Assessment of the Circular Economy in Bangladesh's Buildings and Construction Sector

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Glossary and Acronyms

AAC	Autoclaved Aerated Concrete
ADP	Annual Development Programme
BAU	Business-as-usual
BBS	Bangladesh Bureau of Statistics
BDT	Bangladesh Taka
BEEER	Building Energy Efficiency and Environment Rating
BNBC	Bangladesh National Building Code
BSTI	Bangladesh Standards and Testing Institution
CBD	Central Business District
CDW	Construction and Demolition Waste
CFC	Chlorofluorocarbon
CO2	Carbon dioxide
CSEB	Compressed Stabilized Earth Block
DC	District Commissioner
DoE	Department of Environment
DMC	Domestic Material Consumption
DNCC	Dhaka North City Corporation
EIA	Environmental Impact Assessment
EPR	Extended Producer Responsibility
EU	European Union
FYP	Five-Year Plan
GHG	Greenhouse gas
GoB	Government of Bangladesh
HBRI	Housing and Building Research Institute
HCFC	Hydrochlorofluorocarbon
ICT	Information and Communication Technology
IDCOL	Infrastructure Development Company Limited
IGCRT	Institute of Glass and Ceramic Research and Testing
ILO	International Labour Organization
IMED	Implementation Monitoring and Evaluation Division
KDA	Khulna Development Authority
LBC	Living Building Challenge
LCA	Life Cycle Assessment
LDC	Least Developed Country
LEED	Leadership in Energy and Environmental Design
LGED	Local Government Engineering Department
MoF	Ministry of Finance
MoL	Ministry of Land

$MtCO_2e$	Metric tons of carbon dioxide equivalent
NAPA	National Adaptation Programme of Action
NDC	Nationally Determined Contributions
NDP	National Development Plan
O&M	Operation and Maintenance
PP	Perspective Plan of Bangladesh
PPP	Public Private Partnership
PWD	Public Works Department
R&D	Research and Development
RAJUK R	ajdhani Unnayan Katripakkha
SDG	Sustainable Development Goals
SLR	Sea Level Rise
SME	Small and Medium Enterprise
SREDA	Sustainable and Renewable Energy Development Authority
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UN-Habitat	United Nations Human Settlements Programme
UNOPS	United Nations Office for Project Services

Executive Summary

A circular economy aims to overcome the key global challenges, namely pollution, biodiversity loss and climate change by driving down planetary overshoot, reducing humanity's ecological footprint, boosting the Earth's biocapacity and minimizing pressure on the planetary boundaries. The building and construction sector has a considerable share of this impact, accounting for more than one third of all material consumption and the global waste produced. But with a significant gap between theory and national-level practice, this assessment aims to strengthen the national Government's capacity to measure, promote and advance the uptake of circularity principles in the buildings and construction policy and practices at the country level.

Low-income "build" countries like Bangladesh contribute only about 15.27 per cent to global carbon emissions. But firm economic growth and a simultaneous boom in the built environment sector also point to Bangladesh's tendency of becoming a much higher greenhouse gas (GHG) contributor in the coming years. In its Nationally Determined Contributions (NDCs), Bangladesh vowed to reduce 21.85 per cent of GHG emissions by 2030. However, these NDCs neither set any specific targets for its buildings and construction sector nor mention, specifically, its building and construction sector. But recently the Government and relevant stakeholders of the sector have agreed on a vision for a low-carbon, energy-efficient and inclusive building sector, adapted and resilient to climate change. Notwithstanding the triple planetary crisis of climate change, biodiversity loss, and pollution to which Bangladesh is also exposed, transitioning to a resource-efficient and circular economy hence appears as a vital strategy for its sustenance and growth.

In this lack of tangible action in the circular transition of the buildings and construction sector in Bangladesh, a circularity indicators framework has been developed to measure the current level of circularity at the national level. This project is supported by the Government of Finland and led by the Circular Built Environment Working Group within the Materials Hub of the Global Alliance for Buildings and Construction (GlobalABC). The project is co-led by the One Planet Network and the Life Cycle Initiative hosted by the United Nations Environment Programme (UNEP). By conducting research and developing methodologies and recommendations, this framework aims to support the Bangladeshi Government to accelerate the shift to circularity standards and practices in the buildings and construction sector at the national level, contributing to the Sustainable Development Goals (SDGs), the Paris Agreement on climate change, the implementation of Global Strategy for Sustainable Consumption and Production, and the extension of UNEP's GlobalABC framework.

The developed framework is designed to support a cross-section assessment of circularity in the buildings and construction sector with a holistic view and system thinking of life-cycle thinking, classified into five action areas defined by the GlobalABC. The action areas are (a) strategic priorities, (b) spatial and urban planning, (c) new buildings, (d) existing buildings, and (e) construction supply chain. Within the framework of the circular economy definition in the buildings and construction sector, the indicators are structured in a holistic analysis that aims to cover both the physical and enabling environment with specific quantitative and qualitative indicators. They focus on three categories: material and waste flow, environmental impacts, and economic and social aspects across the buildings and construction sector. The enabling environment consists of seven enabling domains: institutional arrangements; policies, laws and regulations; processes; stakeholders engagement; financial mechanisms and funding; knowledge and technical capacities; and data management and reporting. The projected outcomes of this framework include strengthening circular inputs across the buildings and construction chain, reducing virgin material extraction, increasing circular inputs, reducing non-renewable or non-circular materials

and inputs, circulating products and materials at their highest value possible, reducing waste, promoting circularity through the design process of the existing and new building stock, supporting an equitable and socially inclusive buildings and construction sector at a national level, and regenerating nature.

In this report, a national assessment framework has been used that helped to comprehend the baseline situation. It was found that emissions from the building sector fared low compared with global standards but demonstrate an increasing tendency. In the physical environment, challenges include low use of local organic materials, inadequate management of construction and demolition waste (CDW), widespread informality, unaffordability of housing, environmental pollution, and scarce innovation. Concerns remain with the gradual increase in all emission parameters, despite their current low score. Mainstreaming circularity principles in policy and legal documents, stakeholder knowledge and awareness, proper plan implementation, data availability, certification of low-carbon materials and market incentives have been the key concerns for the enabling environment. Ample opportunities remain in the form of good institutional and governance culture, the presence of policy and legal foundations, and an overwhelming quantity of unaccounted (informal) waste collection and recycling.

Introduction

Low-income "build" countries like Bangladesh currently contribute only about 15.27 per cent to the total carbon emission[1] with their average material footprint being 2.0 tons per person per year, compared with 26.3 tons per person annually of high-income nations.[2] But, Bangladesh's firm economic growth over the last decade (>6 per cent),[3] and a simultaneous boom in the built environment sector with a solid 8 per cent GDP contribution,[4] also point to its ever-impending tendency of becoming a much higher GHG contributor in the coming years. The built environment is one of the biggest global GHG emitters (37 per cent of total global energy-related carbon emissions)[5], and notwithstanding the triple planetary crisis of climate change, biodiversity loss, and pollution to which Bangladesh is exposed, transitioning to a resource-efficient and circular economy hence appears as a vital strategy for its sustenance. By adopting circularity principles in this sector, Bangladesh could actively pursue its ecological overshoot mitigation and warrant sustainability.

The circularity assessment framework aligns with the recently completed Bangladesh Country Roadmap supported by the UNEP's Global Alliance for Buildings and Construction (GlobalABC) initiative, developed through the partnership among UNEP, UN-Habitat and the United Nations Office for Project Services (UNOPS). This country roadmap follows the GlobalABC roadmap template, which is part of a collective effort of GlobalABC members and was developed within the framework of the UNEP's "Transforming the Built Environment through Sustainable Materials" project. This country roadmap emphasizes emission reduction (decarbonization) and improved resilience across building lifecycles, by setting short-, medium- and long-term targets. The roadmap is driven by four cross-cutting objectives: (1) zero embodied carbon; (2) zero operational carbon; (3) adaptation; and (4) well-being and inclusion.

This report will assess Bangladesh's current circular economy status, focusing on its (a) building material flows, production, usage and waste; (b) economic and social impact; and (c) environmental footprint of the buildings and construction sector through the baseline assessment of the mentioned action areas and their seven enabling domains. This assessment should support Bangladesh in accelerating its shift to circularity standards and practices in its buildings and construction sector, attain its NDCs (Paris Agreement on climate change), contribute to the Sustainable Development Goals (SDGs), implement the Global Strategy for Sustainable Consumption and Production, as well as expand and advance the GlobalABC framework.

Bangladesh: an overview

Bangladesh is a least developed (LDC) country, currently ranked 9th in the *WorldRiskIndex 2023*,[6] exposed to many natural hazards including floods, sea level rise, cyclones, landslides, droughts, coastal and river erosion, storm surges, heatwaves and earthquakes.[7] The country has suffered significantly from climate change, losing 11,450 lives and incurring economic losses of $3.7 billion due to 185 extreme weather events between 2000 and 2019.[8] Bangladesh is also the eighth most populous country in the world, nearing 173 million people amounting to 2.15 per cent of the global population.[9] Bangladesh has a tropical climate with a mild winter, a hot humid summer, and warm rainy monsoons. It is a low-lying riverine country. The mean elevation is 85m above sea level, with more than 60 per cent of the total landmass at less than 6m above sea level.[10] Despite its vulnerability to climate-induced disasters, Bangladesh has made significant progress in disaster risk reduction through intensive investment in institutional strengthening, poverty reduction, and an increase in community awareness.

