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PROMOTING REGENERATIVE CONSTRUCTION IN THE BUILDING INDUSTRY

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ABSTRACT

The construction industry is a major contributor to resource extraction, greenhouse gas emissions, waste generation and ecosystem degradation. Scholars argue that conventional sustainability and green building approaches are insufficient because they focus on reducing negative impacts rather than creating net-positive environmental and social outcomes. This paper reviews 18 peer-reviewed publications on regenerative construction, published between 2020 and 2025, drawing mainly on indexed journal repositories, including ScienceDirect/Elsevier, Emerald Insight, and Taylor & Francis Online. The review synthesises evidence on the economic, social, environmental and technological benefits of regenerative construction, while also identifying limitations that hinder implementation in contemporary construction practice using a systematic narrative literature review. The findings show that regenerative construction can improve whole-life asset value, reduce operational and material costs, create new circular-economy markets, enhance occupant health and social inclusion, restore ecological systems, reduce embodied carbon and stimulate innovation through digital technologies, bio-based materials, material passports, building information modelling and life-cycle assessment tools. However, the adoption of regenerative construction practices is constrained by high initial costs, fragmented supply chains, immature markets for reused and regenerative materials, limited professional capacity, the absence of standardised indicators/metrics, weak procurement incentives, regulatory uncertainty, and insufficient post-occupancy evidence. The paper proposes a Regenerative Construction Implementation Framework structured around seven stages: place-based assessment, regenerative briefing, integrated design, circular and bio-based procurement, regenerative construction management, operational stewardship, and end-of-life reintegration. The study concludes that regenerative construction requires a shift from project-based efficiency to long-term stewardship, collaborative governance and measurable net-positive performance across the entire building life cycle.

Keywords: Bio-based materials, Circular economy, Construction management, Life-cycle assessment, Net-positive development, Regenerative construction.

1. Introduction

The last five years have witnessed increasing academic and professional attention on built environments that do more than minimise harm. While green building systems have improved energy efficiency and reduced waste, global reports show that the building and construction sector is not on track to meet

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decarbonisation, biodiversity, and resource-efficiency targets (IPCC, 2022; UNEP, 2023). This has stimulated interest in regenerative construction as a more ambitious approach for transforming how buildings are planned, procured, constructed, operated and recovered at the end of life (Persson, 2023). Regenerative construction is an approach to building and infrastructure development that goes beyond sustainability, actively restoring and enhancing the environment, rather than merely reducing negative impacts (Ajayabi et al., 2019). It is a progressive approach that aims to restore, renew, and grow ecosystems, not only sustain them. It goes beyond typical sustainable design, encompassing the design of structures that actively support ecosystems and have a net-positive impact on the environment (El Kouche, 2024).

Regenerative construction is relevant because the construction sector is simultaneously an economic driver and an ecological burden. It consumes large volumes of minerals, timber, water and energy, generates substantial construction and demolition waste, and locks cities into long-term carbon and resource pathways. The industry makes use of a significant percentage -about 30% of global resources and 40% of global energy consumption (Uddin, 2021). This dependence on natural resources for survival and day-to-day activities has given rise to the idea of sustainability. According to Mouton et al. (2023), a potential strategy to reduce the embodied impacts of buildings is to replace conventional, fossil-fuel-based construction materials with bio-based alternatives. Peretti and Druhmann (2019) stated that moving towards a regenerative economy is a key factor in the purpose of buildings. In the same vein, Oyefusi et al. (2024) argued that the construction industry needs to transition from sustainable to regenerative practices. Construction practices that restore ecosystems, strengthen communities, enhance resilience and create circular material flows.

This involves continuous improvement over time, adapting as the subject changes, and sustaining it long after a construction project is complete (Persson, 2024). From a construction management perspective, regenerative construction is not only a design issue. It requires changes in project governance, procurement, supply chains, site management, labour skills, performance measurement, digital integration and post-occupancy responsibility. The extant studies (Oyefusi et al., 2024; Malheiro et al., 2021; Baper et al., 2020) revealed that, despite the growing emphasis on green and sustainable approaches in construction, there is a noticeable gap in understanding the benefits of implementation and the effective use of regenerative practices in the building and construction industry. The aim of this paper is therefore to identify recent themes in regenerative construction scholarship; categorise the benefits of regenerative construction into economic, social, environmental and technological dimensions; determine the barriers limiting implementation in contemporary construction projects; and propose a practical framework for embedding regenerative principles across the construction life cycle.

