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Editors: M. Trivunić, I. Džolev, M. Šešlija

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ADAPTIVE REUSE OF NEGLECTED AREAS IN SKOPJE BY IMPLEMENTING OF THE CIRCULAR ECONOMY

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Summary

The urban landscape holds significant potential in steering the shift towards a circular economy, particularly given the substantial resource consumption and waste output associated with building construction. This paper delves into the prospect of repurposing abandoned industrial structures, examining the sustainability implications within the framework of a circular economy in Skopje, North Macedonia. Repurposing vacant industrial buildings has the capacity to yield environmental, social, and economic advantages by adopting urban strategies rooted in circular economy principles and innovative methodologies. In the context of Skopje's urban development and the metamorphosis of its industrial zones for reuse, this research identifies potential abandoned industrial sites within the city. The research examines these abandoned industrial sites by assessing their functional transformation and adaptive reuse.

Key words: circular economy, neglected areas, adaptive reuse

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1. INTRODUCTION

The urban landscape holds a pivotal role in steering the transition to a circular economy (CE), particularly in light of the substantial resource consumption and waste generation inherent in building construction. The CE model of production and consumption emphasizes activities such as sharing, leasing, reusing, repairing, refurbishing, and recycling existing materials and products for as long as possible [1]. This stands in stark contrast to the linear economy approach, characterized by the transformation of natural resources into products destined to become waste, encapsulated in the "take, make, waste" paradigm [2].

While the prevailing mindset often views buildings as having a limited useful life and thus destined for eventual discard, CE seeks to challenge this paradigm. Recognizing that a significant portion of the existing building stock will remain in use for the next century [3], there is an imperative to not only devise strategies for designing durable and adaptable new construction projects but also to formulate sustainable CE approaches for existing buildings.

Adaptive reuse (AR) emerges as a strategic avenue for enhancing the environmental, social, and financial aspects of a building, site, or area by repurposing them from disused structures into ones with a renewed function [3, 4, 5]. In the context of the transition towards a circular economy, adaptive reuse assumes a pivotal role in rendering buildings as regenerative and reusable resources. While adaptability stands as a fundamental principle in the design of circular buildings, facilitating their longevity and averting premature demolition, AR approaches can also be applied retrospectively to existing structures not originally conceived with CE principles.

This paper is dedicated to investigating the potential of implementing AR on underutilized or abandoned industrial sites in Skopje, North Macedonia, contributing valuable insights to innovative approaches within the framework of CE initiatives. Through a comprehensive analysis of historical and contemporary urban plans, the evolution of industrial sites in Skopje is delineated. The study includes an examination of identified abandoned industrial sites, evaluating their functional transformation potential and assessing their susceptibility to prevailing demolition practices.

2. SPATIAL DEVELOPMENT OF SKOPJE

2.1. HISTORY

Industrial buildings in Skopje have played a pivotal role in the city's economic development and historical landscape. The establishment of the first industrial enterprises in Skopje occurred towards the end of the 19th century, marking the commencement of machine production. Following the Second World War, during North Macedonia's tenure as part of the Socialist Federal Republic of Yugoslavia, the region experienced a significant surge in economic and industrial activities.

However, this trajectory faced a major setback in 1963 when a devastating earthquake obliterated 80% of the city's buildings. In response, a new General Urban Plan was devised in 1965, aiming at the reconstruction and development of the city. Despite the seismic interruption, the commitment to industrialization persisted, leading to an expansion of the city's borders and an increase in the city's territory to 11,156 hectares. Approximately 10.9% of this area, equivalent to 1,215 hectares, was earmarked for industrial purposes. The city's industry was strategically organized into planned industrial zones, including the Zhelezara industrial zone, Eastern industrial zone, Southern industrial zone, and a new Western industrial zone, Figure 1.

Illustrating this shift, the planned reduction of industrial area in the city decreased from 1,269.6 hectares envisioned by the 1985 Plan to 1,050.29 hectares outlined in the 2002 Plan—a reduction of 219.31 hectares. This trend of decreasing industrial areas in the urban landscape continued with the General Urban Plan of 2012, Figure 3, further reducing the area to 782.19 hectares compared to the 2002 Plan, signaling a decrease of 268.1 hectares.

