Journal of Environmental Science Studies; Vol. 7, No. 2, 2024
ISSN 2591-779X E-ISSN 2630-4821
Published by July Press

The Role of Urban Design in Facilitating a Circular Economy: From Linear to Regenerative Cities

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Received: December 1, 2024 Accepted: December 20, 2024 Online Published: December 26, 2024

doi:10.20849/jess.v7i2.1479 URL: https://doi.org/10.20849/jess.v7i2.1479

Abstract

The increasing urbanization of cities worldwide has driven a parallel rise in resource consumption, waste generation, and environmental degradation. The transition to a circular economy (C.E.) offers a sustainable alternative, shifting from traditional linear resource use and disposal systems to regenerative systems prioritizing material reuse, resource efficiency, and ecological restoration. Urban design and planning are essential in facilitating this shift by creating the physical and regulatory infrastructure necessary to implement C.E. principles in cities. This paper explores the role of urban design in promoting circular economy strategies, focusing on adaptive reuse of buildings, green architecture, and integrating nature-based solutions (NBS) into urban environments. Through detailed analysis of these strategies and case studies from cities worldwide, this paper demonstrates that regenerative design is essential for closing material and resource loops and creating more sustainable, resilient cities.

Keywords: circular economy, urban design, adaptive reuse, green architecture, nature- based solutions, regenerative cities, urban planning, resource loops, sustainable development

1. Introduction

Urbanization is a defining feature of the 21st century, reshaping landscapes, economies, and societies across the globe. As cities expand, they face growing challenges related to resource consumption, waste generation, and environmental degradation (UN-Habitat, 2020; Zora et al., 2021; Tzoulas et al., 2007). Traditional linear economic models characterized by a sequence of resource extraction, product manufacturing, consumption, and disposal have proven unsustainable in the face of these challenges. Such models contribute to resource depletion, environmental pollution, and increased greenhouse gas emissions, leading to a pressing need for more sustainable urban development approaches (Kabisch et al., 2016; Julia C Lars, 2023).

The circular economy (C.E.) concept offers a transformative alternative to linear economic systems. Unlike linear models, C.E. principles emphasize designing out waste, keeping products and materials in use for as long as possible, and regenerating natural systems (Ellen et al., 2017; Ijla C Brostrom, 2015; Geng et al., 2013). The circular economy aims to create closed-loop systems where resource use is minimized, and waste is either eliminated or repurposed (Felipe et al., 2022; Fabi et al., 2021). This shift focuses on environmental considerations and creating new economic activity through novel business models and technologies (Geissdoerfer et al., 2018; Coates, 2013). This post presents a literature review on urban design and planning for the circular economy in cities. Urban design is an urban environment's physical and spatial framework, which shapes resource consumption, building construction and operation, and waste management (Cramer, 2018; Tan C Sia, 2013; Raymond et al., 2017). It has been argued that urban design enabling the shift from linear to circular systems can embrace, for instance, adaptive reuse of buildings, green architecture, and nature-based solutions (NBS) (Raymond et al., 2017; Tight, 2016; Wong, 2016). There are studied approaches that are more efficient in resource utilization and waste reduction and improve urban resilience and sustainability (Zora et al., 2021; Yigitcanlar C Kamruzzaman, 2015). Adaptive reuse entails taking over an existing, unused or underutilized building and giving it a new life without demolition, prolonging its lifecycle span, which tends to generate little to zero waste (Wong, 2016; Remoy C Van der Voordt, 2014). Green architecture is about creating energy- and resource- efficient buildings, as described in the circular economy (Obersteg et al., 2019). The ICLEI (2019) promotes the incorporation of natural processes to support resource provision and climate adaptation with biodiversity enhancement into urban design as nature-based solutions. These strategies present opportunities to enhance circularity in urban areas that will make cities more sustainable and resilient. The transition from a linear system of urbanization to a more circular one also calls for a shift.

The shift from linear to circular urban systems requires a comprehensive understanding of how these strategies intersect and complement each other. This paper explores the role of urban design in facilitating this transition, examining how adaptive reuse, green architecture, and nature-based solutions contribute to circular economy goals. Through detailed case studies and theoretical analysis, this paper aims to provide insights into how urban planning and design can support the development of regenerative cities capable of thriving within the constraints of a circular economy.