Bangladesh's rapid urban development and building construction boom have generated concerns about energy efficiency, environmental impact and occupant well-being. Despite the introduction of relevant policies, other elements are still scarce, especially funding, technical capacity and data management. The extensive focus on new construction overshadows retrofitting possibilities of existing buildings, causing more embodied carbon emissions. Embodied carbon emissions from construction materials, especially bricks and concrete, are also rising alongside operational carbon emissions from energy use in buildings. Many buildings remain vulnerable to natural hazards owing to non-compliance with building codes and the use of substandard materials. Bangladesh's construction sector still relies heavily on high-carbon materials (e.g. cement, brick), with little innovation in sustainable alternatives. Challenges include supply chain vulnerabilities due to climate hazards, political issues, and violations of workers' rights. While the implemented policies aim to promote sustainability, resilience and equity, weak enforcement persists alongside widespread informality. Research and development on low-carbon materials is limited, and traditional sustainable practices are disappearing. The ever-growing demand for construction materials now risks depletion of non-renewable resources, exacerbating environmental concerns.

In its NDCs, Bangladesh vowed to reduce 21.85 per cent of GHG emissions by 2030, although these NDCs do not set any target for the buildings and construction sector, nor mention the construction supply chain. During a recent (2024) consultation for the GlobalABC roadmap preparation, the Government and stakeholders of the buildings and construction sector outlined a vision for a low-carbon, energy-efficient and inclusive building stock. They aim for it to be adapted and resilient to shocks and impacts of climate change. To this end, the Government has agreed to integrate these targets with long-term commitments to reduce household emissions by 50 per cent by 2050 and enforce a ban on HCFCs by 2035.

Methodology

The methodological framework is designed to support a cross-section assessment of circularity in the buildings and construction sector with a holistic view and system approach as in life-cycle thinking (see figure 1), classified into five action areas [11]defined by the GlobalABC. Within the framework of the circular economy definition in the buildings and construction sector, the indicators are structured in a holistic analysis that aims to cover both "physical environment" with specific quantitative and qualitative indicators to deal with the three categories (material and waste flow, environmental impacts, and economic and social aspects across the buildings and construction sector) and the "enabling environment", consistent of seven enabling domains (see figure 2).

The outcomes of this framework include (a) strengthening of circular inputs across the buildings and construction chain; (b) reducing virgin material extraction - increasing circular inputs; (c) reducing non-renewable or non-circular materials and inputs; (d) circulating products and materials at their highest value possible; (e) reducing waste; (f) promoting circularity through the design process of the existing and new building stock; (g) supporting an equitable and socially inclusive buildings and construction sector at a national level; and (h) regenerating nature.

1. Institutional arrangements: looks at the formal and informal divisions of power and responsibilities between public institutions and private organizations for the efficient coordination of building sector activities.

2. Policies, laws and regulations: explores how policies, laws, and regulations govern building programmes. In particular, it looks at (1) how policies, laws, and regulations are defined; (2) how they are implemented; (3) how they align with upstream and downstream policies; and (4) whether they are suitable policies, laws and regulations.

3. Processes: underscores the processes institutions use to make decisions (e.g. new policy or law) or undertake a specific action (e.g. build a new school) and the activities leading up to the decisions and actions.

4. Stakeholders engagement: analyses how the different stakeholders are engaged in processes and if their specific needs are considered. More specifically, it looks at marginalized communities, women, non-governmental organizations, and civil societies.

5. Financial mechanisms and funding: highlights both (1) the capacity to budget, allocate, and adequately spend resources, as well as (2) the capacity to secure funds for building projects through external funding or revenue collection.

6. Knowledge and technical capacities: explores the human and technical capacities necessary to plan, deliver and manage circular buildings. It includes the ability of governments and the private sector to use and develop the proper knowledge, people and technologies. It also includes the availability of existing resources and skills that are appropriate for the tasks at hand.

7. Data management and reporting: looks at how data are managed, including their collection (frequency, desegregation level), analysis, dissemination, and integration into evidence-based planning, as well as the technologies enabling these tasks. It also identifies reporting mechanisms, ensuring that governments are accountable.

Figure 1: The GlobalABC action areas and life-cycle framework with circular economy principles

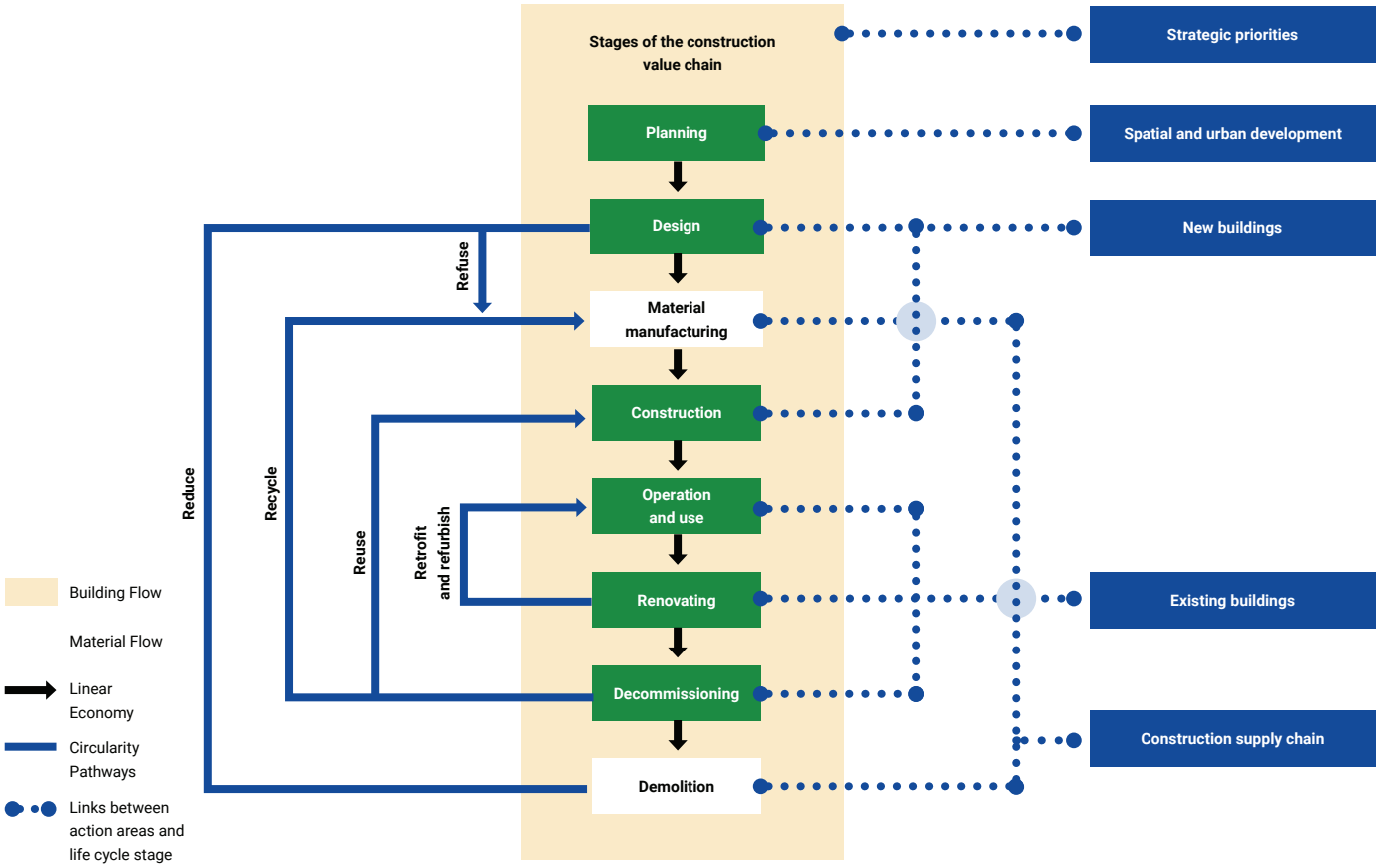
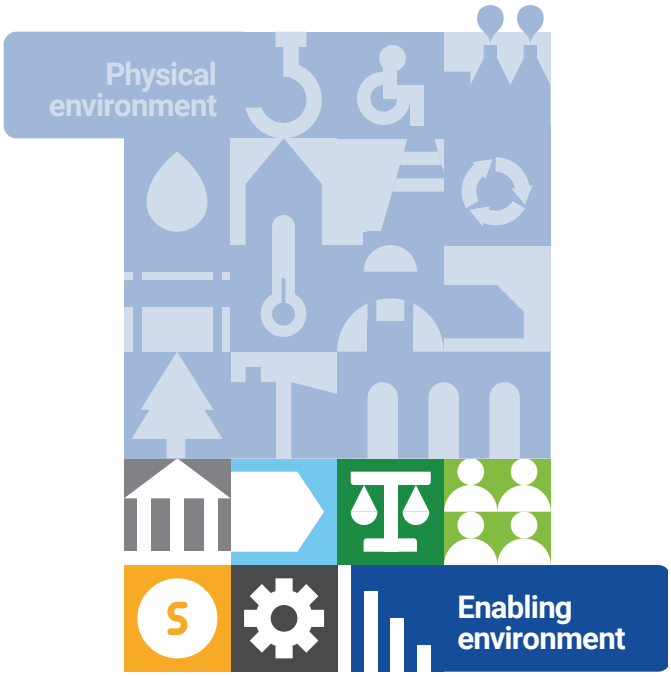


