REGENERATIVE CITIES IN ACTION: THE INTERPLAY OF STRATEGIES TO RESTORE ECOSYSTEMS, STRENGTHEN RESILIENCE, AND DRIVE SUSTAINABLE URBAN TRANSFORMATION

Devindi Geekiyanage [1] and Amila Liyanage

School of Science, Engineering and Environment, University of Salford, Manchester, Lancashire, M5 4WT, UK

The call for climate-resilient urban design has never been more urgent as cities worldwide grapple with rapid urbanisation, extreme weather events, and dwindling resources. This study adopts a systems thinking approach to uncovering the interconnected strategies for building regenerative cities that restore ecosystems, strengthen resilience, and drive sustainable urban transformation. Through a desk study and interviews with 17 experts from the UK, Sri Lanka, and Australasia, the research identifies seven core urban design principles with 36 strategies that restore, renew, and revitalise urban spaces and communities. The findings emphasize that sustainable energy and water management, governance, policy frameworks and technological innovations, and nature-based solutions are central to achieving regenerative cities. Using causal loop diagramming, the study uncovers 47 reinforcing feedback loops, including the dynamic between policy support and community engagement, that propel sustainable practices forward. A balancing loop was identified, showing how compact development reduces green infrastructure, mitigated by permeable surfaces. By advancing urban resilience frameworks, this study provides practical guidance for policymakers and planners, pinpointing areas where governance and practice should focus to overcome barriers and foster long-term sustainability.

Keywords: causal loop diagramming; regenerative cities; systems thinking; urban planning; urban resilience

INTRODUCTION

Urban areas, responsible for over 79% of global carbon emissions (UN-Habitat, 2024), urgently require transformative approaches to address climate risks. Regenerative cities—a paradigm shift beyond sustainability—aim not only to reduce harm but to actively restore ecosystems, foster equity, and create net-positive outcomes (Axinte *et al.,* 2019; Schurig and Turan, 2022). Unlike conventional sustainability models focused on efficiency, regenerative urbanism prioritises renewal, embedding cities as dynamic systems that enhance planetary health.

Global initiatives like Freiburg's renewable energy integration and Melbourne's urban greening programs demonstrate the potential of regenerative strategies to reduce

[1] geekiyanage22@gmail.com

Geekiyanage, D and Liyanage, A (2025) Regenerative Cities in Action: The Interplay of Strategies to Restore Ecosystems, Strengthen Resilience, and Drive Sustainable Urban Transformation, *In*: Thomson, C and Neilson, C J (Eds) Proceedings of the 41st Annual ARCOM Conference, 1-3 September 2025, Abertay University, Dundee, UK, Association of Researchers in Construction Management, 832-841.

emissions, boost biodiversity, and improve liveability (City of Melbourne, 2020; Rohracher and Späth, 2014). Key principles include nature-based solutions (NBS), circular economies, and participatory governance, which together restore ecological and social resilience. However, implementation barriers vary starkly: developed regions face infrastructural inertia, while developing nations grapple with resource constraints and inequity (World Bank, 2019).

Existing research often isolates components like renewable energy or green infrastructure, neglecting systemic interdependencies. This study addresses this gap by employing a systems thinking approach to map 36 interconnected strategies across seven urban design principles, validated by experts from diverse sectors. By analysing causal linkages and feedback loops, the research identifies synergies among regenerative city-building strategies, demonstrating how their integration can amplify ecological restoration, social equity, and climate resilience. It further pinpoints pathways to overcome systemic barriers, such as policy fragmentation or technological gaps, and offers actionable guidance for policymakers and planners to scale regenerative transitions. The findings bridge theory and practice, providing a roadmap for cities to operationalise regeneration through integrated ecological, social, and technological interventions.