The paper will analyze successful implementations of these strategies to offer a nuanced perspective on the practical and theoretical aspects of circular urban design and identify challenges and opportunities associated with integrating circular economy principles into urban planning and design, providing recommendations for policymakers, urban planners, and researchers working towards a more sustainable urban future

2. Adaptive Reuse of Buildings: Extending the Life Cycle of Structures

Adaptive reuse is the process of repurposing existing buildings for new functions, extending the life cycle of structures and aligning closely with the principles of a circular economy (Langston C Shen, 2010; Wong, 2016). This practice offers a viable alternative to new construction, significantly minimizing construction waste and preserving embodied energy, the energy embedded in materials and processes used to create buildings (Ijla C Brostrom, 2015; Coates, 2013). Focusing on repurposing rather than demolishing and rebuilding, adaptive reuse reduces the environmental impact associated with new construction, including the substantial carbon emissions and resource consumption inherent in the production of building materials (Fabi et al., 2021; Felipe et al., 2022).

One of the most notable examples of successful adaptive reuse is the Van Nelle Factory in Rotterdam. Originally a state-of-the-art industrial facility, it has been transformed into a dynamic creative hub and cultural centre, maintaining its architectural integrity while fostering local economic activities (Cramer, 2018). This project revitalized an underutilized industrial space, significantly reduced demolition waste, and conserved valuable resources. The transformation of the Van Nelle Factory exemplifies how adaptive reuse can contribute to urban regeneration and economic development while honouring historical and architectural heritage.

Adaptive reuse is particularly effective in addressing the issue of vacant and underutilized properties. According to research, repurposing existing structures can result in a 40% reduction in energy use compared to new construction (Tan C Sia, 2013; Remoy C Van der Voordt, 2014). This energy saving is critical for reducing the carbon footprint of urban areas, as the production and transport of building materials contribute significantly to global emissions. Moreover, by extending the life cycle of existing buildings, adaptive reuse mitigates the environmental impacts associated with the extraction and processing of raw materials (Circle Economy, 2017; E.U., 2017).

In addition to environmental benefits, adaptive reuse fosters community engagement by preserving historical landmarks and creating spaces that reflect local culture and identity Through the reuse of old factories, warehouses, and other buildings for community centres, office spaces, and residential units, revitalizing neighbourhoods design could also support cultural continuity (Frantzeskaki et al., 2019; Berardi, 2012). The strategy has the dual advantage of conserving urban areas' architectural quality, improving the lives and managing progress for residential societies (Berardi, 2012; Berardi, 2013).

That said, taking these ideas from paper to brick and mortar can pose hurdles in the form of finance and regulatory red tape. Frequently, these projects involve large-scale retrofit and renovation, which can disincentive developers and investors (Langston C Shen, 2010; Yigitcanclar C Kamruzzaman, 2015). In addition, complying with regulations such as zoning laws and building codes can be barriers to overcome in adaptive reuse (O'Toole C Becker, 2014). Solving this requires policymakers, architects and developers to work together, introducing incentives and removing conflicting processes that allow adaptive reuse measures (Williams, 2022; Zora et al., 2021). Integrating

Integrating adaptive reuse into urban design frameworks is essential for promoting circularity and ensuring the long-term sustainability of urban environments. Furthermore, cities continue to grow, and the ability to reposition and repurpose buildings to adapt to sustainable structures will be essential to improving environmental impact and urban greening (U.N., 2018; Langston C Shen, 2010).

3. Green Architecture: Designing for Circularity and Resource Efficiency

Green architecture, also known as sustainable or eco-friendly design, involves creating energy-efficient, resource-conscious, and environmentally responsible buildings throughout their life cycle (Julia C Lars, 2023). This approach overlaps with circular economy principles by optimizing resource use, minimizing waste, and ensuring that materials can be reused, recycled, or repurposed. Critical elements of green architecture include passive design strategies, renewable energy integration, and sustainable building materials (Remoy C Van der Voordt, 2014; U.N., 2018).