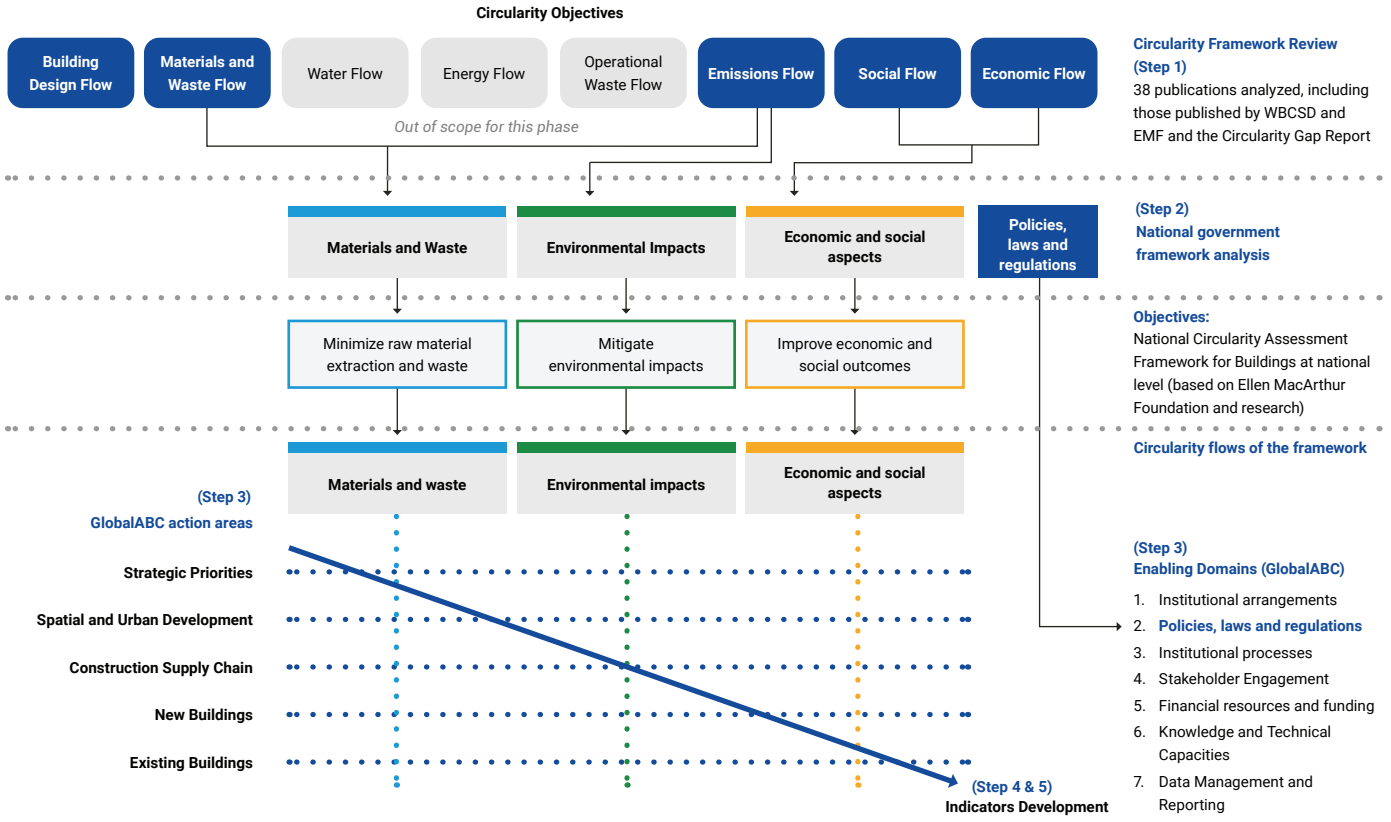
Figure 2:The GlobalABC seven enabling domains



The five action areas and the physical and enabling domains were defined and validated by the GlobalABC international network of experts in 2023. Taken as the foundation on which the circularity framework builds, the next step was to identify the specific objectives of the circularity assessment, with a focus on the materials supply chain and the building life-cycle assessment.

The objectives of the Circularity Indicators Framework are initially based on three design-driven principles defined by the Ellen MacArthur Foundation[12] and further defined and ratified by the International Advisory Group. These are (1) eliminate waste and pollution; (2) circulate products and materials (at their highest value); and (3) regenerate nature.

Figure 3: Methodology overview



Following the methodology outlined in figure 3, the five steps include:

1. An initial mapping of potential indicators where an exhaustive list of 38 publications, reports and indicators framework were reviewed.

2. Three flows of the framework are summarised based on this mapping outcome: materials and waste; environmental impacts; and economic and social aspects. The design flow is considered and included in the GlobalABC action area of "new buildings" and "existing buildings". The policies and processes are incorporated into the enabling domain of "policies and regulations". As this framework focuses on a national level, the flows related to the operational stage fall outside its scope, such as water and energy flow, and operational waste.

3. In line with the outcomes of the circularity and three flows summarised, three corresponding objectives are identified and applied to the indicators' further development.

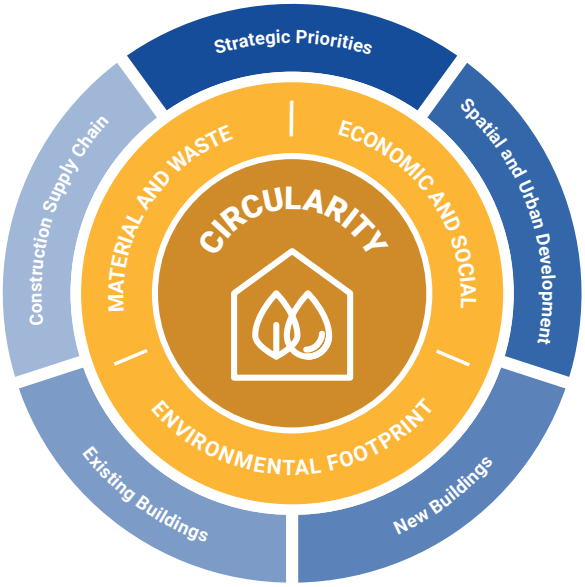
4. Across three flows and categories, the interaction between three objectives and GlobalABC's five action areas form the quantitative indicators list. Adding the enabling domains, the qualitative indicators are structured and formalised.

5. The indicators are classified into "mandatory" and "optional," considering the varying status of the building and construction sector globally (the "shift", "build" and "grow" economies1[3]). This approach ensures alignment with the SDG principle of *"Leaving No One Behind."*

6. After two rounds of consultations and a piloting process online and in person with about 50 international advisory groups were conducted to finalise the framework and mapping of indicators.

As a result, the indicators in this framework measure a country's current circular economy status. It remains focused on its material and waste, economic and social aspects, and environmental impacts in the buildings and construction sector, structured through the five action areas and seven enabling domains. In addition, the indicators are aimed at providing a means to evaluate progress from future iterations of this assessment from quantitative and qualitative perspectives (see figure 4).

Figure 4: The circularity indicators framework



Strategic priorities

The strategic priorities action area refers to the definition of vision, orientations, goals and targets and how they are formalised into strategic documents (e.g. a national development plan), prioritised and implemented by Government entities and the private sector. Setting strategic priorities for a more circular economy in the buildings and construction sector can support the transition across the supply chain.

