Working Paper

SDPI
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Redesigning Resilience through Circularity: A Circular Construction Blueprint for Pakistan's Built Environment

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List of Abbreviations

Abbreviation	Full Form
BCA	Building and Construction Authority (Singapore)
BIM	Building Information Modelling
BCR	Benefit-Cost Ratio
C&D	Construction and Demolition
CBA	Cost-Benefit Analysis
ECBC	Energy Conservation Building Code
GHG	Greenhouse Gas
KfW	Kreditanstalt für Wiederaufbau (German Development Bank)
LCA	Life Cycle Assessment
MoCC&EC	Ministry of Climate Change and Environmental Coordination
NAP	National Adaptation Plan
NDC	Nationally Determined Contributions
NESPAK	National Engineering Services Pakistan
PEC	Pakistan Engineering Council
PPP	Public-Private Partnership
R&D	Research and Development
SDGs	Sustainable Development Goals
SME	Small and Medium-sized Enterprises
UNFCCC	United Nations Framework Convention on Climate Change

1. Executive Summary

The construction sector of Pakistan faces an important decision-making point right now. The built environment of Pakistan faces critical challenges due to fast urban growth together with rising climate threats and non-sustainable resource depletion. The existing "take-make-dispose" linear model under which Pakistan operates results in extreme waste production together with resource overexploitation and significant carbon pollution. Climate-induced hazards including extreme heat along with flooding and water scarcity problems cause additional vulnerabilities throughout urban infrastructure combined with housing facilities which target low-income families who live in disaster areas.

Federal authorities need to adopt circular construction principles immediately as a solution to environmental ruin and climate susceptibility. Circular construction, which prioritizes material reuse, modular design, and resource efficiency throughout a building's lifecycle, presents a transformative opportunity to build smarter, greener, and more resilient cities. This document uses evidence from SDPI's multi-stakeholder webinar together with international academic research to outline emerging solutions and implementation barriers for Pakistani circular construction adoption.

Based on literature review and FGDs, numerous participants revealed that circular methods could redirect 30% of construction debris from landfills lowering both environmental emissions and materials expenses. The presentation focused on low-tech traditional methods including vernacular architecture together with passive cooling and natural materials because they served both local requirements and climate goals. Current policy frameworks which include the National Adaptation Plan (NAP) and the Green Building Code 2023 together with Energy Conservation Building Code (ECBC) 2023 need a combination of effective enforcement along with circularity principal integration to achieve their intended impact. Multiple obstacles found in the field include insufficient regulatory guidelines in contrast to insufficient technical skills and missing financial motivators and inadequate joint efforts between stakeholders.

To also evaluate the economic case for circular construction, a **Cost-Benefit Analysis (CBA)** was conducted. The analysis estimated a **Benefit-Cost Ratio (BCR) of 4.08**, indicating that every dollar spent would yield over four dollars in return. This favourable ratio reflects multiple monetized benefits, including energy savings from passive design, job creation in recycling, avoided import costs, reduced landfill burden, and lower public health expenses due to pollution mitigation. The findings strongly reinforce that circular construction is not only environmentally necessary but also economically viable.

Furthermore, a **PESTEL analysis** was undertaken to assess the enabling environment across six critical dimensions: political, economic, social, technological, environmental, and legal. The analysis revealed several systemic gaps—such as the lack of a national circular construction policy, fragmented governance, limited green financing access, and weak regulatory enforcement—that hinder progress. However, it also identified clear entry points for reform, including political momentum post-2022 floods, market demand for resilient housing, and untapped opportunities in green job creation and material innovation.

The innovative application of green finance together with public-private partnerships and specific policy incentives as used in Singapore and Germany shows potential to quicken the spread of circular construction practices. The lessons provide substantial guidance for Pakistan as it moves toward making its construction sector serve as both sustainable and climate resilient.

The working paper also presents a roadmap of reforms focused on:

1. National Circular Construction Policy should be enacted.
2. Building codes should include two elements: climate risk evaluations together with regulations about recycled materials.
3. Access to green financing instruments and subsidies for sustainable building practices should be expanded.

4. Communities need extensive technical training that will support their building of resilience.
5. Platforms should be built to develop multi-stakeholder collaboration and knowledge exchange opportunities.

These measures, when executed with effectiveness, will enable Pakistan to advance toward an approaching future which sees its construction sector developing by driving economic growth in combination with protecting environmental sustainability and resisting climate changes.