Passive design strategies leverage natural environmental conditions to minimize energy consumption. These strategies include optimizing building orientation, using thermal mass to regulate temperature, and maximizing natural light (Wong, 2016; Tan C Sia, 2013; OECD, 2016). For example, buildings built with big windows that face southwards permit solar energy to be gathered as well, reducing the need for mechanical heating systems (Kozlowski and Romano). Green Architecture that incorporates such design principles has to reduce the energy footprint of buildings and supports a "circular economy" by diminishing the demand for non-renewable energy sources (OECD, 2016; Obersteg et al., 2019). Another core principle of green architecture lies in using renewable energy sources like solar panels, wind turbines and geothermal systems. High- performing Multimedia Information Retrieval (MIR) techniques decrease the demand for fossil fuels and protect the environment due to eco-friendly technologies that produce clean energy at landing sites (EMF, 2017; Berardi, 2016). The use of solar power in the Vauban district, located in Freiburg, Germany, is an example.

How can renewable energy be used within a community to help with sustainability goals (Berardi, 2016; Berardi, 2013)? In addition, green roofs and vertical gardens provide guaranteed advantages for the insulation of structures but also foster a positive impact on urban biodiversity and cleaner air (Bocken et al., 2016)

In comparison, the selection of building materials plays a crucial role in green architecture. Sustainable materials such as bamboo, reclaimed wood, and recycled metals are preferred due to their lower environmental impact and reduced resource consumption (Berardi, 2016). For instance, using reclaimed timber in construction minimizes the need for new lumber and reduces deforestation (Bocken et al., 2016). Additionally, incorporating materials with low embodied energy, such as recycled steel or concrete with supplementary cementitious materials, further supports circular economy principles by reducing the carbon footprint of construction activities (Berardi et al., 2012; E.U., 2017; Coates, 2013). Nevertheless, it is essential to recognize that modular and demountable design principles are integral to green architecture as they facilitate the disassembly and reuse of building components (Frantzeskaki et al., 2019; Fabi et al., 2021). The Edge in Amsterdam exemplifies this approach with its modular construction techniques, which allow for easy reconfiguration and adaptation over time (Circular Economy, 2017; Remoy C Van der Voordt, 2014). By designing buildings that can be easily modified or deconstructed, architects and developers support the circular economy by extending the life cycle of materials and reducing waste (OECD, 2016).

Thus, Green architecture promotes using energy-efficient technologies, such as high- performance insulation, windows, and sophisticated heating, ventilation and air conditioning (HVAC) systems (Tzoulas et al., 2007; Raymond et al., 2017). Designed to decrease the energy requirements of buildings to help meet circular economy objectives as they reduce resource use and emissions (and hence embodiment!), these technologies are used throughout commerce and industry. The use of energy- efficient technology at a large scale complemented by urban policies, such as Copenhagen's green building codes and relaxation of the solar panel, remains the primary way to tackle the demand. At the same time, these renewable energy initiatives are driven to interconnect the markets further and provide ease in adopting systems that drive sustainability objectives (European Commission, 2017). Much of the investments in green architecture and renewable energy solutions are expected to be integrated in direct response to the city's plan to reach carbon neutrality by 2025 (Sustainable Energy Authority of Ireland, 2021). Upon reflection, the green architecture follows similar circular economy principles from different angles: prioritizing resource efficiency, waste elimination, and material optimization. Resilient and Sustainable: Green architecture helps to create more resilient and sustainable urban environments by implementing passive design, harnessing renewable energy opportunities, using sustainable materials, and incorporating modular construction practices.

4. Nature-Based Solutions: Integrating Ecosystems Into Urban Design

Nature-based solutions (NBS) invest in natural functionalities and ecosystems to handle urban problems like climate adaptation, resource management or biodiversity conservation (Raymond et al. Through mainstreaming NBS within urban design, cities can enhance their capacity to regenerate and promote the closure of resource loops, which contributes to the optimal use of natural resources in line with the principles of circular economy

(Tight, 2016; Wong, 2016). In addition, NBS was identified as an opportunity to increase urban areas' resilience against climate change's impacts. Green infrastructure (e.g., parks, green roofs and urban forests) can help reduce the UHI effect, manage stormwater, and improve air quality (Tzoulas et al., 2007). Singapore’s "City in a Garden" initiative exemplifies how NBS can be integrated into urban environments to foster regenerative ecosystems. The city’s extensive network of green spaces, rooftop gardens, and vertical forests enhances biodiversity, improves air quality, and regulates urban temperatures, demonstrating the multifaceted benefits of NBS (Tan et al., 2013; Mguni et al., 2022).