Literature Review Synthesis

The regenerative cities paradigm challenges conventional urban sustainability by prioritising active ecological restoration, equity, and systemic resilience over mere harm reduction. Rooted in resilience thinking and circularity principles, this approach reimagines cities as living systems that repair ecosystems while fostering social and economic vitality. NBS and ecosystem-based adaptation (EbA) exemplify this shift, leveraging green infrastructure (e.g., urban forests, wetlands, permeable surfaces) to mitigate climate risks while enhancing biodiversity and liveability (Casteli Figueiredo Gallardo and Bond, 2025; Davies *et al.,* 2021). Case studies like Singapore's "City in a Garden" and Melbourne's urban greening initiatives illustrate NBS's dual role in cooling cities and improving air quality (City of Melbourne, 2020; Zingoni de Baro, 2022). However, critics caution that NBS's scalability depends on contextual factors like governance capacity and funding—variables often overlooked in Global North-centric success stories.

Similarly, circular economy (CE) models, which replace linear resource flows with closed-loop systems, face implementation asymmetries. While cities like Austria (59%), Wales (59%) and Taiwan (53%) achieve high recycling rates through advanced waste valorisation (Reloop and Eunomia, 2024), developing regions struggle with infrastructural gaps and informality, raising questions about CE's universal applicability. Critics argue that CE's techno-centric focus risks sidelining informal waste economies, which dominate in the Global South (UN-Habitat, 2024).

Participatory planning, another pillar of regenerative urbanism, emerged as a counter to top-down urbanism, emphasising community agency in shaping equitable spaces (Geekiyanage, 2020). Medellín's library-parks and Melbourne's "Open Streets" exemplify how co-designed public realms can bridge social divides (Cruz, 2025). Yet, the literature reveals tensions: while participatory frameworks theoretically empower marginalised groups, they often perpetuate exclusion when tokenistic or poorly institutionalised. For instance, Copenhagen's cycling networks, though lauded for accessibility, initially overlooked low-income neighbourhoods, underscoring the gap between inclusive rhetoric and practice (Gehl, 2010).

Climate-responsive design further illustrates the interplay of tradition and innovation. Bioclimatic strategies, such as passive solar design and green roofs, draw from vernacular architecture (Toroxel and Silva, 2024) but face modern barriers. For instance, Freiburg's Vauban district, despite its carbon-neutral ethos, required heavy subsidies, highlighting cost challenges in replicating such models (Rohracher and Späth, 2014). Meanwhile, debates persist on balancing compact development—praised for reducing sprawl—with green space preservation, as seen in Melbourne's contentious trade-offs between density and canopy cover (City of Melbourne, 2020).

Energy and mobility transitions reveal similar contradictions. While renewable energy systems and smart grids promise decarbonisation (IRENA 2019), their equity implications remain contested. Prosumer models, which decentralise energy production, often benefit wealthier households, exacerbating energy poverty (Milčiuvienė *et al.,* 2019). Similarly, digital mobility platforms (e.g., MaaS) risk excluding non-tech-savvy populations, challenging the inclusivity of "smart" transitions (Hensher, 2017).

Governance innovations, particularly polycentric and data-driven frameworks, are touted for enabling adaptive planning (Huang-Lachmann, 2019). Yet, Barcelona's sensor networks, though efficient, raise concerns about surveillance and data monopolies (Fernandez-Monge *et al.,* 2024). Such tensions underscore a broader critique: regenerative urbanism's reliance on technology and growth-oriented policies may inadvertently replicate neoliberal paradigms, prioritising efficiency over equity.

In synthesising 25 years of literature, a critical gap emerges: while strategies like NBS, CE, and participatory planning are well-theorised, their systemic interdependencies remain underexplored. Most studies isolate components (e.g., renewable energy or green infrastructure) neglecting how their integration amplifies or undermines regeneration. This fragmentation mirrors real-world policy silos, limiting cities' capacity to address climate change and inequality holistically. By foregrounding these gaps, this study's systems approach seeks to advance a more cohesive framework for regenerative urban transitions.

METHODS

A qualitative approach was adopted, combining a desk study of policy documents, urban regeneration case studies, and peer-reviewed literature with semi-structured expert interviews. This design aimed to identify regenerative city-building strategies and analyse their systemic interdependencies in achieving ecological restoration, social equity, and climate resilience. A purposive sampling technique ensured diverse perspectives from 17 experts in urban planning (34%), architecture (24%), climate resilience and policy (24%), and ecological engineering (18%) across the UK (41%), Sri Lanka (29%), and Australasia (29%). Experts were selected based on their academic contributions and involvement in regenerative urban projects, with 12 out of 17 (70%) having over 10 years of industry experience in relevant fields.