2. Overview of the Concept of Regenerative Construction

2.1 Transition from Sustainable to Regenerative Construction

The concept of Regenerative construction integrates ecological principles into the design, construction, and operation of buildings to regenerate ecosystems, enhance biodiversity, and support the health of natural and human systems (Baper et al., 2020; Malheiro et al., 2021; Oyefusi et al., 2024). These studies distinguish regenerative construction from conventional sustainable construction by its emphasis on positive contribution rather than impact reduction. Benachio et al. (2020), Munaro et al. (2020), Çimen (2021) and Norouzi et al. (2021) show that circular construction strategies can reduce resource extraction, promote design for adaptability and generate secondary material markets.

Peretti and Druhmann (2019), in the RESTORE Working Group Three report, examined how buildings can be procured, constructed, operated, and maintained to create positive environmental and social impacts rather than merely reducing harm. A key contribution of the report is its focus on life-cycle thinking in regenerative construction. Kasina et al. (2025) identified seven key themes that hold potential for integrating regenerative design principles in the construction phase. The themes include scheduling and construction logistics, worker health and safety, energy and resource efficiency, waste management and site restoration, On-site water management, Stakeholder collaboration and technology integration, as well as quality control and Life Cycle Assessment (LCA). The authors stress that regenerative performance must extend across procurement, construction, operation, maintenance, and future reuse stages, rather than focusing solely on initial design or embodied impacts. This aligns with regenerative construction principles that advocate closed-loop systems, adaptability, and long-term ecological integration.

2.2 Regenerative Materials and Bio-Based Construction

The Biomimicry theory involves designing buildings and infrastructure based on the principles and processes found in nature (Helmrich et al., 2020). A major theme in recent studies is the use of bio-based and regenerative materials. Baper et al. (2020) highlight material effectiveness as a key aspect of regenerative architecture, while Malheiro et al. (2021) demonstrate the potential of reed as a building material with useful thermal and durability characteristics. Mouton et al. (2023) further show, through life-cycle assessment, that bio-based construction materials can provide environmental benefits compared with conventional materials, particularly by reducing embodied carbon and storing biogenic carbon. Mouton et al. (2023) demonstrated that bio-based materials generally achieve substantially lower embodied GHG emissions than conventional construction products. The study further revealed that straw-based systems had the lowest global warming potential (GWP), outperforming both hemp- and timber-based alternatives and conventional systems. Other scholars, including Persson (2024), Andreucci et al. (2021) and Baper et al. (2020), support the broader transition toward regenerative design and construction by demonstrating that renewable, carbon-storing materials can significantly lower embodied emissions when evaluated through a full life-cycle perspective.

However, literature also warns that bio-based materials are not automatically regenerative. Their benefits depend on responsible sourcing, transport distances, treatment methods, durability, maintenance needs and

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end-of-life recovery. The RESTORE report, Peretti & Druhmann (2019), contributes to the literature on promoting regenerative construction by expanding the concept beyond material selection and energy efficiency to include collaborative governance, operational management, digital integration, smart energy systems, user participation, and circular life-cycle strategies. It therefore demonstrates that regenerative material selection requires whole-life assessment rather than a narrow focus on initial embodied carbon.

2.3 Regenerative Construction and Circular Economy

The circular economy theory (Stahel, 2019) promotes the idea of closed-loop systems in construction. It emphasises reuse, repair, remanufacture, design for disassembly and closed-loop material systems. Materials used in buildings should be renewable, recyclable, or biodegradable. The construction process should aim to minimise waste, and buildings should be designed for easy disassembly and material reuse at the end of their life cycle. This approach aligns with the concept of "cradle to cradle" design.