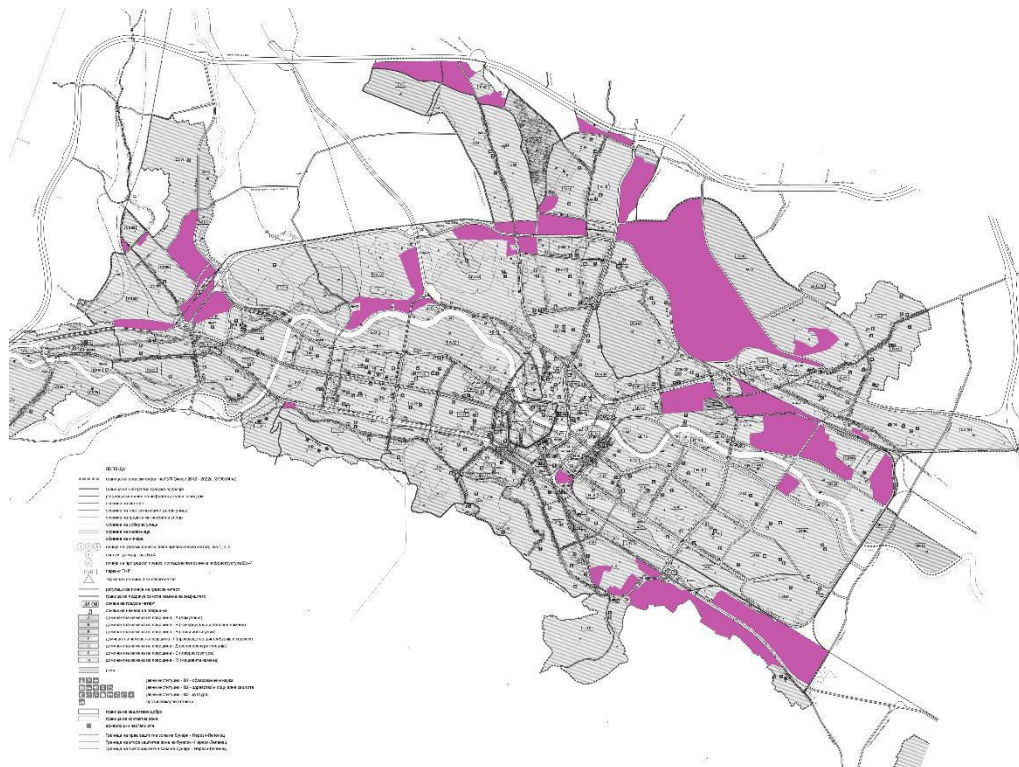


Fig. 3 Industrial zones – General Urban Plan 2012

2.2. CURRENT STATE OF INDUSTRIAL SITES IN SKOPJE

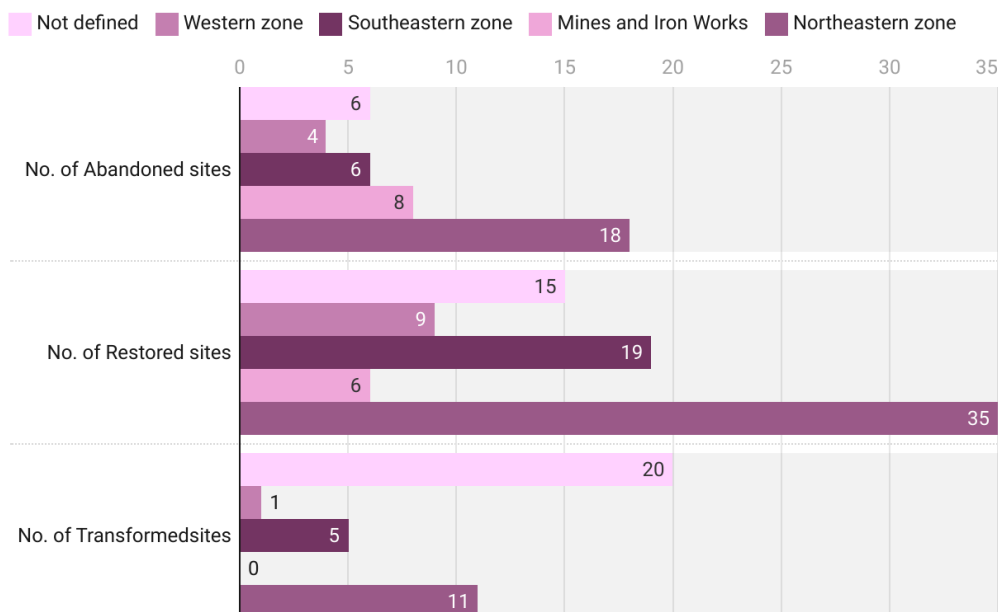
The shift in industrial enterprises during the post-socialist period, driven by the transition to a new socio-economic and political system, resulted in the abandonment or transformation of many of these sites. For the purpose of this research, a total of 163 individual industrial sites in Skopje, covering an area of 849.79 hectares, were considered.