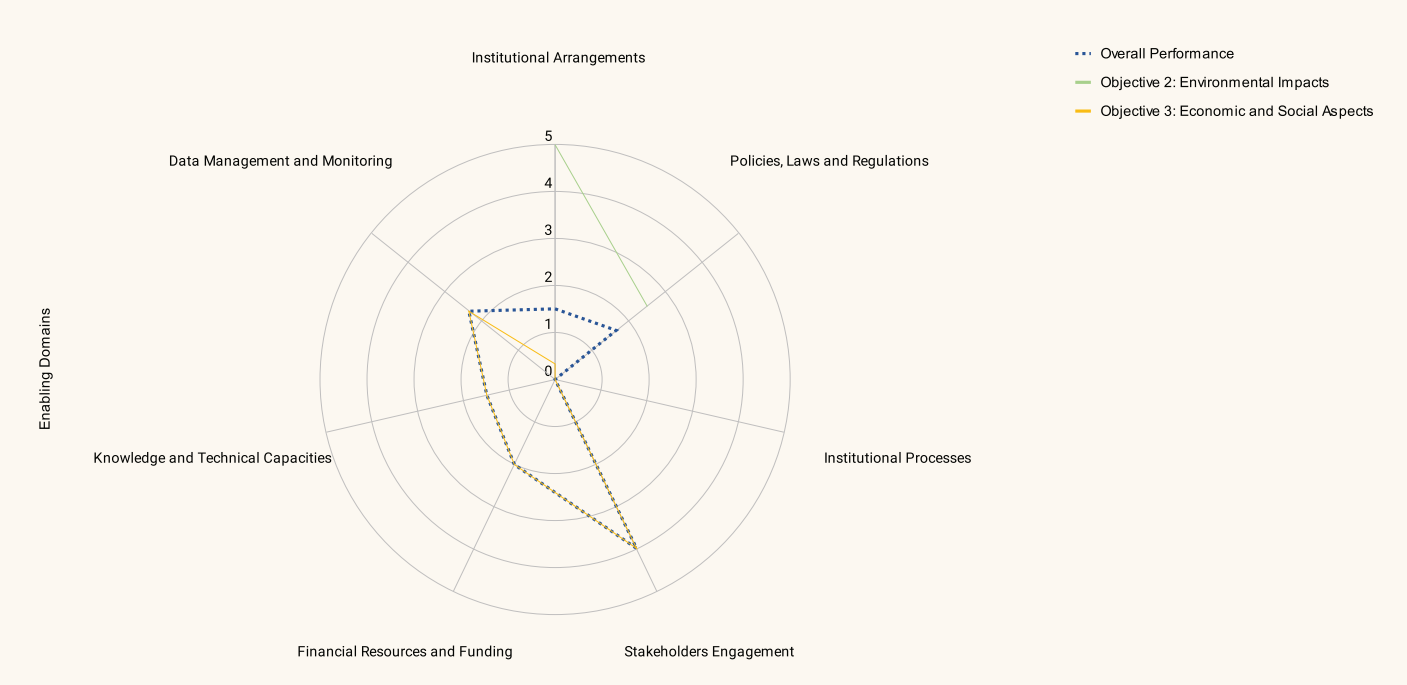
The enabling environment

Figure 5, based on a qualitative assessment, highlights a very-low presence of circular economy principles in the overall national strategic plans and specifically in the buildings construction sector. This negatively impacts the relevant institutional processes (e.g. circular transition of employment), making it the weakest. It also affects institutional arrangements (especially in terms of clearly designated institutions and their responsibilities and institutional coordination) and the formulation of relevant policies, laws and regulations. This is accompanied by limited knowledge and technical capacities of public servants (due to their unfamiliarity with circularity principles), unavailable public information, inadequate awareness, low research and innovation capacity, a lack of dedicated resources for finance, and weak data availability as well as data collection mechanisms for making informed decisions. The stakeholder engagement scenario returns with the highest score.

Institutional arrangements

There are not any institutions in Bangladesh that focus on the circular economy and the construction sector. However, the Ministry of Environment, Forest and Climate Change has increased its efforts towards emission reduction, alongside relevant policies like 3R

Figure 5 : State of Strategic Priorities in Bangladesh's building and construction sector in 2024



Strategy 2010 and Solid Waste Management Rules 2021 that have sporadically focused on certain elements of circularity. The Nationally Determined Contributions of 2021 also outline mitigation targets, although lacking any specific targets for the buildings and construction sector. Many of the targets are set under industry, namely: brick and cement production, energy efficiency in households, water treatment and municipal waste management. Overall, the lack of circular economy goals for the buildings and construction sector leads to the non-existence of any coordination mechanism for the sector. However, the Secretariat Instructions 2014 functions well in ministry-level institutional coordination and inclusive policy formulation. Additionally, local-level institutional arrangements for implementation can be used for the buildings and construction sector's coordination.

Policies, laws and regulations

There is not a national strategy, goal or policy on the circular economy, especially in the buildings and construction sector. Although not significant, BNBC 2020 has, for the first time, set standards for energy efficiency, low-carbon footprint and green building practices. Some circularity principles like adaptive reuse and emission have been included. Moreover, without any commitment to nature and biodiversity, there is a target that by 2030 tree coverage be expanded from 22.37 per cent to 25 per cent of total land area, forest coverage from 14.1 per cent to 16 per cent, and that river bank erosion be reduced to 100 ha annually covering 100 km2 area.

Institutional processes

The lack of policies and programmes to upskill current workers in the buildings and construction sector is hindering workers' transition to green jobs.

Stakeholder engagement

Although local governments are not presently involved in shaping the national priorities or objectives of the circular economy, at the city corporation level, climate adaptation plans like the National Adaptation Programme of Action and the Bangladesh Climate Change Strategy and Action Plan are used in the preparation of development project pro forma proposals, often required by donors (like the Climate Change Adaptation Urban Development and Water As Leverage projects in Khulna). Formal mechanisms (e.g. policies) exist for stakeholder engagement in national plans, including NDCs, SDGs and climate change-related plans.

Financial resources and funding

There is no specific fund for the circular economy. However, the two relevant incentives presently available are Bangladesh Bank's Green and Sustainable Finance Policy 2012, and subsidized loans for renewable energy, installation of solar home systems, biogas systems and improved cookstoves by IDCOL using the Green Climate Fund. Private sector financing is not yet available, except for the little received from donors. However, the Government allocates funds to its research institutes (Housing and Building Research Institute or HBRI, Bangladesh Standards and Testing Institute or BSTI) and universities to innovate low-carbon materials and technologies, and recycling.

Knowledge and technical capacities

Although there are currently not any personnel with circular economy specialization within the national government's buildings and construction structure, the Ministry of Environment, Forest and Climate Change provides training on issues related to climate change (adaptation), nature-based solutions, the green economy, alternative eco-friendly building materials. Similarly, capacity-building training on climate change (adaptation) and SDGs takes place regularly within the Local Government Engineering Department (LGED). The sector lacks a data and information-sharing platform. Most building and construction sector personnel lack awareness, logistics and technological support. In terms of research and innovation, organizations like HBRI are involved in international collaborative and ADP-funded research programmes, despite innovations being few.

Data management and reporting

Except for some digitally accessible data collected by the Bangladesh Bureau of Statistics (BBS) in their housing survey, there is no useful resource on this sector available. The bureau does not collect data on carbon emission. Building data is presented in terms of type, size and technology. However, data related to circularity and building materials are unavailable. Digital data are in portable document format (pdf) and found mostly through basic search engines. However, tracking data remains unavailable.

Challenges and opportunities

nb.	Challenges	Description	Enabling Domain
1	Gross absence of circular economy principles in national thinking	Policy documents like Perspective Plan, Five-Year Plan etc towards achieving NDCs lack circularity focus	1. Institutional arrangements 2. Policies, laws and regulations
2	Absence of circularity-focused visions, policies, rules and laws for the building construction sector	Lack of recognition of the building construction sector's role and potential in carbon emission	2. Policies, laws and regulations
3	Lack of data on the construction supply chain	This includes extraction, production, construction, renovation, reuse, and construction and demolition waste generation in national databases like the BBS	7. Data management and reporting
nb.	**Opportunities**	**Description**	**Enabling Domain**
1	National documents and plans (NDPs) having green and climate change components and commitments	NDCs and building codes (BNBC) can be updated with circular economy principles focusing on the building and construction sector	2. Policies, laws and regulations
2	Municipal culture of adhering to NDPs	The circularity principles in the NDPs should trickle down and translate into municipal plans, rules and laws, and facilitate implementation and actions in attaining NDCs	2. Policies, laws and regulations 4. Stakeholder engagement
3	Stakeholder engagement in policy formulation and planning practices	Highlights the positive culture of involving relevant stakeholders in the institutional processes	4. Stakeholder engagement
4	Some research and development budget is allocated, and research and innovation are presently (sporadically) practised	Additional dedicated funding and creation or strengthening of building construction-focused research agencies should improve research and innovation capacity-building, produce data and make them digitally available	5. Financial resources and funding 7. Data management and reporting
5	Make data and documents digitally accessible		

Spatial and urban development

Spatial and urban development refers to the planning and organization of physical space within a country or an area. The spatial and urban development action area focuses on how spatial and urban development influence the buildings and construction sector, the use and flow of construction materials and waste, and its broader environmental impacts, while striving to provide adequate housing for all.

The physical environment

The physical environment assessment aims to establish a current state understanding of the interactions and influence of spatial and urban development on the principles of the circular economy.

Urban population density

According to BBS, Bangladesh's urban residents in 2022 accounted for 31.5 per cent of the nation's entire population,[14] although, World Bank estimated this to be about 40 per cent[15]. However, another recent study shows the urban population has already reached 42 per cent by 2024.[16] Of the 12 city corporations, the highest population is found in Dhaka North (5,979,537) and the lowest in Barishal (419,351). The most densely populated among these is Dhaka South (39,353 person/km^2), while the least is Rangpur (3,444 person/km^2).[17] When based on the 2022 urban population (52,009,072) and the Bangladesh Institute of Planners (BIP) estimated land area of 14,700 km^2,[18] the overall national urban density is calculated at 3,538 person/km^2. Looking at the much higher density of a few city corporations (above 9,500 person/km^2), it is assumed that population density in smaller urban centres is significantly lower.

The upward urban population trend (75 per cent increase between 2011 and 2022 census [19]) somewhat conforms to the overall global trend towards 2050,[20] but shows a lower overall density compared with similar lower-middle-income nations (about 7,200 person/km^2)[21]. Despite showing disparate land area figures (BBS and World Bank),[22] they all indicate an overall low-density (and possibly sprawling) development for almost all urban areas in Bangladesh and a significantly higher population concentration in very few larger cities (especially city corporations). While this large concentration manifests a challenge for urban management in those few cities, it simultaneously shows opportunities for circularity, voiced previously by eminent urbanists[23]. A reduced carbon footprint and emissions could be achieved with well-managed density supported by non-sprawling, innovative, high-density and low-rise developments.

Percentage of derelict and vacant urban land

Nationwide data on derelict and vacant urban land is scarce. However, three snippets from three cities and their extended urban regions on their land use and land cover change provide a representative picture of the amount of derelict and vacant urban land for 2020. For Dhaka, it is calculated to be a scant 1.9 per cent of the total urban area,[24] while for Gazipur, peripheral to Dhaka that serves more like a satellite city, it remains at 14 per cent.[25] On the other hand, in the smaller city of Khulna, the total quantity of vacant land is calculated at 15.4 per cent. In all three cities, a decreasing trend of vacant and derelict land has been noticed.