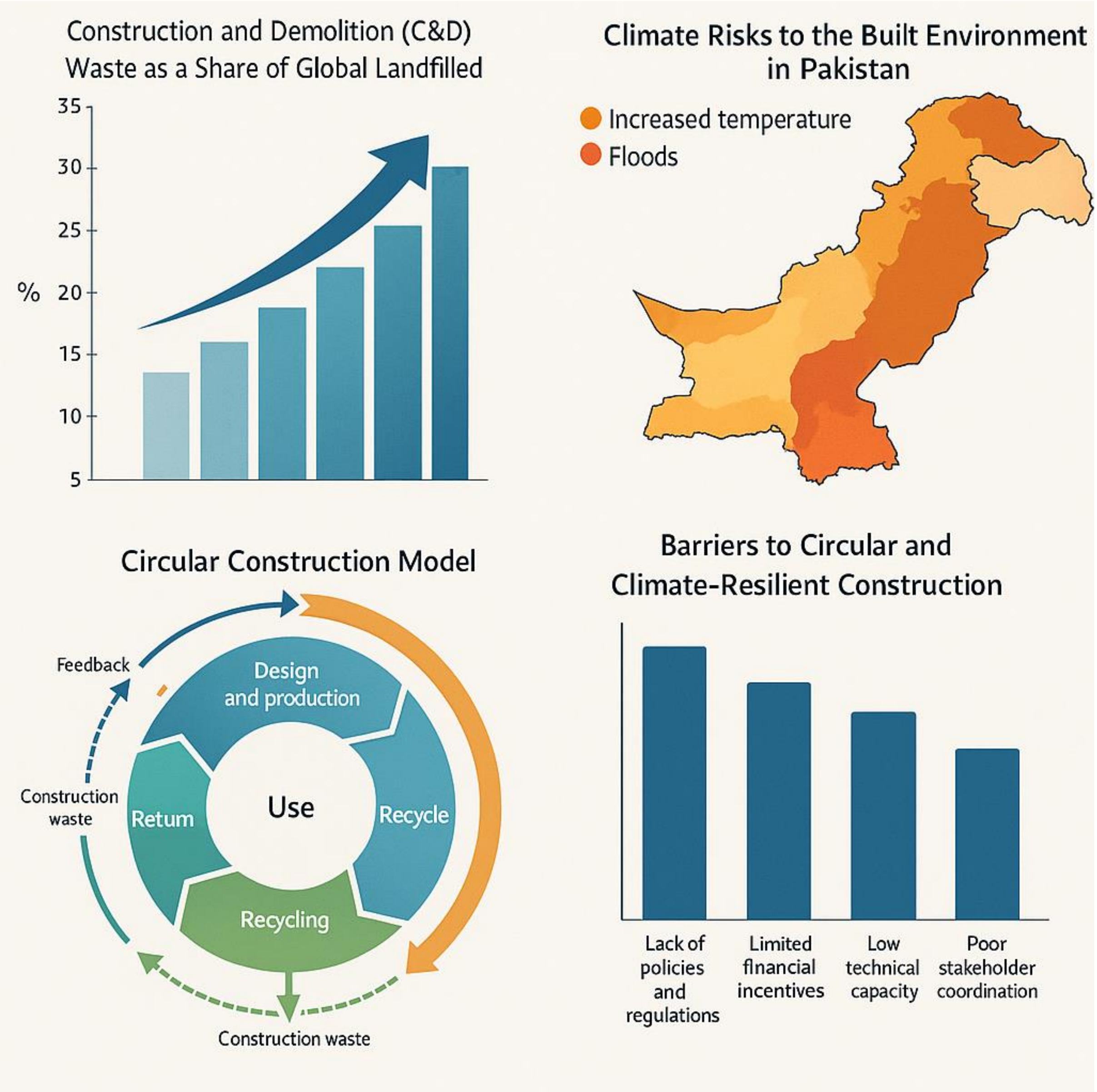

Figure 1: Circular Construction and Climate Risk mitigation- A summary.

2. Acknowledgements

This working paper has been developed as part of the Sustainable Development Policy Institute's (SDPI) broader research efforts on the circular economy and climate resilience in Pakistan. The insights presented herein are drawn from a series of ongoing projects and technical collaborations with partner organizations including United Nations Environment Programme (UNEP) and Institute for Global Environmental Strategies (IGES), national and regional stakeholders.

This working paper builds upon key findings and thematic intersections explored during activities focused on sustainable infrastructure, climate adaptation, and circularity in the built environment. In particular, it synthesizes knowledge generated through stakeholder consultations, technical webinars, and field-based assessments undertaken in the first half of 2025.

We extend our gratitude to all project collaborators, subject-matter experts, and participants who contributed to the dialogue on sustainable construction practices, especially during the multi-stakeholder webinar titled **"Circularity in the Construction Industry and Climate Resilience in Pakistan"** held on March 17, 2025.

Special thanks are due to colleagues at SDPI's Executive Director **Dr Abid Qaiyum Suleri**, whose visionary leadership and guidance has played instrumental role in establishing research and advocacy around the theme of circular economy and also the colleagues at SDPI's Program on Ecological Sustainability and Circular Economy (PESACE) for their technical contributions and dedication to exploring new avenues of research in context of circular economy potential in the region.

3. Background

The construction industry (CI) is responsible for the generation of significant Construction and Demolition Waste (CDW) which contributes 35% landfilling globally (Solis-Guzman et al., 2009). The resource intensiveness of the Construction industry strains the natural resources and contributes to climatic disasters (Athira et al., 2019). The current economic system is based on the linear sequence of "take-make-use-dispose", relying on the exploitation of raw materials and on the irreversible disposal of waste at the End of Life (EoL). The current model is highly unsustainable: on an annual basis, it uses more than 79Gt of raw materials worldwide and more than 50% of Greenhouse Gas (GHG) emissions derive from raw materials management activities.[1]

In 2022, operational energy-related CO_2 emissions from buildings increased by approximately 1% compared to 2021, reaching nearly 10 $GtCO_2$ surpassing the previous peak recorded in 2018. Buildings accounted for around 27% of total global CO_2 emissions due to energy use, while an additional 7-9% of emissions are attributed to the manufacturing of building materials. This marks the highest level of emissions from building operations in recent years, highlighting the sector's growing contribution to climate change. As of 2023, global raw material extraction exceeded 104 billion tonnes, with the construction sector responsible for over 50% of this demand primarily for minerals such as sand, gravel, limestone, and metals used in cement and steel.[2]

Additionally, the production of just 12 major building materials including concrete, steel, bricks, aluminium, and glass accounted for an estimated 9.3 gigatonnes (Gt) of CO_2 emissions in 2019, equivalent to 25% of global fossil CO_2 emissions. Of this, 5.8 Gt CO_2 (approximately 16% of global emissions) was specifically attributed to materials used in construction applications, such as buildings and infrastructure (Kane et al., 2025).

According to Oxford Economics (2022), in its report "A Global Forecast of Construction 2030"[3], the world population is expected to reach 8.5 billion by 2030, accompanied by an urban population increase of approximately 2.5 billion by 2050. This demographic expansion will significantly elevate the demand for civil infrastructure, including housing and built environments. While the construction sector is projected to sustain global economic growth, with an average growth rate of 4.4% between 2020 and 2025 and continued growth of 3.5% annually through 2030, this expansion underscores the urgent need to align construction practices with sustainable and circular economy principles. Without a shift away from resource-intensive, linear models, the anticipated growth risks amplifying environmental degradation, making the integration of circular construction practices critical to ensuring that future development is both climate-resilient and resource-efficient.