Data for these sites were gathered by scrutinizing studies conducted for the new General Urban Plan for Skopje (2022-2032), currently in development, as well as any relevant preceding urban plans. The research focused on former industrial sites, revealing that the industrial zones in the city are undergoing fragmentation and adaptation to new functions. The once-exclusive industrial areas are undergoing changes influenced by processes such as deindustrialization, functional transformation, and industrial reconstruction. These sites were categorized into three groups: (1) Abandoned – sites that are completely inactive or severely underused; (2) Restored – sites that are actively used for industrial purposes; and (3) Transformed – sites that underwent complete changes and are now utilized for non-industrial purposes [6]. This classification provides insight into the dynamic evolution of industrial spaces in Skopje, reflecting the city's response to changing socio-economic and industrial dynamics.

The data presented in Table 1 indicates that the total number of abandoned industrial sites, comprising 42 sites, accounts for 25.76% of the overall analyzed 163 industrial sites in the city, while 51.53% of sites, 84 sites, have been successfully restored and remains functional as an industrial complex. Notably, 22.70% of the industrial sites, 37 sites, have undergone successful transformation and repurposing. In the scope of this paper, the focus will be on examining the abandoned sites due to their significant

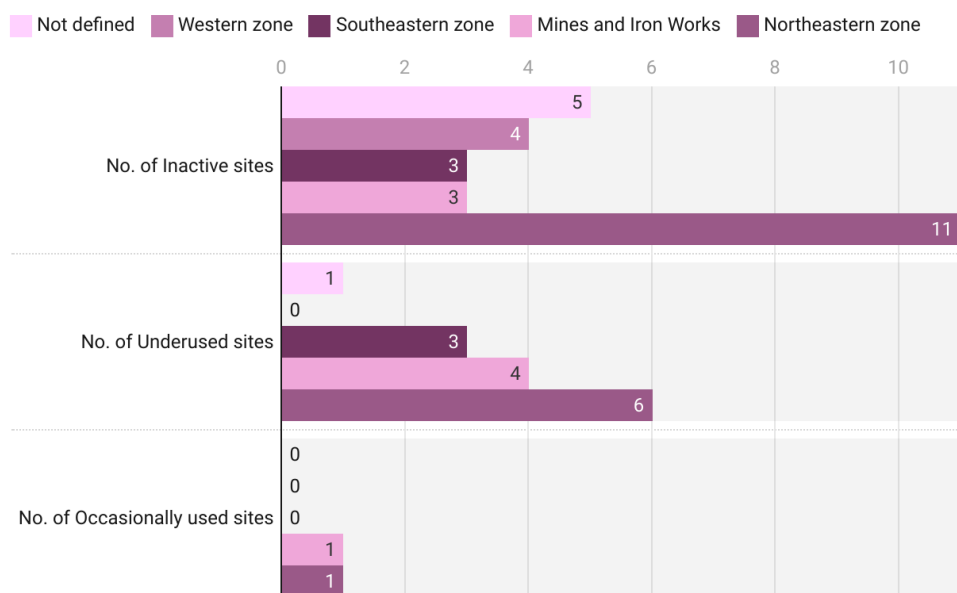
potential and the apparent need for the application of AR. Additionally, attention will be given to the transformed sites to understand the nature and extent of functional transformations achieved thus far.