Circular economy literature provides practical approaches for regenerative construction. Ghaffar et al. (2020) argue that construction and demolition waste should be treated as a resource stream rather than a disposal problem, while Dams et al. (2021) propose evaluation approaches that support design for disassembly and adaptability. These studies indicate that buildings should be treated as temporary material banks whose components can be recovered, reused and reconfigured.

For construction management, circularity affects procurement, logistics, quality control, contracts and risk allocation. Reused materials often require early identification, testing, certification, storage, traceability and coordination between demolition and new-build projects (Ellen MacArthur Foundation, 2021; Akanbi et al., 2019; Adams et al., 2017). This suggests that regenerative construction depends on supply-chain integration and data transparency.

Miller (1973) defines living systems as open, self-organising systems interacting with their environment through exchanges of information, energy, and matter. In a sense, buildings are dynamic, adaptive systems that respond to changes in their environment. In regenerative construction, this could mean creating buildings that evolve over time to better support human and ecological health. For example, buildings might be designed with adaptable features that allow them to adjust to changing climate conditions or the needs of their inhabitants.

2.4. Regenerative Performance and Assessment

Another important trend is the development of performance evaluation frameworks. Oyefusi et al. (2024) proposed a framework for evaluating regenerative practices in construction, demonstrating the need for measurable indicators across environmental, social, economic, and operational dimensions, as regenerative construction is prone to vague claims when performance is not measured.

Literature suggests that regenerative assessment should include embodied and operational carbon, renewable energy generation, water reuse and watershed

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contribution, biodiversity enhancement, material circularity, local employment and skills development, indoor environmental quality, social value and community participation, post-occupancy performance, and adaptability and end-of-life recoverability (World Green Building Council, 2019; Cole, 2012a; Mang & Reed, 2012; du Plessis & Cole, 2011; Pomponi & Moncaster, 2017).

For example, regenerative design prioritises the site of placement as the primary starting point and the connection between people and the spirit of the place. Lyle's (1996) concept of regenerative design focuses on creating systems that restore and renew the resources they consume. Lyle's work emphasises designing built environments that go beyond sustainability and actively regenerate resources, such as water, energy, and biodiversity. A key gap is that many projects claim to have regenerative intent but lack long-term monitoring. This makes it difficult to verify whether regenerative outcomes are achieved beyond design intent.

Ajayabi (2019) highlighted that the potential market for reclaimed, remanufactured, and reused products will be driven by a range of factors. The main factors identified included the rate of new build, building design and technical innovation.

2.5 Digital Technologies Supporting Regenerative Construction

Digital technologies are identified as enablers of regenerative construction by supporting resource optimisation, lifecycle assessment, material traceability, circularity, performance monitoring, and integrated decision-making (Akanbi et al., 2019). BIM supports collaborative design, clash detection, quantity take-off, materials tracking and integration with LCA. Digital twins support operational monitoring of energy, water, indoor environmental quality and maintenance. Material passports can document the origin, composition, reuse potential and recovery approaches of building components. Technological tools also support regenerative decision-making by allowing project teams to compare design options across carbon, cost, circularity and performance criteria (Lu et al., 2020; Akanbi et al., 2019). However, technology alone does not guarantee regenerative outcomes. Digital systems need to be linked to procurement decisions, contractual requirements, site practices and post-occupancy management.

2.6 Restoration and Enhancement

Peretti and Druhmann (2019) argued that the restorative-regenerative approach holds that sustainability is linked to a neutral impact. This is based on the concept of sustainable development, which emphasises meeting present needs without compromising the ability of future generations to meet their own needs. In contrast, being restorative or regenerative would imply having a positive impact. Regenerative construction seeks to restore ecosystems, enhance biodiversity, and improve the quality of the natural environment. This can include activities such as reforestation, wetland restoration, and the creation of green spaces that support wildlife.

2.7 Other Principles of Regenerative Construction

These include:

2.7.1 **Energy Efficiency and Renewable Energy:** Buildings and infrastructure are designed to maximise energy efficiency while incorporating renewable energy

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sources such as solar and wind power. This reduces dependence on fossil fuels, lowers greenhouse gas emissions, and supports low-carbon development (World Green Building Council, 2019).