Interviews, conducted virtually, focused on validating 36 pre-identified strategies derived from the desk study and mapping their causal relationships through a participatory systems thinking lens (Sterman, 2000). Experts engaged in interactive discussions via the MURAL platform, where they identified interconnections between the 36 regenerative city-building strategies and established relationships between them. This process facilitated causal mapping within the urban system, revealing patterns of influence and key leverage points (Sterman, 2000). By integrating theoretical frameworks, such as resilience thinking and circular economy principles, with practical insights, this approach ensured robust triangulation, strengthening the identification of feedback loops critical to regenerative urban transitions.

The qualitative data were analysed by coding thematic patterns to classify the 36 identified strategies into key urban design principles. These were then mapped within the causal loop diagramming (CLD) framework to establish causal relationships and systemic interdependencies (Forrester, 1995). CLDs visualise feedback loops, capturing reinforcing and balancing relationships in urban systems (Sterman, 2000), making them ideal for identifying leverage points for intervention in regenerative cities (Meadows, 2015). Each regenerative city principle was developed into a distinct CLD, integrating expert insights and literature synthesis. The CLDs were iteratively refined based on expert feedback to ensure an accurate representation of interdependencies. This process revealed reinforcing loops, where strategies amplified positive effects (Meadows, 2015), and balancing loops, where interventions mitigated urban challenges (Sterman, 2000). By structuring the analysis this way, the study provided a dynamic understanding of how regenerative principles interact and evolve.

Systems Thinking Data Analysis and Findings

The desk study identified 36 regenerative city-building strategies, systematically categorised under seven core urban planning and design principles that emerged from thematic coding. These strategies were validated by the experts, confirming their relevance without introducing additional ones. A causal analysis was conducted to map cause-and-effect relationships between strategies, identifying both intra-system (within a principle) and inter-system (across principles) interactions. The analysis captured directionality (positive or negative) to understand systemic correlations (Sterman, 2000). For example, Social Equity in Planning (n) positively influences Urban Green Infrastructure (a) and Public Transportation Networks (v). Conversely, Social Equity in Planning (n) is positively influenced by Cross-Sectoral Collaboration (ae) but negatively impacted by Compact/Mixed-Use Development (p). Table 1 summarises these interdependencies.

The causal linkages in Table 1 were structured in a CLD to analyse the cause-and-effect dynamics within and across urban design principles, highlighting key reinforcing and balancing feedback loops (Meadows, 2015). Each set of strategies under a principle was mapped to examine mutual influences and systemic effects, providing insights into how these principles drive regenerative urban transformation. The CLD framework revealed leverage points where strategic interventions could accelerate or regulate urban regeneration. The final CLD models, capturing these interdependencies with overall 47 reinforcing loops and one balancing loop, are presented in Figure 1.

(i) Nature-Based Solutions (NBS) and Ecosystem-Based Adaptation (EbA)
As shown in Figure **1(**i), experts identified seven feedback loops (R1-R7) where Urban Green Infrastructure (a) forms the core strategy for achieving NBS/EbA. Loops R1, R3, and R5 highlight the role of green infrastructure and biodiversity corridors in enhancing pollinator-friendly spaces and green surfaces, fostering ecological resilience. R2 and R4 focus on Blue-Green Networks and Integrated Water Management, ensuring water security.