Tab. 1 Overview of transformation of researched industrial sites in Skopje, 2022 [7]



The determination of the status of these abandoned sites, presented in Table 2, takes into account the degree of use, classified as follows: (1) Inactive Sites: These are completely deserted sites with no ongoing activity; (2) Underused Sites: Referring to sites where the degree of use falls short of matching the size and potential of the site; (3) Occasionally Used Sites: These sites experience intermittent use, suggesting a sporadic utilization pattern. This classification based on the degree of use provides a nuanced understanding of the status of abandoned industrial sites, allowing for a comprehensive analysis of the varied conditions and potentials associated with each site.

Tab. 2 Overview of abandoned industrial sites in Skopje, 2022 [7]

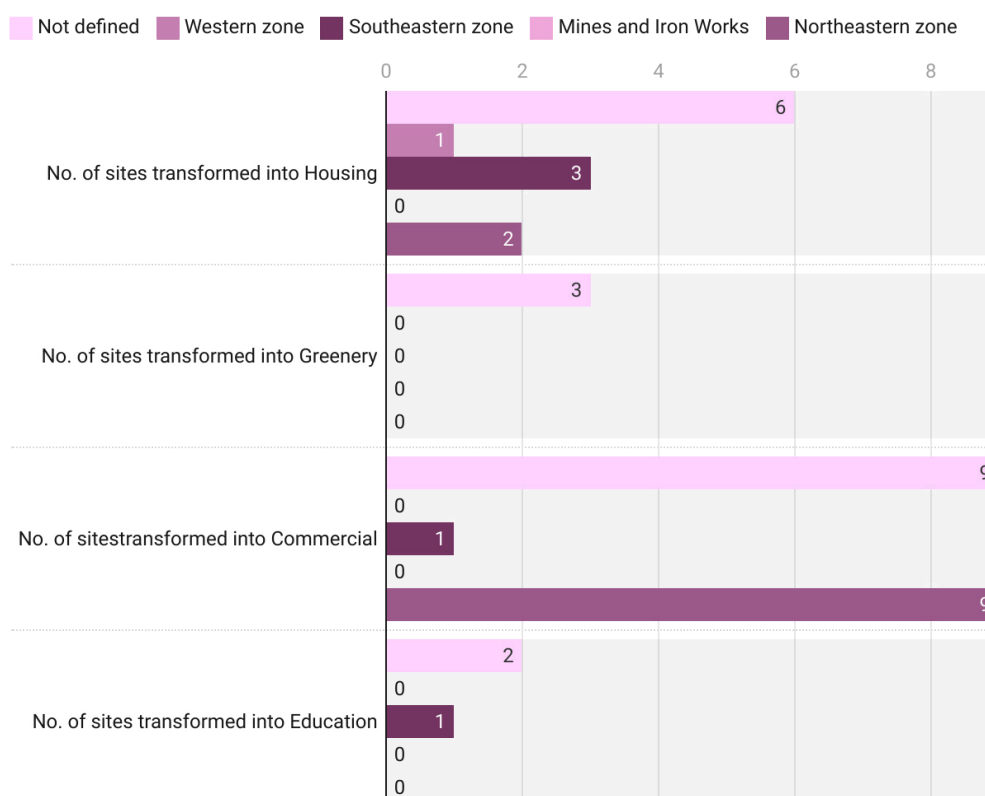


Based on the data outlined in Table 3, it is evident that a modest proportion of the abandoned industrial sites has undergone functional transformations. The predominant functions to which these sites have been transformed are as follows: (1) Commercial Transformation: Approximately 46.38% of the sites have been converted for

commercial purposes, indicating a notable trend toward repurposing industrial areas for business and commercial activities; (2) Housing Transformation: Following closely, about 32.43% of the sites have been transformed into housing which highlights a significant shift in land use, converting former industrial spaces into residential areas; (3) Green Spaces and Parks: A smaller yet noteworthy percentage of sites, amounting to 8.11%, has been cleared and repurposed into green surfaces and parks. This reflects an effort to introduce more environmentally friendly and recreational spaces.

These findings underscore the diverse range of transformations undertaken, showcasing the adaptability of abandoned industrial sites to new functions that contribute to commercial, residential, and green spaces within the urban landscape.