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1 OECD (2019) Global material resources outlook to 2060: Highlights. Paris: OECD Publishing. Available at: https://www.oecd.org/content/dam/oecd/en/publications/support-materials/2019/02/global-material-resources-outlook-to-2060_g1g98d7d/highlights-global-material-resources-outlook-to-2060.pdf

[2] 6. UN International Resource Panel (2023). Global Material Flows Database. Retrieved from: https://www.materialflows.net/global-trends-of-material-use/

[3] https://www.oxfordeconomics.com/resource/future-of-construction/

4. Introduction

Pakistan, the 5th most populous country in the world, is experiencing rapid urbanization and infrastructure expansion. With a population of 220 million, a growing middle class, and a labour force exceeding 60 million, the demand for housing and commercial infrastructure continues to rise. The nation faces population expansion of 2.55% annually (PBS, 2023) which speeds up residential demand to stimulate growth in the construction field.[4] The construction industry facilitates 2.53% of Pakistan's GDP while employing 7.61% of the workforce which makes it a central element of the national economy. Over 95% of total GFCF rests in the private sector while capital investments strong enough to grow private sector GFCF by 20.6% during the FY2019 to FY2020 period. The sector's expansion continued its upward trajectory because of the China-Pakistan Economic Corridor's (CPEC) large-scale infrastructure activities which built highways and power plants together with dams.[5]

The fast expansion of Pakistan's construction industry produces major environmental problems by causing excessive resource use and increasing Construction and Demolition materials waste while generating rising carbon dioxide emissions. The existing linear economic model ensures depletion of resources while creating environmental hazards even though it follows the sequence of "take-make-dispose". The requirement of building climate-resilient infrastructure becomes important because extreme heat and flooding and water shortages from climate change threaten the built infrastructure (Eberhardt et al., 2022). Rising C&D waste quantities manifest due to poor material use throughout different phases of construction development. The brick kiln industry of Pakistan operates more than 18,000 kilns in annual production of 45 billion bricks which generates substantial CO_2 emissions and air pollution for the employment of over 1.3 million workers with many of these workers facing informal and unstable working conditions.[6]

Circularity remains a difficult goal due to the lack of proper reverse logistics infrastructure along with programs to retrieve building materials. Material recovery and reuse efforts face significant challenges because Pakistan lacks proper infrastructure for collecting used construction materials during deconstruction and has not established ways and means to reintegrate these materials into existing supply chains (Bi et al., 2022). The construction sector of Pakistan needs to implement circular economy principles as a solution for its present challenges. The combination of sustainable construction elements which reuse materials and plan modules efficiently while reducing resource consumption forms the basis for minimizing emissions. The adoption of alternative cement technologies remains constrained because policies need improvements along with insufficient funding and technical competence.

This policy brief examines how circular economy principles function as the essential element to develop Pakistan's construction industry into a sustainable resource-efficient sector. The document emphasizes that construction facilities face mounting climate risks as well as the critical requirement of developing infrastructure systems that resist environmental disturbances. The brief also demonstrates innovative building technologies while using recycled materials along with different types of cements for producing low-carbon concrete to reduce environmental effects in construction sectors. International along with Pakistani case examples show that effective practical solutions can be implemented as part of the document. Direct interaction between industry practitioners and both policymakers and researchers constitutes a key aspect of the document because it builds intersectoral communication.

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[4] https://www.pbs.gov.pk/sites/default/files/population/2017/national
[5] https://invest.gov.pk/housing-and-construction
[6] https://www.researchgate.net/publication/376982331_Sustainable_Management_of_Construction_and_Demolition_Waste_to_Achieve_Zero_Waste_and_Circular_Economy

5. Literature Review

Pakistan's vulnerability to climate change is manifest across various sectors, with recent disasters exposing significant weaknesses in its infrastructure, particularly within the construction sector. The nation's diverse geographical features render it exceptionally susceptible to the impacts of climate change, as evidenced by recurrent extreme events, including floods and droughts that disrupt built environments and economic stability (Sajjad, 2024; Ahmad & Hashmi, 2023). For example, the catastrophic floods of 2022 not only displaced millions but also caused profound infrastructural damages, thereby challenging existing construction practices and recovery strategies (Sajjad, 2024; Muhammad & Noor, 2023). The disasters experienced in recent years have revealed a pattern of intensified climate hazards that consistently disrupt critical infrastructure. Studies indicate that unpredictable rainfall, glacial melting, and rising temperatures exacerbate both the frequency and severity of natural disasters in Pakistan (Zia, 2023; Farooq & Fatima, 2022). Such events have devastating implications for the construction sector, as the destruction of roads, bridges, and residential buildings necessitates rapid and resilient reconstruction efforts (Panhwar, 2024). Time and again, flooding and extreme weather events lead to longer repairs and extended recovery periods which exhaust national resources and block sustainable urban development according to Muhammad and Noor (2023) and Zia (2023). Climate-related challenges tightly bind to the operations of the building industry. The analysis shows that construction releases major carbon emissions and stands as a principal target group for climate change impacts (Kalogeraki & Antoniou, 2022). Heavy monsoon-triggered extreme weather events damage construction materials and infrastructure thus requiring building technologies and design codes to upgrade their resilience because of their limited durability (Kalogeraki & Antoniou, 2022). Systemic impacts of flooding encompass land liquefaction together with foundation destabilization requiring integrated intervention among engineering and disaster risk reduction and governmental policy fields (Zia, 2023; Panhwar, 2024). The widespread economic consequences after these disasters generate challenges that slow down the reconstruction efforts of the construction sector. The urgent demand for climate-resistant infrastructure emerges from the multiplying harmful effects which infrastructural damage creates for security functions and public wellness and national economic growth (Muhammad & Noor, 2023; Zia, 2023). Developing climate adaptation solutions during construction is essential because it minimizes upcoming perils and fulfils emerging disaster management protocols (Sajjad 2024; Kalogeraki & Antoniou 2022).

The Pakistani construction industry has reached a decisive point in sustainability development because circular construction approaches present an intelligent environmental solution for minimizing waste together with pollution reduction and maximizing resource utilization. Global interest in circular construction urges stakeholders to move beyond the linear "take-make-dispose" system by developing sustainable regeneration-based solutions. The Pakistan construction sector remains responsible for extensive carbon release and resource deterioration but progressive developments prove the advantages of this method (Amanullah 2024 and Appendino et al. 2021). The full sustainability merger in circular construction starts in design projects and continues through each life cycle phase of produced items. Various studies demonstrate that digital tools must unite with lifecycle analysis methods to implement these strategies. Digital twins along with BIM solutions help track materials while enabling reuse mechanisms that establish waste minimization systems according to Meng et al. (2023). Studies have demonstrated that building design that concentrates on material preservation and waste reduction techniques leads to simultaneous reduction of environmental effects and material usage conservation outcomes (Eberhardt et al., 2020; Huovila & Westerholm, 2022). The local Pakistani scenario matches with these approaches since resource limitations along with extensive waste production requires innovative construction management systems. Several important challenges prohibit Pakistan from adopting circular construction despite its clear advantages.