NBS play a crucial role in urban water management by employing natural processes to address wastewater treatment, stormwater management, and flood risk reduction. Constructed wetlands and green roofs effectively capture and filter rainwater, reducing the burden on municipal water systems and promoting water reuse (Kabisch et al., 2016). For instance, green roof installations in cities like Toronto have been shown to significantly reduce stormwater runoff and improve water quality by filtering pollutants (City of Toronto, 2020). Similarly, in Cape Town, nature-based approaches are currently developed to enhance resilience to water scarcity and climate change. The city has implemented several projects within the NBS framework to improve water management and ecological health (Olivier et al., 2019).

However, the inclusion of NBS into urban design also contributes to the preservation of biodiversity and the provision of essential ecosystem services. Urban green spaces offer viable services such as carbon sequestration, air purification, and habitat creation for wildlife (Frantzeskaki et al., 2019). For example, urban forests and green belts improve carbon purification and provide recreational spaces for residents, thereby improving the overall quality of life (Nowak et al., 2014). Creating wildlife corridors and green roofs enhances urban biodiversity by providing habitats for various species and promoting ecological connectivity (Barton et al., 2015).

Similar studies suggest that including NBS in urban design can also foster community engagement and enhance well-being. Green spaces offer opportunities for recreation, social interaction, and environmental education, contributing to the human livability in urban areas (Frantzeskaki et al., 2019; Coates, 2013). For instance, transforming former industrial sites into green parks in cities like New York has revitalized communities and provided spaces for leisure and social gatherings (Yigitcanclar C Kamruzzaman, 2015; OECD, 2016). In addition, by involving communities in the planning and managing of NBS projects, cities can ensure that these solutions meet local needs and preferences, fostering a sense of ownership and stewardship (Raymond et al., 2017).

Despite the benefits, implementing NBS in urban design faces several challenges. Financial constraints, lack of technical expertise, and institutional barriers can hinder the adoption of nature-based approaches (Barton et al., 2015; Remoy C Van der Voordt, 2014). Overcoming these challenges requires coordinated efforts between policymakers, urban planners, and stakeholders to develop supportive frameworks and allocate resources effectively (Kabisch et al., 2016; Obersteg et al., 2019). Future research should focus on optimizing the design and management of NBS to maximize their benefits and address emerging urban challenges.

For societal transformations in the urban realm, nature-based solutions offer a monumental approach to urban design by integrating ecosystems into city planning and management. Through their capacity to enhance resilience, manage water resources, support biodiversity, and promote community well-being, NBS contribute significantly to the goals of the circular economy (Raymond et al., 2017; Kabisch et al., 2016; Frantzeskaki et al., 2019).

5. Urban Planning for Regenerative Cities: Shifting From Linear to Circular Systems

The transition from linear to circular urban systems represents a paradigm shift in urban planning that emphasizes regeneration over mere sustainability. Traditional linear urban models prioritize economic growth and expansion, often at the cost of environmental degradation and resource depletion (Zora et al., 2021; Tzoulas C Venn, 2007). In contrast, regenerative urban planning seeks to create urban systems that restore and enhance natural resources, minimize waste, and bolster the resilience of cities through integrated, holistic design strategies (Geissdoerfer et al., 2018; Julia C Lans, 2023; Ijla C Brostrom, 2015). To facilitate this shift, urban planners must embrace systems thinking—a methodology considering the interconnectedness of social, economic, and environmental factors (Geissdoerfer et al., 2018; Felipe et al., 2022; Bullen C Love, 2011). This approach involves integrating circular economy principles into urban planning processes, such as developing mixed-use neighbourhoods that reduce transportation needs and support local economies. Planners can enhance resources by designing cities that blend residential, commercial, and recreational spaces.

Efficiency and minimize environmental impact (Fabi et al., 2021; Frantzeskaki et al., 2019). For example, "15-minute cities" is an innovative urban planning approach that ensures all essential services and amenities are within a 15-minute walk or bike ride from residents' homes. This model reduces reliance on private vehicles, thus reducing greenhouse gas emissions and enhancing local economic activity. Such planning strategies contribute to circularity by promoting local resource loops and reducing the overall environmental footprint of urban areas.

Another vital aspect is that participatory design processes are critical for successful regenerative planning. Involving local communities, businesses, and other stakeholders ensures that circular economy initiatives are designed to address the specific needs and priorities of local residents while encouraging a sense of ownership and responsibility (Wong, 2016; Tan C Sia, 2013). Collaborative planning plays a key role in identifying and overcoming challenges such as financial limitations and policy gaps.