Tab. 3 Overview of transformed sites in Skopje according to new purposes in 2022 [7]



The shift in function observed in these abandoned industrial sites is a consequence of evolving economic structures. The prevailing trend favors the most economically lucrative transformations within the city, notably the construction of residential and commercial buildings. This inclination toward profitable transformations is influenced by the changing economic landscape, and the locations of these sites within the urban fabric further support this trend.

As the city expanded and industrial zones underwent fragmentation, some sites found themselves surrounded by incompatible residential and commercial functions. Consequently, those proximate to the city center tend to be repurposed for commercial use, while sites within residential areas are predominantly developed for new residential buildings. Examining the spatial distribution of abandoned industrial sites reveals that they are dispersed across the entire territory of the city. These abandoned sites are not confined solely to the three designated industrial zones but also extend to isolated locations outside these zones, Figure 4.

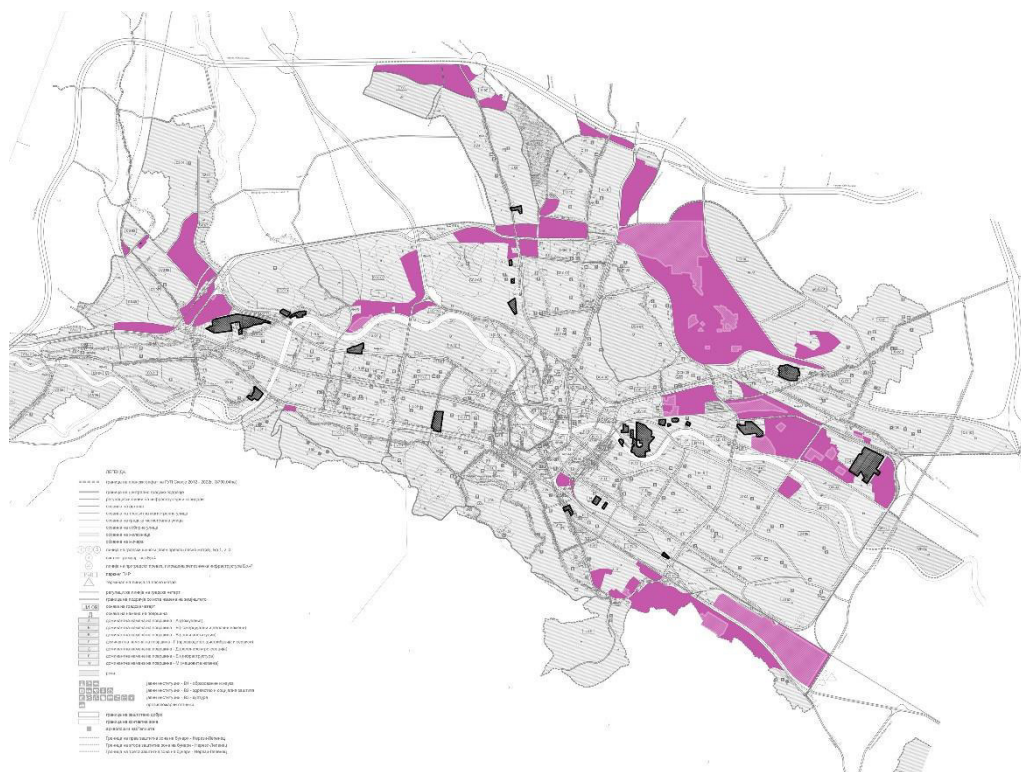


Fig. 4 Sites located outside of current industrial zones

While the transformation of these sites is deemed necessary, the current approach predominantly involves demolishing existing industrial structures and erecting new ones. This approach not only generates waste but also contributes to additional resource consumption. Adopting an AR approach for the remaining locations would not only mitigate these challenges but also bring about environmental, social, and economic benefits. AR represents a sustainable alternative, allowing for the preservation of existing structures, reduction of waste, and the integration of innovative solutions to breathe new life into these industrial sites. This approach aligns with principles of CE, fostering a more resilient and sustainable urban development model.