2.7.2 **Resilience and Adaptation:** Regenerative construction promotes the design of buildings and infrastructure that are adaptable to changing environmental conditions and resilient to climate-related hazards and natural disasters, thereby enhancing long-term sustainability and functionality (Cole, 2012b).

2.7.3 **Water Management:** Regenerative approaches incorporate sustainable water management strategies, including rainwater harvesting, greywater recycling, water-sensitive urban design, and landscape interventions that restore and support natural hydrological cycles (Mang & Reed, 2012).

2.7.4 **Community and Social Well-being:** Regenerative construction emphasises the creation of inclusive, accessible, and healthy spaces that promote social well-being, community participation, equity, and improved quality of life for occupants and surrounding communities (du Plessis, 2012).

2.7.5 **Connection to Place:** Regenerative design considers the cultural, historical, ecological, and social context of a site, seeking to create developments that respect local identity, ecosystems, and community values while strengthening the relationship between people and place (Mang & Reed, 2012; Cole, 2012b).

The literature shows that regenerative construction has evolved from a narrow focus on reducing environmental impact to a broader life-cycle approach that seeks to create net-positive ecological, social, and economic outcomes. The reviewed studies demonstrate that regenerative construction is closely linked to circular economy principles, the use of bio-based materials, design for disassembly, ecological restoration, digital technologies, life-cycle assessment, social well-being, and place-based design. However, despite this growing body of knowledge, there are gaps. The main knowledge gap lies in translating regenerative construction from an aspirational design philosophy into measurable, practical and construction-management-based processes that can be implemented across the whole building life cycle. This study addresses that gap by reviewing recent literature on the benefits and limitations of regenerative construction and proposing a framework that links regenerative principles to the practical stages of modern construction practice.

3. Research Methodology

3.1 Review Design

This study adopted a systematic narrative literature review. The review focused on literature published between 2020 and 2025, with an emphasis on peer-reviewed journal articles indexed in accredited academic databases, particularly ScienceDirect (Elsevier), Emerald Insight, and Taylor & Francis Online. Additional indexed sources, such as Scopus, Web of Science, and Google Scholar, were used for citation tracing and to locate relevant studies that were not directly indexed under the phrase “regenerative construction” but addressed regenerative construction principles, such as circularity, material reuse, design for disassembly, bio-based construction, and net-positive environmental performance.

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3.2 Search Strategy

The search was conducted using combinations of the following keywords shown in Table 1
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Table 1. Search Themes and Search Terms used

Search Theme	Search Terms Used
Core regenerative construction terms	"regenerative construction", "regenerative building", "regenerative built environment", "regenerative design" AND "construction"
Circular construction terms	"circular construction", "circular economy" AND "construction", "construction circularity", "closed-loop construction"
Material and resource terms	"bio-based materials" AND "construction", "regenerative materials", "reclaimed materials", "construction material reuse"
End-of-life and adaptability terms	"design for disassembly", "adaptive reuse", "building material passports", "building as material bank"
Performance assessment terms	"life cycle assessment" AND "building materials", "embodied carbon" AND "construction", "net positive building"
Technology terms	"BIM" AND "circular construction", "digital twin" AND "building performance", "material passports" AND "buildings"

3.3 Inclusion and Exclusion Criteria

Table 2 presents the inclusion and exclusion criteria used to source the relevant literature.

Table 2. Inclusion and Exclusion Criteria

Criterion	Inclusion Decision
Publication period	2020–2025
Language	English-language publications
Publication type	Peer-reviewed journal articles and selected indexed conference papers where directly relevant to regenerative construction.
Subject area	Construction, buildings, built environment, infrastructure, circular economy, regenerative design, building materials, environmental assessment and construction management.
Relevance	Studies had to address at least one of the following: regenerative construction principles, circular construction, bio-based materials, life-cycle performance, design for disassembly, material reuse, digital tools for circularity, net-positive environmental performance or implementation barriers.
Exclusion	Studies were excluded if they focused only on general sustainability without a connection to regenerative, circular, restorative or net-positive construction practices.

