive urban environments. Furthermore, by identifying potential areas for further development of the ARP Model in the context of age-friendly housing, this review aims to stimulate future research in this important field.

II. Materials and Methods

This study employs a systematic literature review methodology to synthesize existing research on the Adaptive Reuse Potential (ARP) Model and its application in age-friendly social housing development. The systematic approach ensures a comprehensive and unbiased review of the available literature, facilitating the identification of key themes, trends, and gaps in the current body of knowledge.

A comprehensive search of academic databases, including Google Scholar, Scopus, and Web of Science, was conducted. The search utilized a combination of keywords and phrases, such as "Adaptive Reuse Potential Model," "ARP Model," "adaptive reuse," "social housing," "age-friendly housing," "sustainable urban development," and "building obsolescence." Boolean operators (AND, OR) were employed to combine these terms and enhance search precision. The search was not restricted by publication date to ensure a thorough review of the model's development and applications over time

Studies were included in the review if they met specific criteria: they must focus on the ARP Model or its variations, discuss adaptive reuse in the context of housing or urban development, be published in English to ensure accurate interpretation, and be peer-reviewed journal articles, conference papers, or book chapters to ensure quality and reliability.

Relevant information was extracted from the selected studies, including descriptions and explanations of the ARP Model's components, discussions of the model's benefits and limitations, details of variations or adaptations of the original ARP Model, applications of the model in housing or urban development contexts, discussions of the model's relevance to age-friendly or social housing, and any critiques or suggestions for improvement of the model.

The extracted data was synthesized to identify key themes, trends, and gaps in the literature related to the ARP Model and its application in age-friendly social housing. This process involved categorizing the information according to the research questions, identifying common themes and patterns across different studies, noting any conflicting findings or interpretations, and recognizing gaps in the current research or areas for further investigation.

III. Results and Discussion

The Adaptive Reuse Potential (ARP) Model, developed by [4], [8], provides a comprehensive framework for evaluating the potential of existing buildings for adaptive reuse. This model has gained significant attention in the field of urban regeneration and sustainable development due to its systematic approach to quantifying reuse potential.

The concept of useful life is central to the ARP Model. It represents the optimal point in a building's lifespan for repurposing. This is calculated using two key parameters: Building's Physical Life (Lp), which is an estimated value representing how long the building is expected to last physically, typically assigned a value of 100 years or less for modern buildings, though values of 150 and 200 years can also be used for more durable structures; and Building's Age (Lb), which is the number of years from when the building was constructed to the current year or year of assessment. The useful life (Lu) is calculated somewhere within the range between Lb and Lp. According to the model, the adaptive reuse potential (ARP) of a building reaches its peak at Lu and then declines to zero as the building ages towards its physical life (Lp).

The ARP Model considers seven obsolescence variables, each evaluated independently. Physical Obsolescence assesses the wear and tear of the building based on its maintenance policy, rated from 0% (high maintenance) to 20% (low maintenance). Economic Obsolescence considers the building's location and its impact on value, ranging from 0% (high-density location) to 20% (low-density location). Functional Obsolescence evaluates the adaptability of the building's spatial layout, rated from 0% (low conversion cost) to 20% (high

conversion cost). Technological Obsolescence assesses the building's energy efficiency, ranging from 0% (low energy demand) to 20% (high energy demand). Social Obsolescence considers the suitability of the building's function in the market, rated from 0% (fully owned spaces) to 20% (fully rented spaces). Legal Obsolescence evaluates compliance with building design and standards, ranging from 0% (high-quality design/compliance) to 20% (low-quality design/compliance). Political Obsolescence assesses community or public interest in the building, ranging from -20% (supportive environment) to 20% (inhibiting environment). These percentages are not cumulative; instead, each variable is equally considered in assessing the building's overall obsolescence.

The model generates an index of reuse potential, known as the ARP score, which is expressed as a percentage. This score helps in benchmarking, timing, and ranking mutually exclusive projects. Scores above 50% indicate high adaptive reuse potential, scores between 20% and 50% indicate moderate adaptive reuse potential, and scores below 20% indicate low adaptive reuse potential.

Fig. 1. illustrates the Adaptive Reuse Potential (ARP) Model, which provides a framework for evaluating the potential of existing buildings for adaptive reuse. This model quantifies their reuse potential, assisting in prioritizing buildings for conversion based on their adaptability to new uses. This division represents roughly one-third of the area under the decay curve in each category.