3. EXAMINING THE POTENTIAL FOR AR

Not all abandoned industrial sites necessarily require functional transformation through adaptive reuse. Some sites, still located within current industrial zones, can retain their original purpose. The vulnerability arises for sites that, according to the General Urban Plan of the city, are no longer situated within industrial zones. Buildings on these sites cannot serve their original function and, as observed in the analysis of transformed sites, are at risk of demolition.

To identify these vulnerable sites, the map of abandoned industrial sites is overlapped with the industrial zones planned in the most recent General Urban Plan for Skopje. Abandoned industrial sites near the central city area and in areas where the dominant function (mostly housing) clashes with industry are earmarked for a change in function. To explore the potential of these sites, an analysis was conducted in the context of other urban studies made for the master plan, particularly focusing on economic perspectives and environmental protection.

The study for environmental protection highlighted two critical aspects: the presence of brownfield sites and pollution [8]. Soil measurements revealed significant contamination with heavy metals around the "Ohis" organic-chemical industry, the "Makstil" iron and steel production and processing industry, and the "Godel" tannery. These sites are identified as industrially contaminated "hotspots," ranking among the 14 largest in the Republic. The risk posed by these localities due to high soil contamination

emphasizes the need for soil remediation before any AR activities can proceed. Of particular concern is the Ohis site, storing hazardous chlorinated organic substances for more than two decades.

The second significant issue impacting AR feasibility is air pollution. Air quality measurements, particularly for suspended particulate matter pollution like PM10 particles, reveal a citywide problem. The highest concentrations are recorded at the Lisiche station and in the city center. This data becomes crucial in determining suitable future functions for these sites, emphasizing the importance of considering environmental factors in the planning and implementation of adaptive reuse initiatives.

The study on the economic perspectives of the city identified issues in the urbanization policy, emphasizing the lack of a comprehensive strategy for even development across the entire city area [9]. The absence of a polycentric dispersion of business buildings and commercial facilities, along with a dispersed distribution of economic and social contents in the broader area, were highlighted. Commercial buildings, primarily concentrated in the city center and surrounding neighborhoods, showcased a spatial concentration.

The study proposed potential solutions, suggesting the development of industrial zones through the establishment of business incubators and technology parks to support entrepreneurship. It also recommended expanding and diversifying contents in peripheral zones, particularly through the creation of commercial centers. This strategy could have a dual impact by fostering business development in these zones and alleviating the burden on the city center. This decentralization could enhance accessibility, mobility, reduce pollution in the city center, and achieve a more even distribution of commercial and business facilities.

However, the study falls short by not considering the AR potential of certain buildings, overlooking the opportunity for a sustainable CE approach. Instead, it leans toward a conventional linear approach where introducing new functions involves the construction of entirely new buildings. The analyzed abandoned industrial sites present an alternative solution to this problem, given that historically, most of these sites were located on the outskirts of the city. Although these areas are now integrated into the city, they still represent its most peripheral zones. Recognizing the AR potential of these sites can contribute to a more sustainable, resource-efficient, and circular development approach, aligning with the principles of the circular economy. This approach could also complement the proposed strategy for the polycentric development of the city, fostering a more balanced and resilient urban landscape.

4. CONTINUING THE ASSESSMENT OF AR POTENTIAL

The evaluation of the potential of adaptive reuse is extremely complex and dynamic because the process involves different stakeholders [10] and a number of aspects need to be taken into consideration for each individual building. So far, this research has been focused on the city level, and exploring the potential benefits for an AR approach at this scale. However, in order to evaluate whether or not the specific buildings have the physical capacity to adapt to new functional needs, a number of aspects at the building scale need to be examined. Their compliance with health and safety requirements needs to be checked; their energy performance needs to be assessed in comparison to current standards; their infrastructures such as electricity, drainage, mechanical systems evaluated; the presence of hazardous materials assessed etc. [11].

Ball [12][13] investigated the industrial property stock in Stoke-on-Trent in the UK and identified the characteristics of buildings that were reused or reoccupied in comparison to the vacant ones. He argued that the characteristics suggested the potential of a building's adaptive reuse. This approach could be implemented in Skopje, since a number of the mentioned sites have been transformed, an analysis of the type of

function and location in the city of these sites could help identify which ones could be next. The redevelopment of brownfield and reuse of industrial buildings has attracted considerable research interest but only a handful of researchers attempted to find solutions for the evaluation of adaptive reuse potential [14].