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3.4 Specific Literature Reviewed

Table 3 outlines the sources of the literature review and the number reviewed.

Table 3. Reviewed Literature Matrix, 2020-2025

Journal / Repository Source	**Number reviewed**
Journal of Cleaner Production, Elsevier/ ScienceDirect	5
Environmental Impact Assessment Review, Elsevier/ScienceDirect	3
IOP Conference Series: Earth and Environmental Science	2
International Journal of Technology	1
Earth's Future	1
Journal of Building Engineering	1
Energies	1
Energy and Buildings, Elsevier / ScienceDirect	1
Proceedings of the Institution of Civil Engineers: Urban Design and Planning	1
Philosophical Transactions of the Royal Society B	1
Journal of Physics: Conference Series	1
Total	**18**

It can be seen from Table 3 that more of the reviewed papers were published in the Journal of Cleaner Production (Elsevier/ScienceDirect), followed by Environmental Impact Assessment Review (Elsevier/ScienceDirect) and IOP Conference Series: Earth and Environmental Science.

4. Results and Discussion

The following sections present the benefits and limitations of regenerative construction identified in the literature.

4.1 Economic, Social, Environmental and Technological Benefits of Regenerative Construction

The literature review was coded into four benefit categories: economic, social, environmental, and technological. The results obtained are presented in Table 4.

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Table 4. Economic, Social, Environmental and Technological Benefits of Regenerative Construction

Benefits	Main Finding	Reference (s)
Economic	Whole-life cost reduction	Dams et al. (2021); Mouton et al. (2023); Oyefusi et al. (2024)
	Material cost recovery	Benachio et al. (2020); Munaro et al. (2020); Ghaffar et al. (2020); Çimen (2021)
	Reduced construction and demolition waste disposal costs	Ghaffar et al. (2020); Benachio et al. (2020); Norouzi et al. (2021)
	New circular business models	Munaro et al. (2020); Çimen (2021); Norouzi et al. (2021); Oyefusi et al. (2022)
	Increased long-term asset value	Scrucca et al. (2023); Plaves et al. (2024); Oyefusi et al. (2024)
	Local economic development	Malheiro et al. (2021); Mouton et al. (2023); Dorninger et al. (2024)
	Risk reduction	Helmrich et al. (2020); Scrucca et al. (2023); Persson (2024)
Social	Improved occupant health and well-being	Baper et al. (2020); Helmrich et al. (2020); Plaves et al. (2024)
	Community participation and place-based design	Dorninger et al. (2024); Plaves et al. (2024); Persson (2024)
	Social value creation	Scrucca et al. (2023); Oyefusi et al. (2024); Dorninger et al. (2024)
	Skills development and employment	Oyefusi et al. (2022); Yao et al. (2023); Kasina et al. (2025)
	Cultural and ecological connection	Dorninger et al. (2024); Persson (2024); Plaves et al. (2024)
	Improved worker well-being and site practices	Kasina et al. (2025); Oyefusi et al. (2024)
Environmental	Reduced embodied carbon	Mouton et al. (2023); Malheiro et al. (2021); Baper et al. (2020)
	Carbon storage through bio-based materials	Malheiro et al. (2021); Mouton et al. (2023)
	Reduced virgin resource extraction	Benachio et al. (2020); Munaro et al. (2020); Çimen (2021); Norouzi et al. (2021)
	Construction and demolition waste minimisation	Ghaffar et al. (2020); Dams et al. (2021); Çimen (2021)
	Improved biodiversity and ecosystem restoration	Helmrich et al. (2020); Dorninger et al. (2024); Persson (2024)