Research into current policies and regulatory standards reveals plenty of holes that inhibit main construction activities from adopting circular economy concepts. The Pakistani construction sector applies circular methods in an unstructured manner because it lacks formal policies and technical knowledge for circular economy alongside informal material reuse practices. Systematic progress in cradle-to-cradle design principles faces further difficulties because of combined institutional and market resistance. The literature shows that circular construction will succeed when it partners with clear regulatory requirements and standardized protocols (Charef et al., 2021). The municipal areas of Karachi showcase the potential of circular economic principles when all sectors apply them on a national scale. Experimental building constructions act as demonstration sites for circular construction techniques and resource-efficient buildings which prove effective methods for national-scale access (Appendino et al., 2021). Extended nationwide implementation needs an integrated plan which combines policy backing with training and investment in technical abilities to support circular design practices in construction (Amanullah, 2024). A strategic framework combining environmental life cycle assessments and circular design indicators would provide solid support for improved sustainable construction project planning and execution and evaluation (Saadé-Sbeih et al., 2022).

6. Methodology

The policy brief draws its foundation from a consultation process that engages multiple stakeholders to achieve diverse perspectives alongside practical evidence and recommendations about circularity practices and climate resilience in Pakistan's construction sector. An extensive **review of academic and grey literature** was conducted to understand the global evolution of circular construction and its relevance for developing countries. The literature review also incorporated national policy documents such as the National Adaptation Plan (NAP), ECBC 2023, Green Building Code 2023, and Pakistan's Nationally Determined Contributions (NDCs).

The primary data collection method also consisted of a focussed group discussion with private sector, industries, Pakistan Engineering Council, NESPAK, Policy makers, researchers and development partners through a webinar-based stakeholder engagement session titled "Circularity in the Construction Industry and Climate Resilience in Pakistan", organized on 17th March 2025. The webinar brought together experts and practitioners from across the public and private sectors, academia, development organizations, and civil society. It was structured around three thematic sessions, each focusing on a key dimension of sustainable construction and circular economy integration:

1. ***Circular Economy in Pakistan's Construction Sector – Challenges & Opportunities:*** This session explored circularity concepts, including material reuse, recycled aggregates, low-carbon concrete, modular design, and barriers to adoption. Case studies were shared to highlight scalable models.
2. ***Climate Risks & Resilient Infrastructure in the Construction Sector:*** This session focused on the impacts of climate change on construction, emphasizing water-efficient building practices, wastewater recycling, and design strategies to enhance resilience against extreme weather.
3. ***Policy and Financial Gaps and Opportunities for Sustainable Construction:*** The discussions addressed sustainable construction support through policy gaps exploration as well as green financing and public-private partnerships and investment incentives. Policy frameworks along with financial models that worked successfully were presented during the webinar.

To evaluate the economic viability of circular construction in Pakistan, a **Cost-Benefit Analysis (CBA)** was performed. The CBA assessed quantifiable monetary values for both benefits and costs associated with a large-scale shift toward circular building practices.

Benefits monetized included:

- Waste reduction and landfill cost savings;
- Energy savings from passive design;
- Avoided import costs for construction materials;
- Job creation in recycling and material recovery;
- Avoided health costs due to reduced air pollution;
- Carbon emission reductions monetized at USD 50/ton CO_2 equivalent (World Bank price).

Costs estimated included:

- Initial investment in technical training and institutional capacity;
- Cost of policy and regulatory reform enforcement;
- Infrastructure for reverse logistics and material recovery.

Formula Used:

Net Benefit = $\sum$ Annual Benefit - $\sum$ Annual Costs

Benefit-Cost Ratio (BCR): $BCR = \frac{\textit{Total Annual Benefits}}{\textit{Total Annual Costs}} = \frac{815}{200} = 4.08$

A **BCR greater than 1.0** indicates a favourable return on investment.

The final step involved synthesizing stakeholder inputs, academic insights, CBA results, and international case studies to develop contextually relevant policy recommendations. The framework draws lessons from successful circular construction models (e.g., Germany's KfW green finance, Singapore's BCA Green Mark Scheme) and adapts them for Pakistan's regulatory, economic, and climatic context.

In addition to economic analysis, a structured **PESTEL (Political, Economic, Social, Technological, Environmental, Legal)** framework was applied to assess the enabling environment for circular construction in Pakistan. The PESTEL analysis provided a systems-level understanding of the macro-level factors influencing the uptake of circular construction. It helped identify policy entry points, institutional gaps, financing needs, technological readiness, and legal constraints, drawing from both stakeholder insights and secondary research. This multidimensional assessment was critical to ground the policy recommendations in practical realities and institutional capacities.

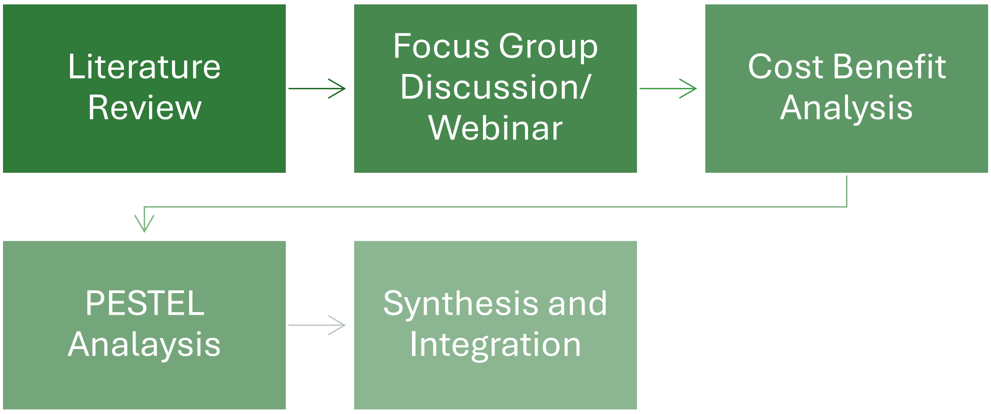

Figure 2: Methodology Snapshot

7. Discussion and Analysis

7.1 The Case for Circular Construction

Developments regarding climate change alongside diminishing resources created an essential change in the development of our built environment. The challenges can be met successfully with circular construction adoption. Unlike the conventional "take-make-dispose" model, circular construction is rooted in the principles of the circular economy, promoting material reuse, modular design, and resource efficiency throughout a building's lifecycle.