5. CONCLUSION

This paper analyzed the abandoned industrial sites in Skopje, North Macedonia in order to explore the potential for AR of underused or abandoned buildings in order to help improve current practices that are not aligned with CE. From the analyzed data it can be concluded that the city of Skopje is undergoing a transformation of its industrial zones. Currently a large number of former industrial sites are underused or completely abandoned, with a number of sites located in areas where according to the current urban plans no industrial functions are planned. These sites will inevitably undergo a functional transformation in the future. The small percentage of sites that adapted to a new function, have been transformed by means of demolition and new construction, which results in waste creation and depletion of resources. This research identifies the sites where by developing a proper AR strategy the buildings can be repurposed, rather than demolished. The AR of vacant industrial buildings can bring environmental, social, and economic and help change the perspective of buildings as products with a limited useful life. The development and implementation of such strategies is crucial in the transition towards CE in the built environment. Further research should look into the specific conditions of the sites identified by this paper and focus on developing a clear plan for AR of the buildings. This type of applicative use of adaptability on existing industrial buildings can be helpful in developing a more general strategy for AR on buildings with different functions. Finally, an in-depth analysis of the application of more sustainable approach from the perspective of CE and AR would provide a set of useful guidelines for practitioners.

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REFERENCES

- [1] European Commission. Directorate General for Communication., *Circular economy action plan: for a cleaner and more competitive Europe*. LU: Publications Office, 2020. Accessed: Feb. 13, 2023. [Online]. Available: <https://data.europa.eu/doi/10.2779/05068>
- [2] Ellen MacArthur Foundation, “A new textiles economy: Redesigning fashion’s future”, 2017. [Online]. Available: <http://www.ellenmacarthurfoundation.org/publications>
- [3] P. Bullen and P. Love, “Factors influencing the adaptive re-use of buildings”, *Journal of Engineering, Design and Technology*, vol. 9, no. 1, pp. 32–46, Mar. 2011, doi: 10.1108/17260531111121459.
- [4] F. Abastante, S. Corrente, S. Greco, I. M. Lami, and B. Mecca, “The introduction of the SRF-II method to compare hypothesis of adaptive reuse for an iconic historical building”, *Oper Res Int J*, vol. 22, no. 3, pp. 2397–2436, 2022, doi: 10.1007/s12351-020-00611-4.
- [5] I. M. Lami, “Shapes, Rules and Value”, in *Abandoned Buildings in Contemporary Cities: Smart Conditions for Actions*, vol. 168, I. M. Lami, Ed. Cham: Springer International Publishing, 2020, pp. 149–162. doi: 10.1007/978-3-030-35550-0_9.
- [6] G. Mickovski, “Transformation of industrial space in the context of post-socialist transition of the city of Skopje”, University of Belgrade, Belgrade, 2015.

- [7] Faculty of Architecture - UKIM, "Study of the Development of the industry of the City of Skopje for General Urban Plan 2022-2032", 2022.
- [8] Faculty of Architecture - UKIM, "Study for the Environmental protection of the City of Skopje for General Urban Plan 2022-2032", 2022.
- [9] Faculty of Architecture - UKIM, "Study for the Economic development of the City of Skopje for General Urban Plan 2022-2032", 2022.
- [10] E. Kurul, "A qualitative approach to exploring adaptive re-use processes", *Facilities*, vol. 25, no. 13, pp. 554-70, 2007.
- [11] P. Bullen and P. Love, "A new future for the past: a model for adaptive reuse decision-making", *Built Environment Project and Asset Management*, vol. 1, no. 1, pp. 32-44, 2011.
- [12] R. M. Ball, "Vacant industrial premises and local development: a survey, analysis and policy assessment of the problem in Stoke-on-Trent", *Land Development Studies*, vol. 6, pp. 105-28, 1989.
- [13] R. M. Ball, "Re-use potential and vacant industrial premises : revisiting the regeneration issue in Stoke-on-Trent", *Journal of Property Research*, vol. 19, no. 2, pp. 93-110, 2002.
- [14] Urban Task Force, *Towards a Strong Urban Renaissance*, London: Urban Task Force, 1999.