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	Water regeneration and improved hydrological cycles	Persson (2024); Plaves et al. (2024); Oyefusi et al. (2024)
	Climate resilience	Helmrich et al. (2020); Scrucca et al. (2023); Persson (2024)
	Improved life-cycle environmental performance	Mouton et al. (2023); Dams et al. (2021); Oyefusi et al. (2024)
Technological	Life-cycle assessment-supported decision-making	Mouton et al. (2023); Dams et al. (2021); Oyefusi et al. (2024)
	Digital support for circular construction	Çimen (2021); Norouzi et al. (2021); Dams et al. (2021)
	BIM-enabled coordination	Dams et al. (2021); Oyefusi et al. (2024); Kasina et al. (2025)
	Design for disassembly and adaptability tools	Dams et al. (2021); Benachio et al. (2020); Munaro et al. (2020)
	Material passports (documenting the material properties) and material traceability	Çimen (2021); Norouzi et al. (2021); Plaves et al. (2024)
	Construction-stage monitoring	Kasina et al. (2025); Oyefusi et al. (2024)
	Smart building and operational technologies	Plaves et al. (2024); Persson (2024); Oyefusi et al. (2024)

Table 4 summarises the key benefits of regenerative construction identified in the literature across four major dimensions comprising economic, social, environmental, and technological. First, the economic benefits include whole-life cost reduction, material recovery, reduced landfill cost, local value creation and improved asset resilience. These findings are supported by circular construction studies that show how design for disassembly, waste recovery and circular material markets can reduce long-term resource costs and create new business opportunities.

Second, social benefits include improved occupant health, community participation, social value, cultural connection and employment generation. The literature shows that regenerative construction is concerned not only with environmental performance but also with improving the relationships among buildings, users, and local communities.

Third, the environmental benefits are the most developed in the literature. They include reduced embodied carbon, carbon storage through bio-based materials, waste minimisation, reduced virgin material extraction, biodiversity enhancement, improved water cycles and climate resilience. However, these benefits depend on life-cycle assessment and responsible sourcing.

Fourth, technological benefits include the use of BIM, life-cycle assessment tools, digital monitoring, material passports, and circularity assessment frameworks. These tools improve decision-making and traceability, but their effectiveness depends on data quality, interoperability and professional capacity.

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4.2 Limitations of Regenerative Construction

The study also sought to know the limitations and barriers of regenerative construction. Table 5 highlights the limitations that restrict the implementation of regenerative construction in the literature.

Table 5. Limitations and Barriers of Regenerative Construction

Limitations / Barriers	Description	Reference (s)
High initial cost	Regenerative construction may require additional design time, specialist consultants, advanced modelling, unfamiliar materials, ecological studies and stakeholder engagement. These increase upfront project cost.	Oyefusi et al. (2024); Plaves et al. (2024); Yao et al. (2023)
Uncertain return on investment	Many clients prioritise capital cost over whole-life value. The long-term financial benefits of regenerative construction are not always immediately visible or easily quantified.	Scrucca et al. (2023); Oyefusi et al. (2024); Plaves et al. (2024)
Fragmented procurement systems	Traditional procurement separates design, construction and operation, whereas regenerative construction requires early contractor involvement, integrated teams and long-term stewardship.	Oyefusi et al. (2022); Yao et al. (2023); Kasina et al. (2025)
Weak circular supply chains	Markets for reclaimed materials, reused components, bio-based products and certified secondary materials are immature in many regions.	Benachio et al. (2020); Munaro et al. (2020); Norouzi et al. (2021)
Material availability and quality uncertainty	Reused and bio-based materials may be difficult to obtain in consistent quantity, quality, specification and timing for construction projects.	Ghaffar et al. (2020); Malheiro et al. (2021); Mouton et al. (2023)
Regulatory and certification challenges	Building codes and product certification systems are often designed around conventional materials, making approval of reused or novel bio-based materials difficult.	Çimen (2021); Norouzi et al. (2021); Mouton et al. (2023)
Smart building and operational technologies	Sensors, digital monitoring, and smart systems can help maintain performance in energy, water, comfort, and indoor environmental quality after handover.	Plaves et al. (2024); Persson (2024); Oyefusi et al. (2024)
Lack of professional knowledge	Many practitioners are unfamiliar with regenerative design principles, ecological systems thinking, circular procurement, LCA and material passport systems.	Yao et al. (2023); Oyefusi et al. (2024); Kasina et al. (2025)