Table 1: Systemic interdependencies between the strategies for building regenerative cities

Variable	Influences (Direction)	Influenced By (Direction)
(i) Nature-Based Solutions (NBS) and Ecosystem-Based Adaptation (EbA)		
a. Urban Green Infrastructure	e (+), f (+), h (+), m (+), r (+), s (+), t (+)	ac (+), ad (+), p (-), ae (+)
b. Wetland Restoration	e (+), s (+), o (+), aa (+)	ad (+), c (+), ai (+)
c. River/Coastal Restoration	h (+), o (+), e (+), f (+)	aa (+), ac (+), ae (+)
d. Urban Rewilding	e (+), f (+), m (+), n (-)	ad (+), p (-)
e. Urban Biodiversity Corridors	f (+), g (+), a (+), r (+)	a (+), d (+), ac (+)
f. Pollinator-Friendly Spaces	e (+), g (+)	a (+), d (+), n (+)
g. Biophilic Design	l (+), ai (+)	e (+), k (+)
h. Blue-Green Networks	a (+), s (+)	c (+), aa (+)
(ii) Circular Economy (CE) and Resource Efficiency		
i. Zero-Waste Cities	j (+), k (+)	ac (+), m (+)
j. Decentralised Wastewater Treatment	ab (+), aa (+)	i (+), o (+)
k. Sustainable Material Use	l (+), i (+)	ai (+), ab (+)
l. Resource-Efficient Building Design	q (+), x (+)	k (+), ai (+)
(iii) Climate-Responsive Urban Design		
o. Climate-Adaptive Infrastructure	s (+), r (+)	ad (+), aj (+)
p. Compact/Mixed-Use Development	t (+), v (+), a (-), n (-)	ac (+), l (+)
q. Passive Design Principles	z (+), w (+)	l (+), g (+)
r. Permeable/Green Surfaces	s (+), e (+)	h (+), o (+)
s. Stormwater Management	ab (+), o (+)	r (+), aa (+)
(iv) Governance, Policy Frameworks and Technology Innovations		
ac. Sustainable Urban Policies	a (+), i (+), p (+)	ad (+), ae (+)
ad. Climate Action Plans	a (+), b (+), d (+), w (+), u (+), o (+)	aj (+), ae (+)
ae. Cross-Sectoral Collaboration	n (+), af (+), aa (+)	ag (+), ah (+)
af. Smart City Solutions	ah (+), aj (+)	ae (+), ag (+)
ag. Digital Twin Models	aj (+), y (+)	ah (+), af (+)
ah. IoT Networks	z (+), y (+)	af (+), ag (+)
ai. Green Building Certifications	g (+), k (+)	l (+), w (+)
aj. Geospatial Analytics	ad (+), aa (+), o (+)	ag (+), ah (+)
(v) Sustainable Energy and Water Management		
w. Renewable Energy Integration	y (+), z (+)	ad (+), ai (+)
x. Energy Retrofitting	z (+), l (+)	w (+), ai (+)
y. Smart Grid Technologies	w (+), z (+)	ah (+), ag (+)
z. Building Energy Management (BEMS)	q (+), y (+)	ah (+), x (+)
aa. Integrated Water Management (IWM)	j (+), ab (+)	ae (+), aj (+)
ab. Rainwater Harvesting	s (+), k (+)	aa (+), o (+)
(vi) Sustainable Mobility Systems		
t. Non-Motorised Transport	p (+), v (+)	n (+), a (+)
u. EV Infrastructure	w (+), y (+)	ad (+), ac (+)
v. Public Transportation Networks	t (+), p (+)	n (+), ac (+)
(vii) Community-Led Inclusive Planning and Place-making		
m. Community Resilience Hubs	n (+), t (+)	o (+), y (+)
n. Social Equity in Planning	a (+), v (+)	ae (+), p (-)

R6 and R7 emphasize biophilic design and green building certifications, promoting sustainable architecture. These loops together create a self-reinforcing urban system that enhances biodiversity, water and energy efficiency, and climate resilience. Effective policy-driven collaboration (ac, ae) is essential for long-term success, with cross-sectoral collaboration seen as critical for the implementation of regenerative strategies.