Involving the community in these planning processes increases the relevance and acceptance of circular initiatives and strengthens public support for sustainability efforts (OECD, 2016; Yigitcanlar C Kamruzzaman, 2015). Robust governance frameworks and supportive policies are critical to successfully implementing circular economy strategies. Urban planners must work closely with policymakers to create and enforce regulations that promote circularity, such as waste reduction goals, resource efficiency standards, and incentives for sustainable practices (OECD, 2016; Zora et al., 2021).

For example, Amsterdam has developed a circular strategy that encloses circular economy principles into waste management, construction, and consumer goods (Circle Economy, 2019). Meanwhile, in today's innovative landscape, infusing technology into urban planning can accelerate the shift toward circular systems. Innovative city technologies, including data analytics and the Internet of Things (IoT), can optimize resource management and enhance the efficiency of urban systems. For instance, intelligent grids and sensor-equipped waste management systems can provide real-time data on resource use and waste generation, enabling more efficient management and reducing environmental impacts (Bocken et al., 2016; Julia C Lars, 2023). These technological advancements support circularity by improving resource flows and promoting more sustainable urban practices.

However, despite the potential benefits, several challenges must be addressed to facilitate the transition to regenerative urban planning. Financial constraints, institutional barriers, and policy fragmentation can hinder the adoption of circular economy strategies (Williams, 2022). Overcoming these obstacles requires innovative financing mechanisms, such as public-private partnerships, and coordinated efforts between various levels of government and stakeholders (Geng et al., 2013). Developing integrated policy frameworks and providing financial incentives for circular initiatives can address these challenges and promote the widespread adoption of regenerative urban practices. These are gaining attention as a critical approach to creating sustainable cities (Zora et al., 2021; Williams, 2022). Looking at case studies of cities that have successfully implemented circular economy principles provides valuable lessons in planning and design strategies. Cities like Copenhagen, celebrated for its bold sustainability targets, and Freiburg, known for its eco-friendly urban planning, offer practical examples of how circularity can be woven into city design (E.C., 2017; EEA, 2022). These cities show that embracing regenerative urban planning can bring meaningful environmental, social, and economic improvements.

6. Final Remarks

The transition to a circular economy marks a transformative change in cities' design, presenting significant opportunities to boost sustainability and resilience. This shift redefines how urban areas manage resources, reduce environmental impact, and shape planning strategies. Critical approaches like adaptive reuse, green architecture, and nature-based solutions are essential in driving this transition. These strategies are crucial for extending the life of buildings, optimizing resource use, and incorporating natural systems into city landscapes.

Adaptive reuse is significant, as it focuses on repurposing existing structures, reducing the need for new construction, and reducing waste and carbon emissions. Projects like the Van Nelle Factory in Rotterdam highlight how adaptive reuse can breathe new life into underutilized spaces, preserve architectural heritage, and stimulate local economies (Cramer, 2018). Also, by prolonging the lifespan of buildings, adaptive reuse saves the energy embedded in these structures. It overlaps with circular economy principles by minimizing waste and promoting efficient use of resources (Langston C Shen, 2010).

Green architecture further supports the circular economy by designing energy-efficient and resource-conscious buildings throughout their life cycle. The Vauban district in Freiburg and The Edge in Amsterdam illustrate how integrating energy-efficient technologies, renewable resources, and modular construction techniques can significantly reduce environmental impact. These approaches enhance resource efficiency and demonstrate how green architecture can contribute to circularity by fostering sustainable building practices and reducing reliance on finite resources (Berardi, 2016).

Nature-based solutions (NBS) offer another crucial dimension by leveraging natural processes to address urban challenges, such as climate adaptation and resources management. Singapore’s "City in a Garden" initiative and Cape Town’s exploration of nature-based water management solutions highlight how integrating ecosystems into urban design can improve environmental quality and enhance urban resilience (Tan et al., 2013). NBS supports circularity by closing resource loops and providing essential ecosystem services that improve livability and community well-being (Raymond et al., 2017).

Despite these promising strategies, the path to a circular economy is fraught with challenges. Financial constraints, political resistance, and institutional barriers must be navigated to implement circular economy practices effectively. Innovative governance models and robust policy frameworks are essential for overcoming these obstacles. Engaging stakeholders through participatory design and collaborative planning ensures that circular economy initiatives reflect local needs and foster community support. The experiences of cities such as Amsterdam, Copenhagen, and Singapore offer valuable lessons in how urban design can drive circularity and highlight the need for continued research and policy development (European Commission, 2017; Circle Economy, 2017).