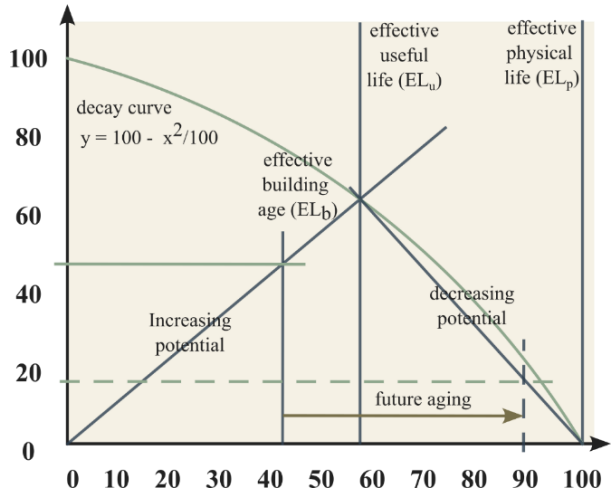

Fig. 1. Adaptive reuse potential model [8], [9].

The ARP Model offers several significant benefits in the context of urban regeneration and sustainable development. It facilitates a shift in traditional property stakeholder decision-making processes toward more sustainable practices and outcomes. By identifying and ranking existing buildings with significant potential for adaptive reuse, the model enables the industry to embrace sustainable development strategies. The model aids in identifying buildings where resource efficiency benefits can be maximized, thereby promoting reduced environmental impact through decreased material consumption and waste generation on a larger scale [10]–[12]. Additionally, by providing a framework for assessing the reuse potential of existing structures [13]–[15], the ARP Model supports the preservation of cultural heritage and historical significance, particularly important in urban areas where older buildings contribute significantly to the character and identity of neighbourhoods. The model also helps identify buildings where adaptive reuse can be most economically beneficial, enhancing overall economic efficiency in urban development projects.

Several variations and extensions of the original ARP Model have been developed to address specific contexts or incorporate additional considerations [16], [17]. The Adaptive Reuse Decision-Making Model expands on the ARP concept to aid practitioners in deciding whether to reuse or demolish existing buildings. It integrates critical factors including financial considerations of capital investment, asset condition, regulatory requirements, and sustainability principles across environmental, economic, and social dimensions.

This decision-making model, as illustrated in Fig. 2. provides a comprehensive framework for evaluating whether existing buildings should be repurposed or demolished.

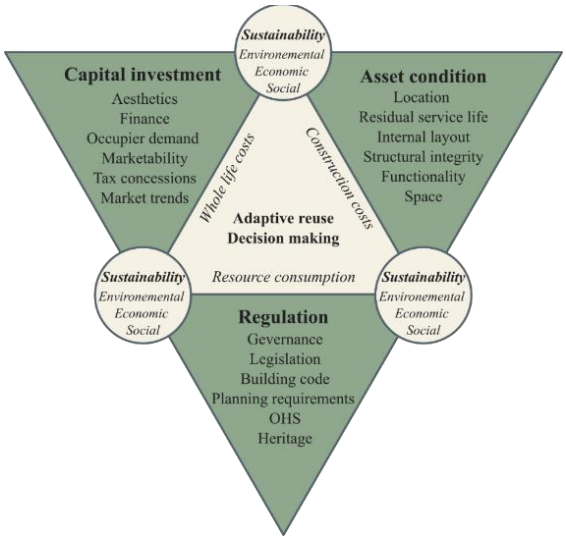

Fig. 2. The adaptive reuse decision-making model [8], [18]

The Green Adaptive Reuse (GAR) Model incorporates green building principles into the adaptive reuse of existing structures, aiming to enhance environmental, social, and economic performance through seven major design criteria and emphasis on eco-friendly materials and energy efficiency [19], [20]. The Adaptive Sustainable Reuse Model focuses [21] on revitalizing historical and cultural heritage buildings, integrating advanced decision-making techniques and taking a participatory approach engaging local stakeholders. The Sustainable-Driven Adaptive Reuse Model emphasizes [22] the integration of sustainability into the redevelopment of existing buildings, highlighting multifaceted benefits and using multi-criteria analysis to assess project viability.

In applying these models to age-friendly social housing, several key considerations emerge. The model can be adapted to prioritize buildings with potential for incorporating accessibility features crucial for age-friendly housing, such as ramps, wider doorways, and elevators. By evaluating the social obsolescence factor, the model can help identify buildings well-situated for community integration, with good access to community facilities, public transport, and healthcare services. The technological obsolescence factor can be used to assess a building's potential for energy-efficient retrofitting, particularly important for maintaining affordable operating costs in age-friendly social housing. The functional obsolescence factor can help identify buildings with layouts adaptable to the changing needs of older residents, particularly those that can be easily modified to incorporate universal design principles. While not explicitly part of the original ARP Model, considerations of health and safety are crucial for age-friendly housing and could be incorporated into the assessment of physical obsolescence, with buildings that can be easily upgraded to meet health and safety standards for older adults receiving favourable scores.