Speakers at the webinar stressed that circular construction represents an absolute need especially for Pakistan considering its combined challenges of urban growth and environmental issues. The expertise of Mr. Akbar Mehmood Zaidi confirmed circular construction methods could redirect 25-30% of construction and demolition (C&D) waste from reaching landfills which matches findings presented by Stuetzer et al. (2024) and Iwuanyanwu et al. (2024). Practical steps in waste material reuse combined with building design for disassembly emerged as effective cost-efficient methods for achieving environmental sustainability.

The AEC sector contains circular construction according to the research literature which shows it as a transformative methodology. The research work of Almusaed et al. (2021) matches Dams et al. (2021) when they present circular construction as a unified system which minimizes environmental damage through material innovation and architectural design. Practical and academic communities value modular construction due to its capabilities to sustain materials through time as well as its adaptability features and reduced onsite waste.

The Pakistani landscape displays positive indicators toward circulating economy development. The Telenor office in Islamabad provides an excellent demonstration of building certification achievement through circular construction standards. According to Ahmed (2023) Pakistan has elevated its use of low-carbon and alternative cement blends for new construction projects. These materials reduce both their environmental impact and help cut down resource consumption by using industrial by-products and recycled materials. The policy environment in Pakistan shows movement toward positive change besides technological advancements and material choices. The webinar highlighted the progress of two essential programs namely the Naya Pakistan Housing Program and the Green Building Code of 2023. The government demonstrates its dedication to bringing sustainability into the construction sector through these announced initiatives.

Interior Sindh experienced an exciting revival of traditional architectural styles during the webinar. Traditional practices utilize mud bricks and passive cooling features combined with local construction skills to show that ancient methods are sustainable by nature. The researchers Dams et al. (2021) demonstrate that circular construction does not need advanced technology since traditional low-tech building methods from the past have survived successfully.

Globally, countries like Singapore and Germany offer valuable lessons. Through their webinar the speakers explained that Singapore provides financial aid to green developers at the same time German FW Bank gives favorable loans for sustainable construction projects. Research carried out by Jayawardana et al. (2023) and Husgafvel & Sakaguchi (2023) confirms that financial approaches serve as vital enablers for circular construction transition. The examined international cases function as guidelines that Pakistan can adapt to develop its sustainable building framework.

Academic research and practical projects indicate that circular construction represents an actual method for creating smarter sustainable cities which also resist climate changes. Circular practices need complete alignment between modern technological frameworks with traditional practices and policy innovation as well as stakeholder development through training initiatives (such as the UNOPS' GHAR project) to become mainstream.

7.2 Climate Risks Facing the Built Environment

Climate-induced hazards are real-time events which transform the approach to infrastructure planning and maintenance together with construction activities. Panellists during the webinar demonstrated that heatwaves create difficulties for the energy system by increasing cooling demand while floods depart large-scale infrastructure damage and lengthen project timelines and escalate maintenance expenses. Academic research conducted by Borg et al. (2024) confirms as well as Nissanka et al. (2024) demonstrates that power grids along with roads and basic structures encounter overwhelming stress because of elevated temperatures and strengthened rainfall occurrences. Urban systems remain highly exposed to risks because people use water poorly according to Zięba et al. (2020) which makes water scarcity worse in quickly developing regions.

The situation becomes considerably more difficult to analyse through the dual perspective of urban development and waste management. The webinar participant Senator Sherry Rehman pointed out that Pakistani cities experience loaded sanitation systems because rapid urban growth increases waste buildup and strains the environment. Gibberd's (2020) analysis shows urban sustainability suffers at low-income dense areas because their poor sanitation systems worsen climate risks.

The National Adaptation Plan (NAP) serves as the key policy instrument targeted at guiding climate-smart urban planning under current circumstances. The NAP implements flood-resistant design methods while performing site-specific risk assessment combined with the adoption of the Energy Conservation Building Code (ECBC) 2023 to achieve comprehensive enhancement of urban resilience. Dr. Passive cooling technologies as well as energy-efficient building design receive enthusiastic support from Naveed Ahmad who backs up these recommendations with research from Ricciardi et al. (2025).

Urban construction stands out as an important topic at the webinar because it addresses water-efficient practices. The NAP endorses both rainwater collection systems and wastewater regeneration methods in construction which will decrease freshwater dependence in times of growing water scarcity. Research by Zięba et al. (2020) together with Gibberd (2020) confirms this direction because green building codes facilitate water-efficient landscaping to address sustainable urban water management under changing climatic conditions.

The webinar continuously emphasized the need for community-based solutions. The NAP promotes community-based disaster preparedness training as part of its design to acknowledge that technical flood control needs to integrate with social capabilities. The resilience of infrastructure systems receives reinforcement through community engagement according to literature from Goh et al. (2024) and Nissanka et al. (2024) specifically in disaster-prone and marginalized zones.

The construction and urban planning sectors face climate change as a fundamental operational challenge that exists right in front of them. Global and Pakistani infrastructure development needs a complete systems approach to combine policy structures and efficient design practices and community participation with innovative technology application. Future cities' resilience depends both on the power of materials and the flexible approaches of institutions and social attitudes that emerge from the unfolding climate crisis.

7.3 Barriers to Circular and Climate-Resilient Construction

During the webinar several fundamental obstacles emerged as obstacles blocking Pakistan from moving toward circular and climate-resistant construction. At the heart of the discussion was the understanding that while the urgency of climate action is clear, progress is constrained by systemic gaps in policy, practice, finance, and coordination.