Urban populations continue to grow, and environmental pressures mount; integrating circular economy principles into urban design and planning will be crucial for creating sustainable and resilient urban environments. Recognizing and embracing strategies that extend building life cycles, optimize resource use, and integrate natural systems, cities can address pressing environmental challenges, enhance resource efficiency, and improve overall quality of life. The ongoing evolution of urban design in response to circular economy principles promises to transform cities and pave the way for a more sustainable and regenerative future.

Author Contributions

Williams Chibueze Munonye: Responsible for conceptualization, data collection, draft writing, review, diting, and supervision.

George Oche Ajonye: Responsible for proofreading, reading drafts, writing, and collecting data.

Declarations

Competing interests: The authors declare no competing interests.

References

Ancapi, F. B., Van den Berghe, K., & van Bueren, E. (2022). The circular built environment toolbox: A systematic literature review of policy instruments. *Journal of Cleaner Production*, *373*, 133918. https://doi.org/10.1016/j.jclepro.2022.133918

Barton, H., Grant, M., & Guise, R. (2015). *Shaping Neighbourhoods: For Local Health and Global Sustainability*. Routledge.

Berardi, U. (2011). Beyond sustainability assessment systems: Upgrading topics by enlarging the assessment scale. *J. Sustain. Build. Technol. Urban Dev.*, *2*, 276-282.

Berardi, U. (2012). Sustainability assessment in the construction sector: Rating systems and rated buildings. *Dev*, *20*, 411-424.

Berardi, U. (2013). Sustainability assessments of communities through rating systems. *Dev. Sustain.*, *15*, 1573-1591.

Berardi, U. (2016). The outdoor microclimate benefits and energy saving resulting from green roof retrofits. *Energy and Buildings*, 121, 217-229**.**

Bocken, N. M. P., De Pauw, I., Bakker, C., & Van Der Grinten, B. (2016). Product design and business model strategies for a circular economy. *Journal of Industrial and Production Engineering*, *33*(5), 308-320.

Bullen, P. A., & Love, P. E. D. (2011). Adaptive reuse of heritage buildings. *Structural Survey*, *29*(5), 411-421.

Circle Economy. (2017). *Circular Amsterdam: Circular Amsterdam: A vision and action agenda for the city and metropolitan area*.

Coates, G. J. (2013). The sustainable urban district of Vauban in Freiburg, Germany. Int. J. of Design C Nature and Ecodynamics, *8*(4), 265-286.

Cramer, J. (2018). The function of transition brokers in the regional governance of implementing circular economy–A comparative case study of six Dutch regions. *Sustainability*, *10*(9), 3233.

Ellen MacArthur Foundation. (2017). *What is a circular economy?.* Retrieved from https://www.ellenmacarthurfoundation.org/circular-economy/concept

European Commission. (2017). *The Circular Economy: A European Overview*. Retrieved from https://ec.europa.eu/environment/circular-economy/

European Environment Agency. (2022). Building renovation: where circular economy and climate meet. Retrieved from https://www.eea.europa.eu/publications/building- renovation-where-circular-economy

Fabi, V., Vettori, M. P., & Faroldi, E. (2021). Adaptive Reuse Practices and Sustainable Urban Development: Perspectives of Innovation for European Historic Spa Towns. *Sustainability*, *13*, 5531. https://doi.org/10.3390/su13105531

Frantzeskaki, N., & *et al.*. (2019). Nature-based solutions for urban sustainability: A review of the role of ecosystems in urban design. *Urban Ecosystems*, *22*(2), 239-257.

Geissdoerfer, M., & *et al.*. (2017). The circular economy – A new sustainability paradigm?. *Journal of Cleaner Production*, *143*, 757-768.

Geng, Y., Sarkis, J., & Ke, Y. (2013). Greening the supply chain: A review and some research directions. *International Journal of Production Economics*, *140*(1), 150-159.