When compared, Dhaka shows the almost non-existence of any vacant land, while the other two, despite their declining trend, show some availability of vacant land. Considering the smaller cities like Khulna and Gazipur, and their future urbanization potential, brownfield redevelopment integrated with circular economy principles could hence be a useful approach to sustainable development. Tackling economic and environmental challenges could revitalize derelict urban land through innovative and resource-efficient approaches. Brownfield recycling, development of more compact city strategies, development of closed-loop systems, and urban regeneration approaches could act

as key opportunities that could reduce the need for new construction projects, make use of existing sites and resources and use recycled materials.

Ratio of land consumption to population growth rate

The ratio of land consumption to population growth rate in Bangladesh for 2019 was 1.15, while for 2020 it decreased to 0.71.[26] While <1 indicates that the rate of population growth is greater than the rate of land being used, suggesting a more efficient use of land per capita (as in Dhaka/RAJUK area), more compact settlements and avoidance of sprawls, in principle, >1 indicates a greater rate of land consumption against population growth, probably in the smaller and less dense urban centres. In other words, the latter indicates land being consumed faster than population increase, which can be viewed as a less efficient land consumption to accommodate the changing population, often described as low density or urban sprawl. However, the overall decrease from 1.15 to 0.71 indicates an overall positive land consumption trend through a higher achieved density and more utilized (vacant) space.

From a circular economy perspective, it is important to ensure the most efficient land use to meet people's present aspirations, notwithstanding the future needs. For a land-scarce country like Bangladesh, more efficient land use can be achieved by keeping the land consumption trend low, and by increasing the use of vacant land, especially in its smaller urban centres. By adhering to the sustainable density standards suggested by UN-Habitat, which are compact, moderate-, or high-density development, more people can live within the present urban footprints. Approaches like "Planned City Infill" can be an effective way to decrease the higher consumption ratio, especially in these smaller urban centres. New expansion should be kept to a minimum, while inefficient land use and leapfrogs that generate wasteful areas should be avoided. [27]

Share of urban population living in informal settlements

According to 2022 BBS data, more than 1.8 million people (or about 1.1 per cent of the entire population) in Bangladesh live in slums and informal settlements.[28] According to Bangladesh's SDG tracker[29] and the World Bank,[30] this number is significantly higher (30 per cent and 52 per cent, respectively). As per the same World Bank source on the global average for lower-middle income countries, these latter numbers are also about 17 per cent and 7 per cent higher.

These, however, indicate the overall informal socio-environmental condition of the urban poor and the sheer magnitude of the informal housing problems in Bangladesh. The circular economy principles can be used as an opportunity to solve the twofold challenge of housing affordability and sustainability. Informal settlements, which employ core circular economy principles of recycling, indexing and reusing, also often remain engaged in CDW management and businesses. Considering these two, circular economy principles could be effectively used in slum upgrading, leading to housing affordability[31] and thus demonstrating an alternative pathway towards adequate housing. This approach should minimize environmental impact and improve circularity by recycling a significant amount of waste generated by the linear economy's construction activities. Ample scopes remain within urban planning to determine the permitted degree of formalization that would support circularity. Skill and awareness development activities on circularity principles and their possible contribution to adequate housing could be integrated with ongoing slum upgrading works, for example those by UNDP and the Bangladesh Rehabilitation Assistance Committee, and necessary infrastructure may be provisioned.

The enabling environment

At the level of spatial planning, despite the lack of focus on and linkage with circular economy principles, some strong policies, laws and regulations persist, especially in the areas of zoning ordinance, and nature and biodiversity conservation. However, the areas requiring

critical improvement include implementation and monitoring resources, inter-organizational coordination, informality (including informal housing, building construction, and waste management), and institutional processes and arrangements. This analysis also concludes that the overall level of data availability is also low, alongside the lack of financial resource provisioning and funding (e.g. for incentivising refurbishment, reuse, or recuperation of buildings and brownfield areas; see figure 6).

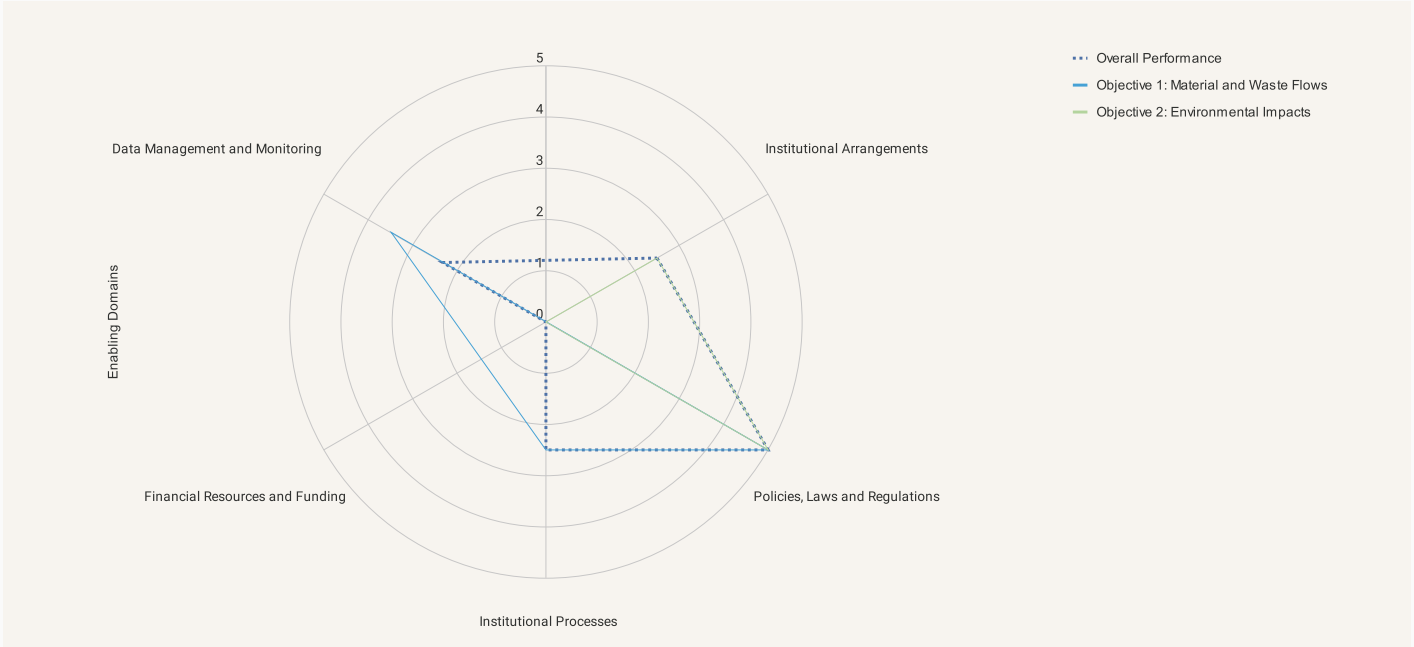
Institutional arrangements

There is no dedicated entity for the application of circularity principles in urban planning. The Draft Urban and Regional Planning Act of 2014 does not outline it, either. Planning and development control agencies (like RAJUK) are also unaware. City corporations and *Pourashavas* are key bodies for conducting informal settlement upgrading programmes, supported by the Local Government Engineering Department and financed by donors. Other bodies involved are the Department of Public Health Engineering and international non-governmental organizations.

Policies, laws and regulations

The present shift from master planning to strategic and detailed area planning allows a certain degree of flexibility in land use. There are also official processes to request use change in buildings, supported by planning agency-specific acts (e.g. KDA Act 2018). The Antiquities Act 1968 provides a framework for safeguarding structures and conserving architectural heritage, although it requires updating as it does not speak much of urban heritage. The Department of Archaeology, the custodian of this act, lacks resources for effective planning and monitoring of architectural heritage. The newly implemented Bangladesh National Building Code (BNBC) 2020, however, has specific guidelines and promotes adaptive reuse (as in the case of heritage buildings). In terms of nature and biodiversity

Figure 6: State of spatial and urban development in Bangladesh's buildings and construction sector in 2024



conservation, the recently published Dhaka Detailed Area Plan (DAP) 2022–2035 and similar documents highlight their worth. However, it lacks practicality and instruments for implementation.

Institutional processes

Urban planning practices follow a land-use zoning-based methodology and a clear decision-making process. But, without any regional planning and their integration with urban (municipal) planning, raw material extraction sites (located in remote rural areas) often remain outside the discretion of planning. Departments like Roads and Highways with their regional plans (e.g. road projects) show weak coordination with urban planning agencies like RAJUK. However, a national trend has become apparent toward creating more green-blue spaces in cities, as seen in the Dhaka DAP 2022–35, the Climate Change Adaptation Urban Development Project in Khulna and the Rajshahi City Beautification project.

Financial resources and funding

The recently published Dhaka DAP 2022–35 provides incentives (e.g. additional floor area ratio) for transit-oriented development, transfer of development right, and the block development approaches. There are not any national incentives for spatial and urban planning for the refurbishment, reuse (e.g. functional transformation), or recuperation of brownfields or neighbourhoods and urban or rural areas. BNBC 2020 acknowledges the significance of incentives but does not offer any.