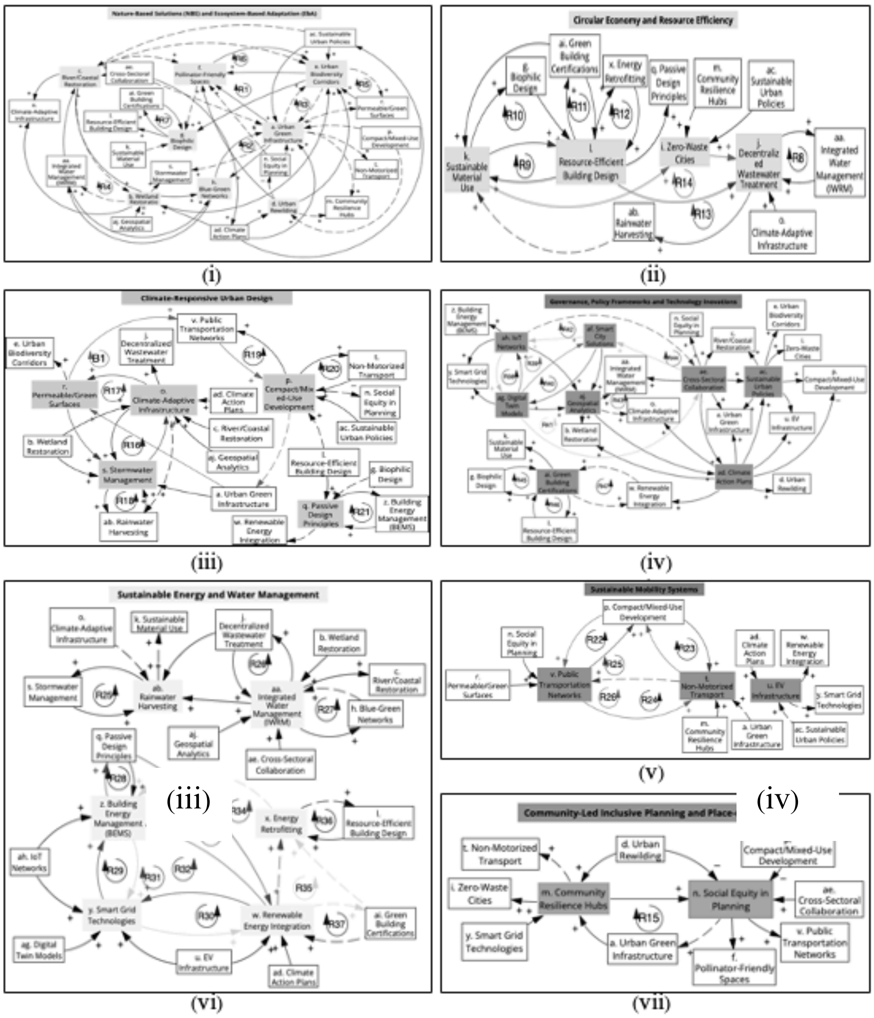

Figure 1: Causal loop diagrams illustrating interactions among strategies under seven urban planning and design principles of: (i) Nature-based solutions and eco-based adaptation, (ii) circular economy and resource efficiency, (iii) climate-responsive urban (vi) (iv) governance, policy frameworks and technology innovations, (v) sustainable mobility systems, (vi) sustainable energy and water management, (vii) community-led inclusive planning and place-making for building regenerative cities

(ii) Circular Economy (CE) and Resource Efficiency
Seven feedback loops (R8-R14), shown in Figure **1(**ii), illustrate how CE strategies support a self-sustaining urban system. Loops R8 and R9 link wastewater treatment and sustainable materials to resource-efficient construction and water management, creating closed-loop systems. Loops R10 and R11 connect biophilic design and green building certifications to material efficiency. R12 and R13 integrate energy retrofitting and rainwater harvesting into resource-efficient systems. Experts stressed that zero-waste policies (R13 and R14) and decentralised wastewater treatment are vital enablers of circularity. Aligning regulatory incentives with CE principles is key to supporting regenerative resource cycles.

(iii) Climate-Responsive Urban Design

Six reinforcing loops (R16-R21) and one balancing loop (B1) are identified, as shown in Figure **1(**iii). Loops R16-R17 highlight the synergy between stormwater management and green surfaces, contributing to flood mitigation and urban cooling. R18 links stormwater management and rainwater harvesting for water conservation. Compact/mixed-use development (R19-R20) and passive design principles (R21) further promote energy efficiency and sustainable mobility. Balancing loop (B1) reflects land-use trade-offs, where increased compact development may reduce green infrastructure, though permeable surfaces mitigate these effects. As proposed by several experts in Sri Lanka, regulatory frameworks must incentivise green infrastructure in compact city designs.