One of the most pressing issues raised by the experts was the *lack of enabling policy and regulatory frameworks*. Currently, there is no dedicated national policy that prioritizes circularity or sustainability in the construction sector. While some green building codes exist, enforcement remains weak, and these codes often fail to incorporate core circular economy principles, such as material reuse or lifecycle assessments. The panellists emphasized that until sustainability becomes a legal and regulatory requirement, not just an option, industry practices are unlikely to shift. This aligns with findings in the literature, which highlight regulatory fragmentation as a common barrier in emerging economies (Borg et al., 2024; Ricciardi et al., 2025).

Equally concerning is the *limited technical capacity and lack of awareness* across the construction workforce. The sector maintains traditional construction practices which site workers have received from prior generations based on informal methods. Builders and design engineers fail to utilize sustainable building designs and energy-efficient materials and waste-minimizing techniques even though these solutions are available because their training falls short and there is no sufficient incentive to adopt them. A speaker indicated the existence of persistent knowledge barriers which affect learning at every stage from basic skills programs to engineering education. The study from Gibberd (2020) indicates that sites controlling by informal labor show marked lack of technical expertise in adopting innovation.

During the discussions *financial obstacles* presented a significant topic. The high initial expenses related to sustainable materials as well as green technologies discourage builders from implementing green construction methods. Builders maintain the use of conventional building methods since these methods appear cost-effective during the initial building phase. The webinar exposed the fact that the absence of financial incentives including tax rebates and subsidies, and concessional loans leads stakeholders to stick with traditional practices. Most stakeholders in the sector face challenges with accessing green financing options because such mechanisms including green bonds or sustainability-linked loans are either non-existent or hard to acquire. A similar point emerges in Nissanka et al.'s (2024) research about sustainable construction where financial innovation proves essential for expansion in this domain.

The systematic issue stems mainly from inadequate coordinated participation between stakeholders. Multiple presenters pointed out that government agencies together with private institutions and financial bodies and civil society organizations continue to operate in a dispersed manner. The establishment of public-private partnerships remains quite uncommon as they usually struggle from restricted project sizes and inadequate governance together with limited confidence among developers and investors. The webinar demanded the creation of collaborative platforms which enable stakeholders to work together for standard-setting and priority-setting and financial strategy formulation. The literature points out whole-of-sector approaches serve as the key requirement to defeat institutional silos because they create a unified circular construction vision according to Borg et al. (2024).

Guests at the webinar achieved comprehensive understanding about how obstacles stand in the way of resilient green building construction practices. The combination of policy hurdles and skill shortages and funding constraints and organizational collaboration problems makes up a compound set of issues which require combined stakeholder-based solutions. The solution to these problems needs urgent attention because it makes our built environments more resilient to the quickening effects of climate change.

7.4 Enabling Policy and Financing Environment

The webinar showed that Pakistan faces no obstacles in its circular and climate-resilient construction advancement because strategic reform implementation and financing support create the current gaps in progress. The National Adaptation Plan (NAP) offers high-level guidance about urban flood management but construction practices in the field operate with conventional methods before circularity reaches meaningful implementation.

The gathering established that Green Building Code 2023 and Energy Conservation Building Code (ECBC) 2023 serve as foundational resources. However, these frameworks lack enforcement power and practical application, rendering their impact minimal. Webinar speakers called for urgent reforms, specifically the integration of circular economy principles, such as design for disassembly, recycled content standards, and lifecycle costing, into building regulations. This perspective is echoed by Nissanka et al. (2024) and Rahul et al. (2025), who argue that codes must go beyond efficiency and embrace resilience and circularity in practice.

A major gap identified was the absence of a National Construction Waste Management Strategy. Stakeholders pointed out that without a coherent waste policy, opportunities to reuse demolition materials, reduce landfill pressure, and create green jobs in material recovery remain untapped. Aligning construction practices with Pakistan's Nationally Determined Contributions (NDCs) and Sustainable Development Goals (SDGs) was emphasized as a necessary step to embed sustainability across all levels of planning. Furthermore, the webinar also placed strong emphasis on financial incentives and disincentives. The speakers introduced tax breaks and green subsidies together with penalties for environmental construction practices to modify market activities. The panel presented Singapore and Germany as countries whose public financial instruments have rapidly promoted the adoption of green buildings.

The primary enabling factor behind green finance proved to be essential. The panel suggested that building climate-aligned construction should use green bonds together with sustainability-linked loans along with dedicated housing finance lines. The green financial system in Pakistan exists at a basic level due to limited development while most developers show limited knowledge regarding these financial options. The establishment of green building finance instruments requires simultaneous development of skills for banking organizations and real estate developers alongside regulatory institutions to implement and use these instruments. The panel concluded about public-private partnerships (PPPs) being essential for both innovation promotion and successful model scalability. A UNOPS-initiated GHAR Project served as a real-world example which illustrated sustainable housing outcomes that result from combined actions of public institutions with donor support together with private sector involvement. The project model included skills education programs and supply network assessments together with initial building work that researchers believe would work in different urban settings. Multiple stakeholders need to actively participate according to research findings that describe system-wide transformation (Rahul et al., 2025).

8. Cost-Benefit Analysis (CBA) for Circular Construction in Pakistan

The integration of circular construction practices in Pakistan presents a compelling case not only from an environmental and resilience perspective but also from a socio-economic and fiscal standpoint. A **Cost-Benefit Analysis (CBA)** was conducted to evaluate the economic viability of transitioning from a linear construction model to a circular one. This section outlines the methodology, assumptions, formulae, and resulting insights from this analysis.

The CBA was performed by identifying and monetizing both the **quantifiable benefits** and **associated costs** of adopting circular construction practices at scale. Benefits were derived from a combination of environmental, economic, and social gains, while costs reflected the investments necessary for policy reform, workforce development, and infrastructure for circularity.

Primary data was drawn from SDPI's stakeholder webinar (March 2025), while secondary estimates were based on global literature and successful case studies from Singapore, Germany, and UNOPS's GHAR Project. Assumptions were also guided by data from the World Bank, WHO, and Pakistan Bureau of Statistics.

Key benefits identified include:

- Reduction in landfill-bound Construction and Demolition (C&D) waste.
- Energy savings through passive and modular designs.
- Creation of green jobs in recycling and material recovery.
- Reduced import costs for construction materials.
- Lower public health costs due to pollution mitigation.
- Monetized carbon emission reductions based on global carbon pricing.

Costs primarily included initial investments in skills training, infrastructure development (like reverse logistics), and regulatory enforcement for circular building codes.