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Measurement difficulties	Regenerative outcomes such as biodiversity gains, social value, community resilience, and ecological restoration are harder to measure than energy or carbon reductions.	Oyefusi et al. (2024); Plaves et al. (2024); Dorninger et al. (2024)
Risk of greenwashing	Without standardised indicators, projects may claim to be regenerative without demonstrating measurable net-positive performance.	Plaves et al. (2024); Oyefusi et al. (2024); Persson (2024)
Technology fragmentation	BIM, LCA, carbon tools, cost planning systems, material databases and facility management platforms are not always interoperable.	Dams et al. (2021); Norouzi et al. (2021); Kasina et al. (2025)
Limited post-occupancy evidence	Many regenerative ambitions are stated at the design stage, but few projects provide long-term post-occupancy data proving ecological, social and operational performance.	Plaves et al. (2024); Oyefusi et al. (2024); Persson (2024)
Maintenance and stewardship problems	Regenerative performance depends on facility managers and users maintaining energy, water, biodiversity and circular systems after handover. Poor operation can undermine design intentions.	Persson (2024); Plaves et al. (2024); Kasina et al. (2025)

Table 5 shows that the principal limitations are high upfront cost, fragmented procurement, weak circular supply chains, lack of regulatory clarity, limited professional knowledge, poor measurement systems, data fragmentation and insufficient post-occupancy evidence.

4.4. Discussion of Findings

The review shows that regenerative construction is best understood as a life-cycle management approach rather than a single design style or material choice. Its success depends on aligning ecological intention with construction management processes. First, regenerative construction challenges the traditional project success criteria of cost, time and quality. These remain important, but they must be expanded to include carbon, biodiversity, social value, adaptability, circularity and long-term performance. This requires new key performance indicators and contract clauses.

Second, regenerative construction shows how circular economy and construction management are related. Waste prevention, material reuse, and design for disassembly cannot be achieved at the end of a project; they must be embedded from the briefing and procurement stages. Contractors must therefore be involved earlier in design decisions.

Third, the benefits of regenerative construction are interdependent. For example, bio-based materials may reduce embodied carbon, support local employment and stimulate innovation. Similarly, green infrastructure can improve biodiversity, reduce flood risk, enhance public space and increase asset value. This confirms that regenerative construction should be assessed in terms of integrated value rather than isolated environmental metrics.

Fourth, the review highlights the need for post-occupancy evidence. Many regenerative claims are made during planning and design, but fewer studies provide long-term data on

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actual performance. Without monitoring, it is difficult to prove net-positive outcomes.

Finally, regenerative construction requires policy support. Voluntary action by a built environment professional or client alone may be insufficient because market systems often reward short-term cost minimisation. Regulations, incentives, carbon pricing, public procurement standards and circular material certification can accelerate the adoption of regenerative construction principles.

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5. Proposed Regenerative Construction Implementation Framework

The proposed framework aims to provide a roadmap for implementing regenerative construction across the building life cycle.

5.1 Overview of the Framework

Table 6 shows the constituents of the regenerative construction implementation framework

Table 6. Regenerative Construction Implementation Framework

Stage	Key Activities	Main Actors	Performance Indicators
1. Initiation – Place-Based Assessment	Assess climate, ecology, culture, community needs, water systems, material flows and risks.	Client, urban planners, ecologists, community, designers	Baseline carbon, biodiversity, water, social value and material inventory
2. Briefing (Regenerative targets)	Define net-positive goals and measurable outcomes before design begins.	Client, project manager, consultants, users	Regenerative KPIs, whole-life value targets, social value targets
3. Integrated Design	Use collaborative design, BIM, LCA, passive design, adaptability and ecological integration.	Architects, engineers, quantity surveyors, contractors, construction managers	Energy demand, embodied carbon, adaptability score, biodiversity gain
4. Procurement (Circular and Bio-Based)	Prioritise reused, renewable, local, low-carbon and responsibly sourced materials.	Procurement team, suppliers, contractors	Reused content, recycled content, biogenic carbon, local sourcing ratio
5. Construction Management (Regenerative)	Minimise site disturbance, waste, water use, emissions and ecological damage during construction.	Contractor, site manager, construction manager, subcontractors	Waste diversion, site energy, water reuse, pollution incidents, worker welfare
6. Operations & Maintenance	Monitor performance, engage occupants and maintain ecological and technical systems.	Facility managers, owners, users	Actual energy use, water reuse, indoor air quality, occupant satisfaction