(iv) Governance, Policy Frameworks, and Technology Innovations

Ten feedback loops (R38-R47) in Figure **1(**iv) demonstrate how governance, technology, and sustainability practices work together to support regenerative cities. IoT networks and digital twins (R38-R44) enhance smart city solutions, enabling adaptive policymaking and resource efficiency. Loops R45-R47 show how green certifications accelerate biophilic design, resource-efficient buildings, and renewable energy integration. While these loops can drive market shifts, experts caution that equity-centred governance is needed to avoid technological exclusion and ensure inclusive outcomes. Therefore, successful regenerative transitions require coupling technological innovation with inclusive governance and circular material flows.

(v) Sustainable Energy and Water Management Systems

Thirteen (13) reinforcing loops (R25-R37) demonstrate the integration of water and energy systems (Figure **1(**v)). Loops R25 and R26 show the bidirectional effects of rainwater harvesting and Integrated Water Management (IWM) on water strategies and policy. Loops R27-R33 highlight the role of smart grids and renewable energy integration in advancing energy efficiency. Loops R34-R37 emphasize energy retrofitting and renewable energy in strengthening the sustainable energy framework. These interconnected loops underscore the importance of governance, policy, and technology in achieving sustainable energy and water systems.

(vi) Sustainable Mobility Systems

Six feedback loops (R22-R26) reinforce sustainable urban mobility (Figure **1(**vi)). Non-motorised transport and public transportation networks (R22-R23) create mutual benefits by enhancing each other. Loops R24-R26 emphasize the interdependence of non-motorised transport, public transit, and transport infrastructure, promoting sustainability and reducing congestion. Given that, integrated transport systems are essential for reducing urban sprawl and fostering sustainability.

(vii) Community-Led Inclusive Planning and Place-making

As shown in Figure **1(**vii), a single feedback loop (R15) demonstrates the connection between community resilience hubs (m) and equitable urban planning (n). Green infrastructure (a) enhances community resilience by prioritising access to green spaces in underserved areas, which in turn supports social equity and climate adaptability. Experts emphasize the importance of participatory planning for long-term sustainability and regenerative urban transformation.

DISCUSSION AND STUDY IMPLICATIONS

This study advances regenerative urban discourse by quantifying systemic interactions among 36 regenerative city-building strategies through a CLD analysis, revealing 47 reinforcing and one balancing loop. While aligning with the literature on NBS and CE, it extends these frameworks by identifying critical governance and equity dimensions often overlooked in practice. The CLD demonstrates how Urban Green Infrastructure (a) and Biodiversity Corridors (e) enhance ecological resilience through feedback loops (R1-R7), corroborating NBS's multifunctional benefits (Davies *et al.,* 2021). However, it uniquely highlights policy-driven collaboration (ac, ae) as a prerequisite for scaling NBS—a gap in cases like Singapore's "City in a Garden," where governance fragmentation risks undermining success without adaptive frameworks (Zingoni de Baro, 2022). Similarly, CE literature emphasizes closed-loop systems (Kara *et al.,* 2022), while the study reveals how decentralised wastewater treatment (j) and green certifications (ai) create self-reinforcing resource loops (R8-R14). Certifications, when enforced by policy (ac, ad), accelerate biophilic design (g) and renewable energy (w), bridging a gap in CE's market-driven scaling mechanisms. This aligns with Amsterdam's circular construction but stresses regulatory rigour to avoid greenwashing. The study also critiques equity narratives in participatory planning. While Medellín's Green Corridors validate place-making's potential (Silberberg *et al.,* 2013), the CLD's singular feedback loop (R15) exposes fragility in community-led systems compared to techno-centric models. Experts caution that grassroots initiatives require institutionalisation to prevent tokenism, as seen in Melbourne's balancing act between compact development (p) and green infrastructure (a) (City of Melbourne, 2020). Notably, the findings challenge techno-optimism in smart city literature (Huang-Lachmann, 2019). Smart grids (y) and IoT (ah) drive efficiency (R25-R37) but risk exclusion without equity-centred governance (n), echoing Milčiuvienė et al.'s (2019) energy justice principles. For instance, digital twins (ag) enhance predictive modelling but may marginalise underserved groups without participatory frameworks-a tension reflected in the weak influence of social equity (n) on pollinator spaces (f).