Formulae Used

Net Benefit = $\sum$ Annual Benefit - $\sum$ Annual Costs

Benefit-Cost Ratio (BCR):

$$\text{BCR} = \frac{\textit{Total Annual Benefits}}{\textit{Total Annual Costs}} = \frac{815}{200} = 4.08$$

A **BCR greater than 1.0** indicates a favourable return on investment. Here, a BCR of **4.08** demonstrates that every USD 1 invested would return **USD 4.08** in value to the economy and environment, underlining the economic feasibility of circular construction reforms.

Table 1: Cost-Benefit Analysis of Circular Construction in Pakistan.

Category	Estimated Annual Benefit (Million USD)	Estimated Annual Cost (Million USD)	Net Benefit (Million USD)
Reduction in C&D Waste (30%)	250	0	250
Energy Savings from Passive Design & Modular Construction	180	0	180
Job Creation in Recycling and Material Recovery	100	0	100
Savings from Reduced Material Import	120	0	120
Reduced Health Costs due to Pollution Reduction	75	0	75
GHG Emissions Reduction (Carbon Credit Potential)	90	0	90

Initial Investment in Training & Infrastructure	0	150	-150
Cost of Policy Reform & Regulation Enforcement	0	50	-50
Total	815	200	615

1. Interpretation

The net annual benefit of **USD 615 million**, alongside a **BCR of 4.08**, suggests strong economic justification for investing in circular construction systems. These findings indicate that adopting circularity not only advances climate and sustainability goals but also generates significant economic gains, reduces public sector burdens (health, waste management), and fosters inclusive green job creation.

This analysis provides a financial rationale to accompany the policy, institutional and technical reforms recommended throughout this brief. Going forward, detailed sectoral feasibility studies and localized pilot programs can further refine these estimates, supporting the upscaling of circular construction practices across Pakistan.

9. PESTEL Analysis:

To support evidence-based policymaking and assess the readiness of Pakistan's enabling environment for a transition toward circular and climate-resilient construction, a PESTEL (Political, Economic, Social, Technological, Environmental, and Legal) analysis has been undertaken. This structured framework allows for a holistic examination of the external factors—ranging from governance structures to financial instruments, technological capacity, and regulatory mandates—that influence the uptake and scalability of circular practices in the built environment. The analysis provides clarity on existing challenges and identifies key leverage points where targeted interventions can align national development goals with climate adaptation and sustainability imperatives. It draws upon insights generated from stakeholder consultations, cost-benefit evaluations, literature review, and international case studies to inform strategic and context-specific recommendations.

9.1. Political

Pakistan's construction sector currently lacks a dedicated national policy on circular construction. Although frameworks such as the Green Building Code 2023 and the Energy Conservation Building Code (ECBC) 2023 provide some direction, they remain limited in scope and are poorly enforced. These documents do not incorporate essential circular principles such as lifecycle design, resource recovery, or circular procurement. While broader climate strategies, such as the National Adaptation Plan (NAP), acknowledge the importance of resilient infrastructure, circularity is not explicitly addressed within their operational agendas. Furthermore, fragmented institutional mandates—spanning federal ministries, provincial departments, and regulatory bodies—impede coherent planning and implementation. However, the increasing frequency of extreme weather events, especially the 2022 floods, has brought urban resilience to the forefront of the political agenda, providing an opportunity to integrate circular construction practices into national development priorities.

9.2. Economic

The economic rationale for adopting circular construction in Pakistan is compelling. The cost-benefit analysis (CBA) presented in this brief estimates a benefit-cost ratio of 4.08, equivalent to a net annual gain of USD 615 million. These gains arise from reduced demand for virgin construction materials, lower waste management costs, improved energy efficiency, and job creation in the recycling and retrofitting sectors. Nevertheless, the shift to circular construction entails significant upfront investments in technical training, reverse logistics infrastructure, and innovation ecosystems. Financial constraints, especially for small and medium-sized enterprises (SMEs), are a critical barrier. Access to green financing instruments—such as sustainability-linked loans, concessional green bonds, or blended finance—is limited due to a lack of awareness, inadequate creditworthiness assessments, and the absence of enabling financial regulations in the construction sector.

9.3. Social

Circular construction can generate substantial social benefits, particularly for marginalized and climate-vulnerable communities. Design elements such as passive cooling, use of local materials, and disaster-resilient housing can directly enhance community wellbeing. However, widespread awareness and technical capacity to implement these practices remain lacking. Professionals across the construction value chain—including engineers, architects, and site contractors—often have limited exposure to circular economy principles or energy-efficient building techniques. At the same time, traditional knowledge and vernacular architecture, such as mud construction in Sindh or passive design in Gilgit-Baltistan, offer culturally relevant circular models but are underutilized. The integration of green skills training into vocational and technical education presents a significant opportunity to address the skills gap while improving employment outcomes for youth and women.

9.4. Technological

Pakistan's construction industry is under-equipped to leverage emerging technologies that support circularity. Tools such as Building Information Modelling (BIM), digital twins, and lifecycle assessment (LCA) systems remain underdeveloped or inaccessible to most stakeholders. The use of innovative building materials—such as recycled aggregates, fly ash cement, and modular pre-fabricated components—is largely limited to pilot projects and lacks commercialization pathways. The weak connection between research institutions and industry further constrains the localization of technological solutions. International examples such as Singapore's Green Mark system and Germany's material passports provide valuable models that could be adapted to Pakistan's context through innovation hubs and public-private partnerships. However, without structured incentives for R&D, certification, and technology diffusion, the sector will struggle to scale circular innovations.

9.5. Environmental

The environmental case for circular construction is urgent. The built environment is a major driver of environmental degradation in Pakistan, contributing significantly to GHG emissions, air and water pollution, and land degradation. Construction and demolition (C&D) waste alone accounts for more than 30% of urban solid waste. Circular construction offers viable mitigation pathways through the reuse of materials, design for disassembly, low-carbon material use, and water-saving systems such as greywater recycling and rainwater harvesting. These practices align with Pakistan's commitments under the Paris Agreement and support objectives outlined in the National Adaptation Plan, particularly in relation to flood control, water management, and thermal comfort. However, the lack of environmental impact assessments specific to circularity and the absence of material flow data limit policy and regulatory planning.