This systematic review examines the Adaptive Reuse Potential (ARP) Model's application in age-friendly social housing development, revealing both its capabilities and limitations. The model's seven obsolescence factors (physical, economic, functional, technological, social, legal, and political) provide a comprehensive framework for evaluating buildings, effectively addressing our first research question about key components and principles. The model's quantitative scoring system, which clearly categorizes buildings based on their adaptive reuse potential (high: >50%, moderate: 20-50%, low: <20%), demonstrates its effectiveness in assessment, answering our second research question.

Various adaptations of the model, including the Green Adaptive Reuse Model and Adaptive Sustainable Reuse Model, have enhanced its applicability by incorporating sustainability metrics and advanced decision-making techniques. These variations, addressing our third research question, show the model's evolution to meet contemporary challenges in urban development. Regarding our fourth research question, the model shows strong potential for age-friendly social housing development through its adaptable framework, though some modifications may be needed for optimal application.

The model's primary strengths lie in its comprehensive framework, quantitative assessment approach, and flexibility in adaptation to various contexts. Its integration of multiple stakeholder perspectives and sustainability principles makes it particularly valuable for current urban development challenges. However, several limitations exist, including insufficient explicit criteria for age-specific requirements, an overemphasis on economic factors at the expense of social considerations, and gaps in addressing smart technology integration. The model's complexity can also make implementation challenging, particularly in different cultural and regulatory contexts.

Future development opportunities include creating specialized assessment criteria for age-friendly housing requirements, better integration of smart technologies, and enhanced consideration of social factors specific to older adults. The model could benefit from incorporating innovative funding approaches for social housing and structured methods for stakeholder participation, particularly involving older adults in the evaluation process.

These findings suggest that while the ARP Model provides a strong foundation for evaluating adaptive reuse potential, targeted modifications would enhance its effectiveness for age-friendly social housing development. As global populations age and housing demands evolve, such refinements will become increasingly important in supporting sustainable urban development strategies.

IV. Conclusion

- This systematic literature review demonstrates that the Adaptive Reuse Potential (ARP) Model and its variations offer valuable tools for assessing and prioritizing buildings for adaptive reuse in the context of age-friendly social housing development. The model's comprehensive approach, considering multiple obsolescence factors, aligns well with the complex requirements of creating suitable living environments for older adults.
- The ARP Model provides a structured framework for decision-making in adaptive reuse projects, offering several key benefits:
- It promotes sustainable urban development by encouraging the reuse of existing building stock, reducing the need for new construction and preserving cultural heritage.
- The model's consideration of multiple obsolescence factors allows for a holistic evaluation of a building's potential, ensuring that various aspects crucial for age-friendly housing are considered.
- The flexibility of the model and its variations allows for adaptation to specific contexts and requirements, making it a versatile tool for diverse urban environments.
- By providing a quantitative measure of adaptive reuse potential, the model facilitates objective comparison and prioritization of potential projects, aiding in resource allocation and strategic planning.
- However, the review also suggests areas for further development and research:

- There is potential to more explicitly incorporate age-friendly design principles into the model, enhancing its specificity for age-friendly housing projects.
- Further exploration of the economic aspects specific to age-friendly social housing could strengthen the model's applicability in this context.
- Integration of smart city concepts and digital technologies into the ARP Model could enhance its relevance in increasingly digitalized urban environments.
- More emphasis on participatory approaches in the model could ensure that adaptive reuse projects better meet the needs and preferences of older adults.
- Empirical studies and case analyses of the ARP Model's application in age-friendly housing projects would provide valuable insights for refining and validating the model.
- In conclusion, the ARP Model and its variations provide a robust foundation for decision-making in adaptive reuse projects aimed at developing age-friendly social housing. By leveraging these tools, stakeholders in urban planning and development can make informed decisions about adaptive reuse projects, contributing to sustainable urban development while meeting the housing needs of aging populations.
- Future research should focus on developing a specialized version of the ARP Model that explicitly incorporates age-friendly considerations, potentially enhancing its effectiveness in this specific application. Additionally, practical case studies and longitudinal research on the application of the ARP Model in age-friendly housing projects would provide valuable insights for practitioners and policymakers.
- As cities worldwide grapple with the dual challenges of aging populations and the need for sustainable urban development, the ARP Model offers a valuable framework for creating innovative, inclusive, and sustainable housing solutions. By guiding the transformation of existing buildings into age-friendly social housing, this approach has the potential to significantly contribute to the creation of more livable and inclusive urban environments for all ages.

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