Theoretical and practical implications

The findings advance regenerative urban theory by framing cities as interconnected socio-technical-ecological systems rather than siloed domains. The CLD's 47 reinforcing loops illustrate how circularity, climate resilience, and equity are co-dependent, supporting Larsen's (2020) concept of "climate-adaptive urbanism" while offering a tangible framework for operationalising it. Practically, the study identifies leverage points: cross-sectoral collaboration (ae) amplifies policy coherence, while green certifications (ai) and IoT networks (ah) act as multipliers for sustainability transitions. However, experts cautioned that compact development (p) and technological innovations must be deliberately coupled with equity safeguards to avoid trade-offs-a lesson for cities like Freiburg and Copenhagen aspiring to carbon neutrality (Rohracher and Späth, 2014; Khan *et al.,* 2021).

Policy implications

The CLD underscores the need for adaptive, polycentric governance to manage systemic complexity. For example, Climate Action Plans (ad) strongly influence NBS, energy systems, and mobility (R38-R44), but their effectiveness depends on integrating informal governance networks-a gap noted in Medellín's grassroots initiatives. Policymakers must prioritise metrics for socio-ecological co-benefits (e.g., stormwater management (s) linked to public health) to align with UN-Habitat's (2024) regenerative goals. Additionally, the study advocates for mandatory equity assessments in urban policies to mitigate risks of technological exclusion, ensuring that regenerative transitions benefit all demographics.

CONCLUSIONS

This study systematically maps the interdependencies among 36 regenerative city-building strategies, revealing 47 reinforcing feedback loops and one balancing loop that drive synergies and tensions across seven urban design principles. Key findings highlight the centrality of cross-sectoral governance in amplifying policy coherence, the multiplier effects of green certifications and IoT networks in scaling sustainability, and the critical role of equity-centred planning in preventing technological exclusion. Urban policymakers, planners, and developers can leverage these insights to prioritise high-impact interventions, such as integrating nature-based solutions with compact development or coupling CE practices with participatory governance, to accelerate regenerative transitions. The study's limitations include its reliance on expert perspectives from Sri Lanka Australasia and the UK, which, while diversely sampled, may underrepresent region-specific challenges in other Global South contexts, such as Sub-Saharan Africa or South America. Additionally, the CLD's complexity, while illustrative of systemic interactions, requires simplification for practical application. Future research could validate these causal relationships through longitudinal case studies, incorporate citizen perspectives to enhance equity considerations and explore the role of informal governance networks in polycentric systems. By expanding the model to diverse urban contexts and integrating real-time data from digital twins (ag), cities can refine adaptive strategies that balance ecological restoration, technological innovation, and social justice in their pursuit of regeneration.

REFERENCES

Anguelovski, I, Irazábal-Zurita, C and Connolly, J J (2019) Grabbed urban landscapes: Socio-spatial tensions in green infrastructure planning in Medellín, *International Journal of Urban and Regional Research*, **43(**1), 133-156.

Axinte, L F, Mehmood, A, Marsden, T and Roep, D (2019) Regenerative city-regions: A new conceptual framework, *Regional Studies, Regional Science*, **6(**1), 117-129.

Casteli Figueiredo Gallardo, A L and Bond, A (2025) A Nature-based Solutions framework for embedding climate change mitigation and adaptation into urban land use plans through, *Strategic Environmental Assessment (Sea) Environmental Management*, **75(**2), 256-271.

City of Melbourne (2020) *Urban Forest Strategy: Making a Great City Greener 2012-20*, Melbourne City Council.