9.6. Legal

Legally, the regulatory framework governing the construction sector is outdated and ill-equipped to support a circular transition. While the ECBC 2023 and Green Building Code set standards, compliance is voluntary, and enforcement mechanisms are weak or non-existent. There is no national legislation for C&D waste management, nor are there regulations mandating the use of recycled materials or lifecycle cost assessments. Builders operate without clear standards or accountability for circular practices, and certification systems for green or resilient buildings remain underdeveloped. This legal ambiguity not only deters private investment but also makes it difficult for municipalities to mandate sustainability measures in public procurement. Legislative reforms are essential to create a binding framework that supports transparency, enforcement, and incentivization of circular construction.

This PESTEL analysis reveals that while the economic and environmental rationale for circular construction is strong, systemic bottlenecks in the political, technological, financial, and legal spheres constrain progress. The transition to circular construction in Pakistan requires a coordinated response that includes the development of a national policy framework, enforcement of green codes, creation of financial instruments, and investment in capacity building and innovation. If appropriately addressed, these reforms can position Pakistan's construction sector as a driver of both climate resilience and inclusive green growth.

10. Policy Recommendations

This section, based on expert discussions with academic literature alongside emerging practices from both Pakistan and global sources, presents operational policy recommendations which can promote circular and climate-resilient construction across Pakistan. The built environment worldwide requires Pakistan to abandon current conventional building methods because advanced sustainable approaches provide resilience and efficient material utilization. The recommendations stem from the webinar observations to provide practical solutions for addressing both regulatory gaps and capacity limitations and financial impediments and coordination issues in the architecture engineering and construction (AEC) sector.

1. Regulatory Reforms for Circular and Climate-Resilient Construction

- Enact a specific national policy which integrates circular economy principles of design for disassembly and material reuse and modular construction into regular construction standards.
- Include sector-specific targets specifically for the construction and demolition sectors to lower waste generation to between 25-30 percent in accordance with expert recommendations and worldwide excellence standards.
- Revise the *Green Building Code 2023* and *ECBC 2023* to include enforceable standards on lifecycle assessments, recycled material quotas, passive cooling requirements, and climate resilience benchmarks.
- Introduce mandatory certification systems for new urban developments.
- Develop and implement a unified strategy to manage C&D waste, focusing on recycling, material recovery facilities (MRFs), and green jobs.
- Mandate construction waste audits for major infrastructure projects.

2. Financial Incentives and Green Investment Mobilization

- Offer tax rebates, reduced import duties, and VAT exemptions on certified green construction materials and technologies (e.g., low-carbon cement, solar cooling systems).
- Subsidize retrofitting of existing buildings to meet circular design standards.
- Facilitate access to *green bonds*, *sustainability-linked loans*, and *climate finance* instruments through public-private partnerships.
- Encourage banks and microfinance institutions to develop specialized financial products for SMEs in the construction sector.
- Establish a fund under the Ministry of Climate Change or Housing to support circular pilot projects, research, and innovation in building technologies.

3. Technical Capacity Building and Workforce Development

- Partner with TVET institutions, engineering universities, and industry associations to develop curriculum and vocational training in sustainable construction.
- Include modules on passive design, lifecycle costing, modular building, and construction waste management.
- Provide grants and capacity-building support for the revival of vernacular architecture techniques, especially in climate-vulnerable rural areas.
- Create awareness campaigns for builders, architects, local authorities, and citizens on the benefits and practices of circular and resilient construction.

4. Institutional Coordination and Stakeholder Engagement

- Create a multi-stakeholder platform comprising government, private sector, academia, financial institutions, and civil society to drive coordination, monitor implementation, and align with NDCs and SDGs.
- Design PPP models that include incentives for green procurement, innovation hubs for circular materials, and private investment in resilient infrastructure.
- Empower local governments with technical guidelines, financial resources, and monitoring tools to enforce green building regulations and oversee waste management practices.

5. **Integration with Climate and Urban Policies**

- Ensure that all new infrastructure projects undergo climate risk assessments and include resilience features like flood-resistant design, rainwater harvesting, and energy-efficient systems.
- Update urban development plans to incorporate green infrastructure, climate buffer zones, and nature-based solutions (e.g., green roofs, permeable pavements).
- Require that building approvals consider localized climate risks, especially in flood-prone and water-stressed areas.
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6. **Research, Innovation, and Knowledge Sharing**

- Support R&D into low-carbon alternatives such as fly ash cement, recycled aggregates, bamboo, and local composites.
- Document case studies (like Telenor's green office), create open-source design toolkits, and share best practices from local and international contexts (e.g., Singapore, Germany).
- Implement robust M&E systems for circular construction pilots to derive lessons, refine policy tools, and demonstrate business cases for scale-up.

11. Conclusion and Way Forward

The adoption of circular and climate-resilient construction practices is no longer optional, it is essential for Pakistan's sustainable development in the face of growing environmental and urban challenges. The insights presented in this brief underscore that circular construction is both feasible and urgently needed. The enthusiasm and expertise demonstrated by stakeholders during the webinar reflect a clear appetite for change and innovation. However, realizing this vision will require overcoming entrenched policy, financial, and institutional barriers. While positive steps have been taken through existing policy instruments and demonstration projects, the current pace and scale of implementation are insufficient to meet the demands of a rapidly changing climate and urban landscape.

Going forward, a concerted and coordinated approach is essential. The government must take the lead in developing and enforcing a dedicated circular construction policy, updating existing codes to incorporate climate risk assessments and recycled material standards, and offering fiscal incentives for green building practices. Financial institutions and development partners should expand access to green finance instruments such as green bonds, sustainability-linked loans, and concessional credit lines for eco-friendly construction. The investment needs to focus on building human capital by implementing technical training and conducting awareness programs to teach circular economy concepts in engineering and vocational education. Multi-stakeholder platforms and partnerships like UNOPS GHAR Project should expand their scale to promote sectoral innovation dedicated to knowledge sharing between stakeholders.

To create Pakistan's construction sector into a resilient climate-based and environmentally steadfast structure requires both policy and investment changes alongside new thinking from all stakeholders. Through proper reforms and ongoing dedication Pakistan can pioneer a transformation of construction into a resource that builds sustainable development.

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