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7. End-of-Life Reintegration	Plan for disassembly, reuse, recycling, ecological restoration and material recovery.	Owners, demolition contractors, recyclers, manufacturers	Recovery rate, reusable components, material passport completeness

5.2 Logic of the Framework

To obtain the benefits of a regenerative construction and overcome its limitations, the following framework of construction activities, shown in Figure 1, is proposed.

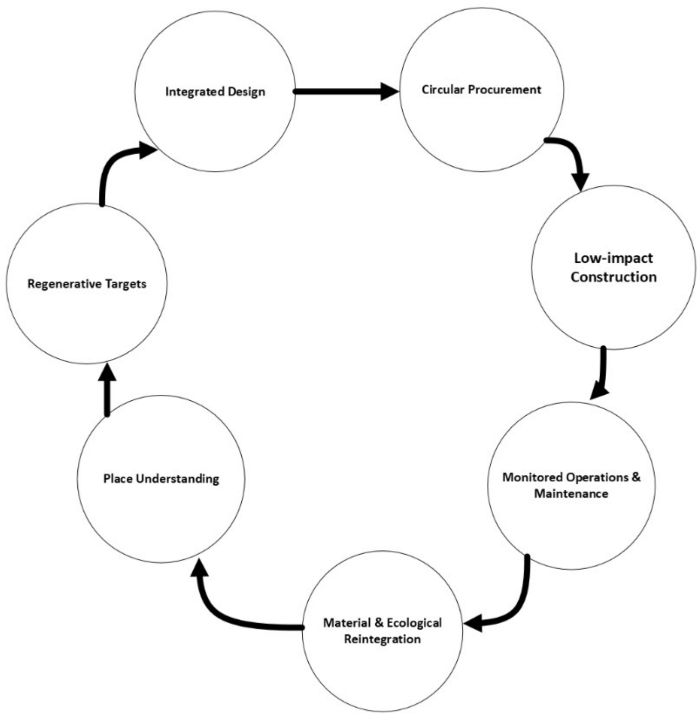

Figure 1. Regenerative Construction Framework

Figure 1 shows that the sequence ensures that regenerative construction is not treated as an add-on but as a continuous process from project conception to future reuse. To apply the framework in practice, project teams should establish regenerative objectives at the business case stage; include environmental and social value specialists in early planning; use BIM-linked LCA and cost tools to compare options; specify materials with reuse, repair and disassembly potential; include regenerative KPIs in contracts; monitor actual performance after handover; update material passports throughout the building's life; and reinvest project benefits into local ecological and social systems.

6. Conclusion and Recommendations

The literature review from 2020 to 2025 shows that regenerative construction is progressing beyond conventional sustainability in the building industry. Its benefits are economic, social, environmental and technological. Economically, it can reduce whole-life costs, create new circular markets and improve asset resilience. Socially, it can enhance health, inclusion, community participation and skills development. Environmentally, it can reduce

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carbon emissions, restore biodiversity, improve water systems, and reduce waste. Technologically, it encourages the use of BIM, LCA, digital twins, material passports, smart systems and advanced material innovation.

Despite these benefits, regenerative construction is limited by upfront costs, fragmented procurement, immature supply chains, uncertain regulation, limited skills, weak measurement systems, and a lack of long-term performance data. These limitations suggest that regenerative construction cannot be achieved through design intention alone. It requires coordinated action by clients, contractors, consultants, suppliers, regulators, facility managers and building users.

The proposed framework provides a structured approach to implementing regenerative construction principles throughout the project life cycle. Future research should test the framework through empirical case studies, professional surveys and post-occupancy performance evaluations in different regional contexts. Attention should be given to developing measurable indicators for biodiversity, social value, circularity and long-term regenerative performance.

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