Cruz, T (2025) *Building a Citizenship, Culture in Architecture and Social Change*, Abingdon: Routledge, 206-229

Davies, C, Chen, W Y, Sanesi, G and Lafortezza, R (2021) The European Union roadmap for implementing nature-based solutions: A review, *Environmental Science and Policy*, **121**, 49-67.

Fernandez-Monge, F, Barns, S, Kattel, R and Bria, F (2024) Reclaiming data for improved city governance: Barcelona's new data deal, *Urban Studies*, **61(**7), 1291-1307.

Forrester, J W (1995) The beginning of system dynamics, *McKinsey Quarterly*, 4-17.

Geekiyanage, D, Fernando, T and Keraminiyage, K (2020) Assessing the state of the art in community engagement for participatory decision-making in disaster risk-sensitive urban development, *International Journal of Disaster Risk Reduction*, **51**, 101847.

Gehl, J (2010) *Cities for People*, Island Press.

Hensher, D A (2017) Future bus transport contracts under a mobility as a service (MaaS) regime in the digital age: Are they likely to change? *Transportation Research Part A: Policy and Practice*, **98**, 86-96.

Huang-Lachmann, J T (2019) Systematic review of smart cities and climate change adaptation, *Sustainability Accounting, Management and Policy Journal*, **10(**4), 745-772.

IRENA (2019) *Renewable Energy and Cities: A Policy Roadmap for 100% Renewables*, International Renewable Energy Agency.

Kara, S, Hauschild, M, Sutherland, J and McAloone, T (2022) Closed-loop systems to circular economy: A pathway to environmental sustainability? *CIRP Annals*, **71(**2), 505-528.

Khan, I, Hou, F and Le, H P (2021) The impact of renewable energy on reducing CO_2 emissions: Empirical evidence from Europe, *Renewable Energy*, **179**, 531-541.

Larsen, K (2020) Climate-adaptive urbanism: Lessons from Copenhagen, *Urban Climate*, **32**, 100617.

Meadows, D H (2015) *Leverage Points: Places to Intervene in a System*, The Sustainability Institute.

Milčiuvienė, S, Kiršienė, J, Doheijo, E, Urbonas, R and Milčius, D (2019) The role of renewable energy prosumers in implementing energy justice theory, *Sustainability*, **11(**19), 5286.

Reloop and Eunomia Research and Consulting (2024, June 5) *Global Recycling League Table - Phase One Report (Phase 1 Report)*, Reloop and Eunomia Research and Consulting

Rohracher, H and Späth, P (2014) The interplay of urban energy policy and socio-technical transitions: The eco-cities of Graz and Freiburg in retrospect, *Urban Studies*, **51(**7), 1415-1431.

Schurig, S and Turan, K (2022) The concept of a ‘regenerative city’: How to turn cities into regenerative systems, Journal of Urban Regeneration and Renewal, **15(**2), 161-175.

Silberberg, S, Lorah, K, Disbrow, R and Muessig, A (2013) Places in the making: How placemaking builds places and communities Massachusetts Institute of Technology.

Sterman, J D (2000) *Business Dynamics: Systems Thinking and Modelling for a Complex World*, New York: McGraw-Hill.

Toroxel, J L and Silva, S M (2024) A review of passive solar heating and cooling technologies based on bioclimatic and vernacular architecture, *Energies*, **17(**5), 1006.

UN-Habitat (2024) *Urban Regeneration for Localising the Sustainable Development Goals*, United Nations Human Settlements Programme.

UN-Habitat (2024) *World Cities Report 2024: Cities and Climate Action*, United Nations Human Settlements Programme.

Wakhungu, H, Kaloi, F, Ali, J and Laichena, J (2024) Leveraging multiscale polycentric governance (MPG) and climate-smart governance (CSG) tools for climate change adaptation in Kenya Colombo, Sri Lanka, *In*: *International Water Management Institute (IWMI) CGIAR Initiative on Climate Resilience*.

World Bank (2019) *Building Sustainable Cities and Towns*, New York: The World Bank Group.

Zingoni de Baro, M E (2022) *Singapore Case Study in Regenerating Cities: Reviving Places and Planet*, Cham: Springer International Publishing, 163-206