Data management and reporting

In most cases, informal settlements and building footprints indicated in land-use maps and geographic information data sets are shown under the residential land-use category. When squatters of public land are mapped, the original landowner's name (mostly public agencies like Bangladesh Railways) is provided. Typically, DAP and master plan documents are accessible for free, often on concerned planning agency websites in PDF format. However, often, websites are hardly updated and documents are unsystematically presented. Data on protected areas are often incorporated into digital maps or geographic information data sets. However, these maps are often of very low resolution and are difficult to use.

Challenges and opportunities

nb.	Challenges	Description	Enabling Domain
1	Inadequate translation of circularity principles into urban and land-use planning policy, rules, laws and practices	Without any specific national discourse on circularity, this concept remains unharnessed and unexplored at the urban planning level. This translates into non-responsive building codes	1. Institutional arrangement
2	Weak urban planning	Despite the availability of DAPs and master plans in many urban centres, their weak monitoring and execution remain scarce due to resource scarcity Underutilized and vacant land, sprawled growth, absent regional planning (that does not address sites of extraction and pollution) and widespread informality are problematic for urban plan-making and planning	2. Policies, laws and regulations 3. Institutional processes
nb.	**Opportunities**	**Description**	**Enabling Domain**
1	Compact urban development	More density can be achieved by efficient land use, especially in smaller urban centres using approaches like “Planned City Infill”	1. Institutional arrangement 2. Policies, laws and regulations
2	Urban redevelopment	Urban planning can promote all sorts of reuse of current sites and buildings through various (brownfield) regeneration and revitalization schemes	2. Policies, laws and regulations 5. Financial resources and funding
3	Informality	This can promote the reuse and recycling of construction and demolition waste in informal housing and settlement upgrading; recycling will lead to housing affordability and adequacy, and increased economic opportunity	2. Policies, laws and regulations 3. Institutional processes 5. Financial resources and funding

Existing buildings

The existing buildings action area refers to Bangladesh's current building stock. This action area focuses on existing building management, maintenance, renovation, decommissioning and recycling, as well as actions to reduce carbon emissions and increase climate adaptation while fostering well-being and inclusion.

The physical environment

The physical environment assessment aims to establish the current understanding of Bangladesh's building stock from a circular economy perspective, across materials and waste, broader environmental impacts and social and economic aspects.

Ratio of renovations and repairs over demolished buildings

Despite having legal requirements to seek prior approval, renovations and demolitions are carried out informally in Bangladesh. Therefore, the number of permits for renovation and demolition is not available, nor is any comprehensive data on the construction sector. However, based on BBS,[32] and scholarly sources,[33] costs associated with renovation and demolition in Dhaka during 2016–2017 have been estimated. While the building maintenance cost in Dhaka is calculated as BDT 20,789 million ($174 million), which is 33 per cent of a total maintenance cost of BDT 62,998 million ($528 million),[34] the demolition cost is calculated as BDT 2,695 million ($23 million).[35]

Comparing the maintenance cost with that for demolition provides a ratio significantly higher than 1 (>1), indicating that the general tendency leans more towards renovation than demolition in a given year. This is indeed desirable in a circular economy, as it indicates that existing buildings are being retained and utilized, although many are demolished. In Dhaka and elsewhere in Bangladesh, the key factors considered for demolition are (a) the age of buildings, and (b) the need for retrofitting low-quality or badly designed buildings.

The above information, without specific data, needs to be viewed as a fairly unproven assumption. Instead, this should be treated as proxy data with understandable limitations. These limitations include the high percentage of informal construction that has not been considered. At the same time, in view of the lack of demolition and renovation data, analysing this trend further, with more comprehensive (nationwide) data, could provide more insightful information.

Ratio of buildings demolished over new buildings

This data is unavailable. However, a calculation based on the amount of waste from new building construction and demolition generated from floor area construction in Dhaka in 2016 shows that building construction outweighs building demolition by almost three times. Against the 792,569 square meters of floor area demolished in 2016, the floor area built was 2.33 million square meters.[36] This indicates that there are more construction activities than demolition. This, however, is data from Dhaka city only. Nevertheless, considering the positive growth trend from the overall construction sector over 2016–2022,[37] it can be inferred that there is also a general growth in the built environment (new buildings).

As in the case of the above indicator, the demolition and construction numbers have been calculated based on demolition waste and unaccounted-for informal construction. At the same time, given the lack of demolition and new construction data, further analysis of this trend using more comprehensive national data could provide more insightful information.

Construction and demolition waste generated per capita

Construction and demolition waste (CDW) constitutes at least 30 per cent of the total solid waste generation due to large-scale construction and demolition activities in Bangladesh.[38,39] Considering the 2019 urban population of Bangladesh as 61,911,343[40]and the 7,500,000 kg CDW generated during this time,[41] the waste generation rate is calculated at 0.12 kg/person/day. This quantity, when

compared with Dhaka North's CDW generation scenario (includes the most affluent areas of Bangladesh and understandably higher than the national average), is about half of 0.22kg/person/day from 2019 to 2020.[42] In either case, this quantity is still significantly lower than the global average of 1.68 kg/person/day calculated in 2018 [43]and similar to 0.2 kg, 0.15 kg, 0.15 kg and 0.15 kg generated by less affluent European Union nations like Cyprus, Greece, Poland and Romania, respectively (2012 data). [44]

Share of construction and demolition waste collected, managed in controlled facilities

The Government's statistical documents (e.g. BBS yearbook, municipal surveys) seem to collect no data on the CDW component. There is no dedicated category for CDW and construction waste in its recent publications [45] despite identifying 11 other components. Municipalities in Bangladesh, in total, generated 7,199,224 tons of MSW in 2019–2020, which, applying the 30 per cent rule used earlier, helps calculate the total amount of CDW generation as 2,159,767 tons.

Furthermore, owing to the predominantly informal nature of CDW collection and recycling, controlled facilities are not common in Bangladesh. Only about 2.23 per cent of total solid waste was collected in controlled facilities in 2019–20,[46] which, for CDW, should be about 0.8 per cent. However, in the city corporations (metropolitan cities) and larger Pourashavas (non-metropolitan municipalities), the concerned bodies collect solid waste. However, it is mostly the non-construction demolition portion of the waste that municipalities collect, while most of the CDW is managed at the site informally and disposed of or recycled by the building owner in nearby vacant areas, water bodies, roadsides and landfills.

Share of vacant buildings

Comprehensive data on the vacancy in the overall building sector is unavailable. Therefore, this analysis is based on partial data from two sectors only (private and public commercial buildings, and private housing and flats) and gives only a glimpse of an overall vacancy scenario. About 59 per cent floor area (about 71,800m2) of public technology park buildings was found vacant, out of a total of 121,985m2 built between 2015 and 2021.[47] Similarly, despite depicting the post-COVID scenario, private commercial high rises in Dhaka's Central Business District areas showed a very high (about 70 per cent) vacancy rate.[48] In the housing sector, about 30 per cent of flats (i.e. apartments) remain unsold; out of 15,000 flats, about 5,000 were unsold in 2022–2023. [49] Considering the average size of flats to be about 120m2, this accounts for about 600,000m^2.

All three scenarios indicate the existence of a lower-efficiency level. This high percentage of vacant spaces points to inefficiency in building use and low redundancies. Identifying and proper utilization of vacant buildings and spaces remains critical for enhancing the usage of existing buildings that would discourage the necessity for new constructions and consumptions of greenfield land.

Average age of demolished buildings

Three categories of buildings get demolished in Bangladesh, excluding the numerous informal and non-permanent buildings that are torn down. First are the heritage buildings, both publicly and privately owned, which are often 80 to 400 years old.[50] These buildings are mostly of colonial and Mughal origin but are now demolished to make way for new developments. This action is due to cultural insensitivity, precarious structural conditions, and lack of legal provisioning for built heritage preservation.[51] Second, buildings were erected between the 1950s and 1970s, that is during the Pakistan period. These buildings are mostly 50–70 years old and often have modernist heritage values [52] that represent the public and private sectors, similar to the earlier category. Building types include single-family residences in planned residential areas [53] to multifamily flats (mostly under public ownership). The third category is the illegally (without a permit) built structure, often 10–20 years old, which occasionally get demolished by concerned bodies like RAJUK and DNCC. [54]

Among these three, the most demolished type are the modernist buildings. In most parts of the country, this type, alongside some heritage buildings,[55] has been quickly replaced by new public sector office and other institutional buildings, multifamily high-rise flats and private sector (developer-built) multifamily flats. This trend, compared with the global average lifespan of 50 years, however, seems to be meeting their technical lifespan potential.