Ijla, A., & Brostrom, T. (2015, August). The Sustainable Viability of Adaptive Reuse of Historic Buildings: the Experiences of Two World Heritage Old Cities; Bethlehem in Palestine and Visby in Sweden. *International Invention Journal of Arts and Social Sciences*, *2*(4), 5266. Retrieved from http://internationalinventjournals.org/journals/IIJASS

Kabisch, N., & *et al.*. (2016). Nature-based solutions to climate change mitigation and adaptation in urban areas: Perspectives on indicators, knowledge gaps, barriers, and opportunities for action. *Ecology and Society*, *21*(2), 39.

Langston, C., & Shen, L.-Y. (2010). Application of the adaptive reuse potential model in Hong Kong: A Lui Seng Chun case study. *International Journal of Strategic Property Management*, *11*(4), 193-207. https://doi.org/10.3846/1648715X.2007.9637569

Mguni, P., Abrams, A., Hedlund, L. B., Cardem, K., Fell, J., Armitage, N., & Dollie, A. (2022). Towards water resilience through Nature-based Solutions in the Global South? Scoping the prevailing conditions for Water Sensitive Design in Cape Town and Johannesburg. *Environmental Science & Policy*. https://doi.org/10.1016/j.envsci.2022.05.020

Nowak, D. J., & Greenfield, E. A. (2014). *Tree Cover and Urban Forest Effects on Air Quality*. Springer.

Obersteg, A., Arlati, A., Acke, A., Berruti, G., Czapiewski, K., Dąbrowski, M., & Knieling, J. (2019). Urban Regions Shifting to Circular Economy: Understanding Challenges for New Ways of Governance. *Urban Planning*, *4*(3), 19-31. https://doi.org/10.17645/up.v4i3.2158

OECD. (2016). *Circular Economy and the Role of Urban Planning*. OECD Publishing.

OECD. (2016). *Circular Economy in Cities: Overview of the policy landscape*. Retrieved from https://www.oecd.org/environment/circular-economy/

Olivier, C., Dixon, K., & Fisher, D. (2019). *Addressing Water Scarcity through Nature- Based Solutions: A Case Study of Cape Town*. Springer.

Raymond, C. M., *et al.*. (2017). A framework for assessing and implementing the co-Benefits of nature-based solutions in urban areas. *Environmental Science & Policy*, *77*, 15-24.

Remoy, H. T., & van der Voordt, D. J. M. (2014). Adaptive reuse of office buildings into Housing: Opportunities and risks. *Building Research and Information: The International Journal of Research, Development and Demonstration*, *42*(3), 381-390. https://doi.org/10.1080/09613218.2014.865922

Sustainable Energy Authority of Ireland. (2021). Retrieved from https://www.seai.ie/news-and-events/news/energy-in-Ireland-2021/

Tan, P. Y., Wang, J., & Sia, A. (2013). Perspectives on five decades of the urban greening of Singapore. *Cities*, *32*, 24-32.

Tight, M. (2016). Sustainable urban transport - the role of walking and cycling. Institution of Civil Engineers Proceedings. *Engineering Sustainability*, *169*(3), 87-91. https://doi.org/10.1680/jensu.15.00065

Tzoulas, K., Korpela, K., & Venn, S. (2007). Promoting Ecosystem and Human Health in Urban Areas Using

Green Infrastructure: A Literature Review. *Landscape and Urban Planning*. https://doi.org/10.1016/j.landurbplan.2007.02.001

UN. (2018). *World Urbanization Prospects: The 2018 Revision*. United Nations.

Williams, J. (2022). Challenges to implementing circular development – lessons from London. *International Journal of Urban Sustainable Development*, *14*(1), 287-303. https://doi.org/10.1080/19463138.2022.2103822

Winslow, J., & Coenen, L. (2023). Sustainability transitions to circular cities: Experimentation between urban vitalism and mechanism. Cities, *142*, 104531. https://doi.org/10.1016/j.cities.2023.104531

Wong, L. (2016). Adaptive Reuse: Extending the Lives of Buildings. https://doi.org/10.1515/9783038213130

Yigitcanlar, T., & Kamruzzaman, M. (2015). Planning, Development and Management of Sustainable Cities: A Commentary from the Guest Editors. *Sustainability*, *7*, 14677-14688. https://doi.org/10.3390/su71114677

Zora, K., Strand, R., & Volker, T. (2021). The Circular Economy in Europe Critical Perspectives on Policies and Imaginaries. Retrieved from https://www.routledge.com/The-Circular-Economy-in-Europe-Critical-Perspectives-on-Policies-and-Imaginaries/Kovacic-Strand-Volker/p/book/9781032085357