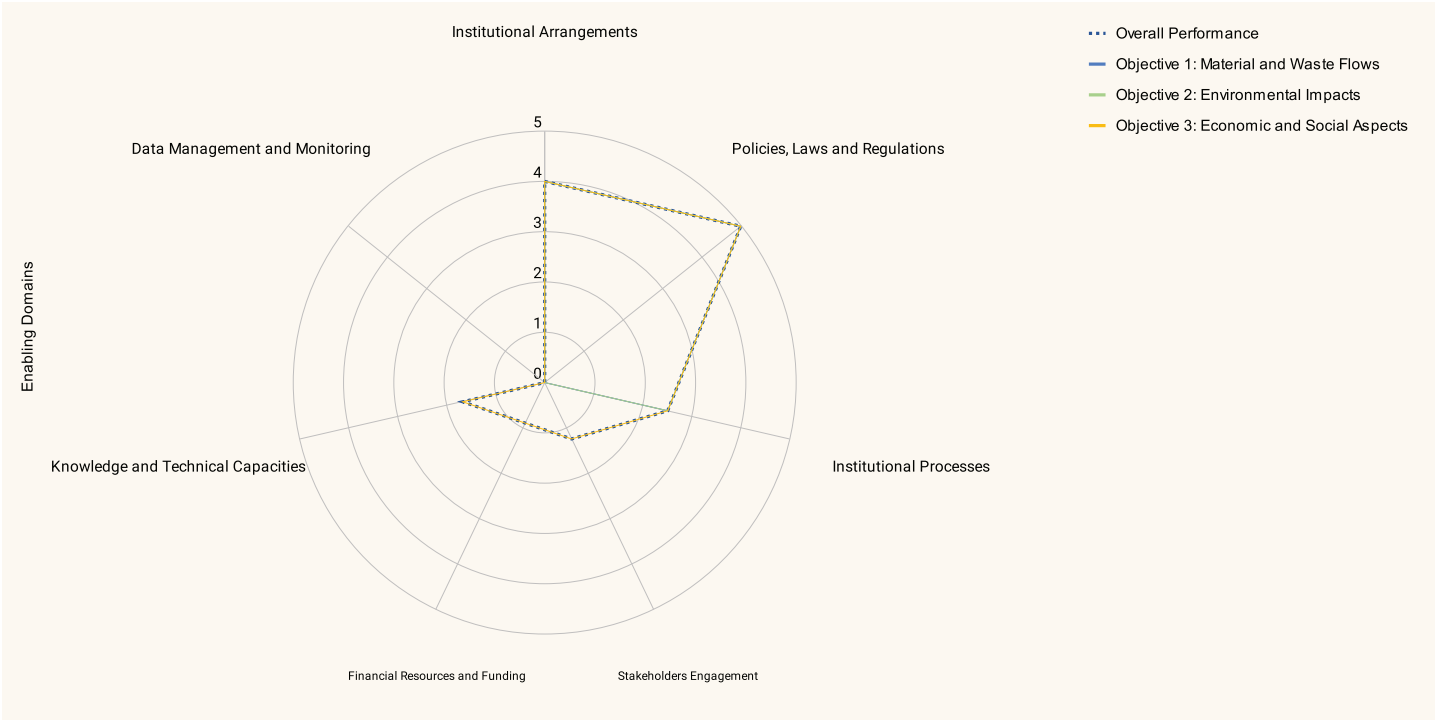
The enabling environment

In the country's building sector, there are ample policies and good national and local level institutional arrangements (like RAJUK Dhaka) and the Government's Public Works Department (PWD), and their designated role in public and private building renovation, management monitoring and decommissioning. However, institutional processes (e.g. renovation need assessment, pre-demolition audit, decommissioning), knowledge and technical capacities (public awareness, professional training) and stakeholder integration (mainly building owners and users) remain low. Alack of public-private partnership provisioning, financial incentives (e.g. tax exemption) in promoting renovation and reuse, failure to ensure a maintenance budget are some of the reasons for the low scores in the financial resources and funding area. Data management and reporting, for example, on issues like building passports and permits and vacancy status are absent (see figure 7).

Institutional arrangements

There is not any agency responsible for private building renovation in Bangladesh. PWD and the Department of Architecture support renovation works of public buildings when asked. PWD is also mandated to design and implement building projects for various public agencies. However, organizations like RAJUK or the Khulna Development Authority (KDA) and their line ministry (Ministry of Housing and Public Works) can define building management policies and processes by formulating and upgrading codes like BNBC 2020. This code also highlights the need for site safety and the involvement of concerned agencies in the renovation

Figure 7: State of existing buildings in Bangladesh's buildings and construction sector in 2024



process. For some private buildings, architectural and engineering firms and professionals take care of the maintenance activities, although it is done informally for most. Usually, the client agency takes care of maintenance. Although no dedicated entity exists for regulating the decommissioning process, development control agencies (e.g. RAJUK) have the legal mandate to act as the concerned agency for regulating decommissioning.

Policies, laws and regulations

Development control agencies have the legal capacity to approve and adopt pre- and post-modification works. Although no policy for incremental construction exists, the present building code (BNBC 2020) does not prohibit the practice. For example, after design approval, agencies allow phased construction and hence incrementality. At present, policy is lacking to incentivize renovation in existing buildings and to discourage demolition. Provisions are presently there for the adaptive reuse of significant or heritage buildings (only) using instruments like "Transfer of Development Rights".

In terms of CDW management, the National Solid Waste Management Rules 2021 outlines a framework for handling construction waste, emphasising waste segregation and monitoring mechanisms, and promoting resource conservation. On the other hand, BNBC 2020 requires construction companies to develop and implement waste management plans that include measures to reduce waste at all sites. National Solid Waste Management Rules 2021 also outlines a framework for managing and recycling construction waste, emphasising waste segregation, recycling targets and monitoring mechanisms. BNBC 2020 requires construction companies to develop and implement waste management plans that include measures to reuse and recycle waste in all sites.

Institutional processes

There is not a known process for periodically reviewing and mapping building quality and renovation needs, although BNBC 2020 clearly outlines various approaches and methods for routine inspection and maintenance for all types of buildings (including those private). For demolition, no pre-demolition audit provision exists. A large presence of informal markets for recycling construction materials is typically found in all cities and towns. Online marketplaces have dedicated sections for used construction materials. There is not any decommissioning process to ensure sustainable practices, such as responsible and healthy disposal of hazardous materials.

Stakeholder engagement

Typically, systematic mapping of community needs is not practised, although communal multifamily flats have committees that are allowed to repurpose the communal spaces of the buildings based on community needs. In decommissioning, current policies do not demand owners' responsibility for communicating the carbon costs associated with their undertaking. There is not a process of owners' declaration of CDW quantity disposed to landfills, either. Information on data transparency on the circularity of all built environmental assets is absent. Public-private partnerships (PPP) in Bangladesh are not practised in smaller built environmental projects.

Financial resources and funding

PPPs are not applied to support building maintenance, renovation and retrofitting. There are neither any financial incentives nor tax reductions provided to promote building longevity. Usually, there are no dedicated provisions for the operation and maintenance budget for public buildings or different public bodies' ADP annual development plans. There is not funding for research and development for existing building renovation and their longevity. Moreover, there is not a process to halt tax evasion and introduce tax management for the existing buildings. People (especially urban residents) pay at least two types of property taxes annually: land tax paid to central Government land department; and holding tax, levied by local governments and municipalities.

Knowledge and technical capacities

Among relevant stakeholders (building owners, construction workers, and end users), the present level of awareness of circular economy practices in the existing buildings sector (e.g. recovering building materials during building disassembly) is quite

low. In academia, interior design courses taught in undergraduate programmes or as individual courses are government-approved (by the University Grants Commission), but there is no course on refurbishment available. At present, no professional training is provided on the recovery of building materials during building disassembly.

Data management and reporting

A building passport does not exist in Bangladesh, which might include data on buildings and materials in existing buildings, nor is there any data on building vacancy (rates).

Challenges and opportunities

nb.	Challenges	Description	Enabling Domain
1	Scarcity of research and data	Data on renovation (needs), repair, demolition (including CDW, reuse), decommissioning and vacancy are not collected by any research organization, nor does any database on existing buildings exist	1. Institutional arrangement 3. Institutional processes 7. Data management and reporting
2	Disengaged stakeholders	Lack of building owner and user participation in building code formulation Lack of awareness about circularity principles (renovation, repurposing, reuse, recycling etc.) among building owners and users No PPP opportunity is available for small-scale building projects	2. Policies, laws and regulations 4. Stakeholder engagement 5. Financial resources and funding
3	Low collection of CDW in controlled facilities	Very little solid waste is collected by municipalities let alone CDW, leading to erratic disposal, environmental pollution and missed opportunities for their recovery and recycling potential	2. Policies, laws and regulations 3. Institutional processes
4	Inefficient building use	There are more new constructions compared to renovation, especially in larger cities – often without maximizing the use of vacant and unused buildings. No financial incentives (e.g. tax exemption) are available for promoting recycling, renovation and waste reduction	3. Institutional processes 5. Financial resources and funding
nb.	**Opportunities**	**Description**	**Enabling Domain**
1	Utilization of vacant buildings and spaces	A regularly updated citywide database and better floor space management can lower the need for new construction	1. Institutional arrangement 2. Policies, laws and regulations 7. Data management and reporting
2	Increase existing building lifespan	Good quality building construction, proper maintenance and regular repair can increase building life and reduce the need for new construction	2. Policies, laws and regulations 6. Knowledge and technical capacities

New buildings

The new buildings action area focuses on the planning, design, procurement and construction of new buildings and the types and quantities of materials in Bangladesh.

The physical environment

The physical environment assessment aims to establish an understanding of the current state of Bangladesh's material consumption to satisfy building needs and its environmental and social impact.

Consumption of secondary materials compared to virgin materials

Based on an assortment of sources,[56] it is estimated that about 160 million tons of raw and virgin materials (including coal used for brick production) were consumed in 2019–2020 by Bangladesh's construction sector. Without specific data on non-virgin and secondary materials, the stock of recycled materials, including those managed by the informal sector, is considered. Taking account of about 2.2 million tons of CDW generated in the municipalities during the same period using the 30 per cent rule earlier, and considering that about 21.5 per cent of this remains unused (discussed later), the total volume of recycled CDW stands at 1.73 million tons. This data, however, needs to be regarded only as a proxy, thus should be used with a certain level of caution. With comprehensive (e.g. nationwide) data, this method could help gain more in-depth insights about the sector.

This calculation is the quantities of recycled materials consumed over the total quantities of materials consumed, thus returns with a very low value for the secondary materials. Despite a good part of these CDWs being consumed mostly by non-formal sectors of the construction industry, this still signifies a lower degree of circularity. Incentives could be given, while the remaining landfilled portions of the CDW could be brought under the circularity principles through Government policy interventions (e.g. provide incentives to those who use a certain percentage of recycled or secondary materials) and investments from the private sector.

Material footprint of new buildings per capita

The overall per capita material footprint of Bangladesh in 2017 amounted to 2.51 tons.[57] This is slightly above the 2017 data for lower-income countries (2.0), lower than lower-middle-income countries (4.7), and significantly lower than upper-middle-income (16.9) and high-income countries (26.3). This amount is also much lower than the global average footprint of 12.44 tons per capita.[58] With an annual average increase of 0.03 per cent, calculated from the year 2000 footprint of 2.0 tons, the 2023 material footprint should be about 2.7 tons.

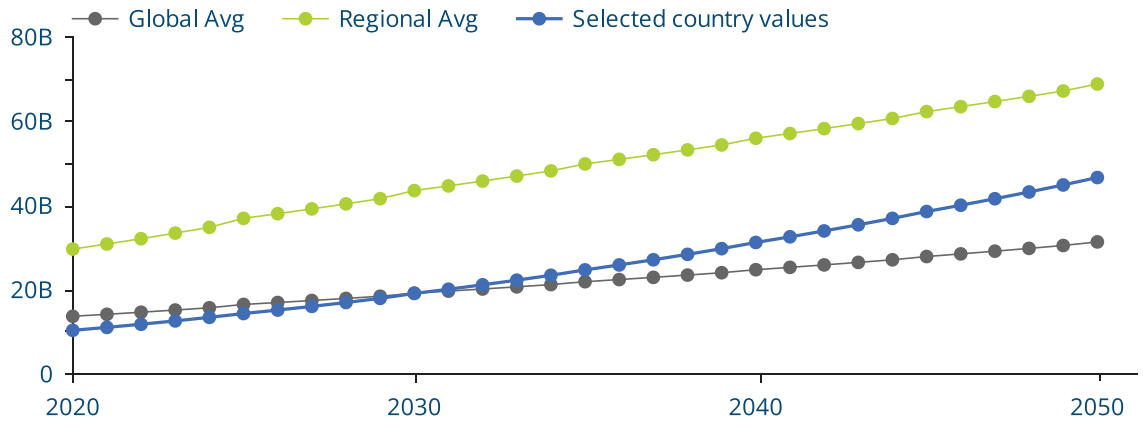
In terms of building material footprint, the domestic material consumption, by type of raw material consumed annually by its total population is calculated.[59] By taking account of the 2023 population of about 171 million, Bangladesh's raw material consumption of about 160 million tons and its very little export, the building material footprint is calculated as 0.94 tons per capita.

Annual new building stock embodied carbon emissions

The annual building stock embodied carbon emission for 2030 is estimated at 20 BTCo2e, which in 2020 was 10 BTCo2e.[60] Using a linear extrapolation between 2020 and 2030, it can be inferred that new buildings have contributed and will keep contributing about 1 BTCo2e annually. Now, considering the 2020 and 2030 projected population of 167.4 million and 186 million, respectively, a clear per capita increase is observed. In 2020, it was about 59.7 tCo2e per person per annum and is expected to rise to 107.5 tCo2e in 2030. This growing challenge, however, points to the need for the reduction of material consumption, improvement of material efficiency, and

Figure 8: Annual building stock embodied carbon emission

Annual estimate for 2020- 2050 of the total amount of carbon dioxide equivalent (CO2e) emissions released during the construction of new buildings or existing building renovation.



prioritizing organic and bio-based materials that are locally sourced. It also infers that if the "business-as-usual" approach is not changed to reduce emissions, Bangladesh would likely exceed the global average emission of 20 BTCo2e in 2030.

Share of materials on the LBC Red List banned or controlled nationally

Out of the 23 Red Lists for chemical class changes, BNBC 2020 places only asbestos and CFC under the hazardous material category, while the Import Policy Order 2015–2018 only prohibits the import of formaldehyde. [61] BNBC 2020, instead of prohibiting it, approved halogenated hydrocarbon as a construction material.

When compared, it is found that only about 13 per cent of Red List materials are somewhat prohibited (either use or import) compared with the entire LBC Red List. Without the availability of data on the actual consumption of such materials, this low share indicates that Bangladesh needs to put greater effort into avoiding the use of toxic and hazardous building materials. The presence and enforcement of a more comprehensive material control or ban policy should limit the consumption of these materials.

Affordability of housing

According to BBS, [62] the average national income of a Bangladeshi household in 2022 was BDT 32,422 ($270) and the average household expenditure was BDT 30,603 ($255), from which the household spends about 62.19 per cent for non-housing purposes (including food, clothing, medical, and education), while about 17.7 per cent for housing and 20.11 per cent for miscellaneous purposes. However, in bigger cities like Dhaka, the affordability situation is much worse. On average, housing expenditure for lower-middle-income groups is about 59.5 per cent, while it is about 38.2 per cent for middle-income groups. [63] Lower income groups, especially people living in informal settlements, spend 20–40 per cent of their overall income on housing. [64]

Housing is considered "affordable" if households do not spend more than 30 per cent of their gross income on housing costs.[65] For low-income households, spending even 10 per cent to 20 per cent of their household income on housing costs may leave little money left for other key consumption items.[66] Overall, these point to the demand for additional housing units for all income groups and affordable housing scarcity for about 90–95 per cent of the low- and middle-income population.[67]

For the circular economy, priorities should be given to formulate necessary policies, and innovation and even incentivise affordable and locally sourced materials that keep the building cost affordable. Alongside the Government, the private sector should be actively involved in the process.

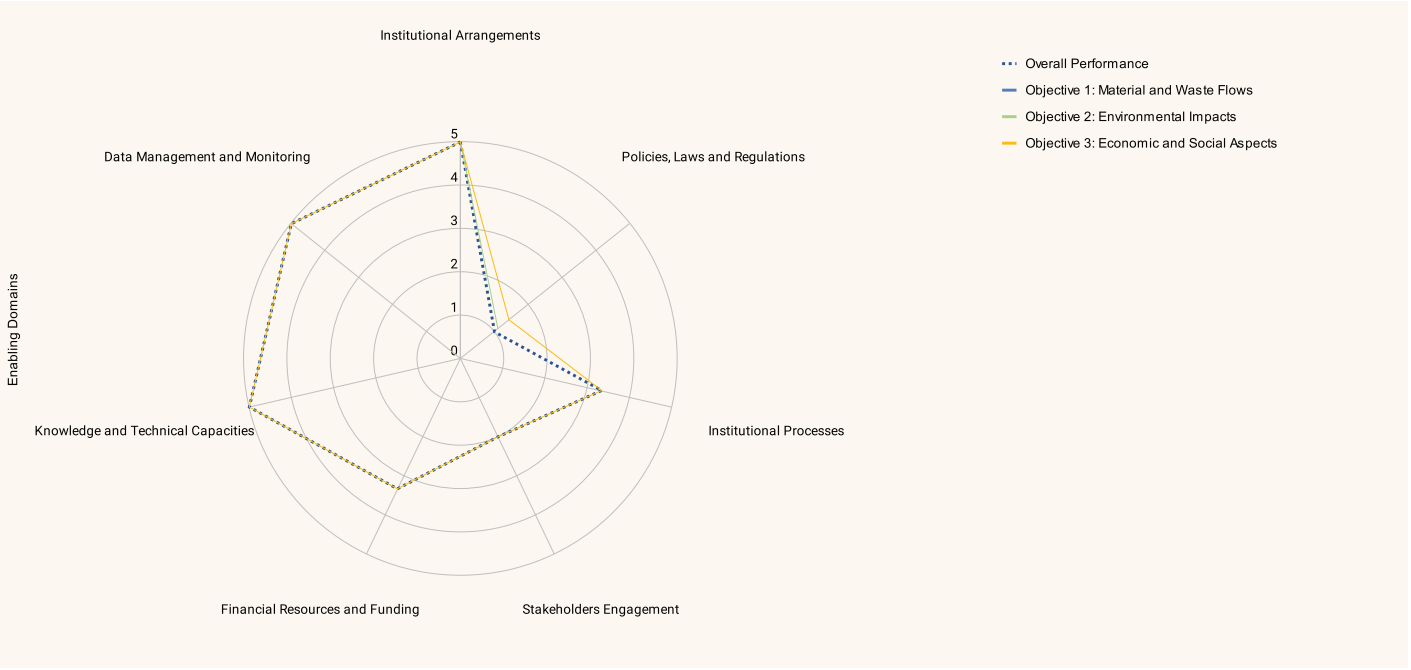
The enabling environment

The new buildings action area has the best performing enabling environment among all action areas. The scores for institutional arrangements, knowledge and technical capacities, and data management domains are excellent. These factors are due to the availability of a green material certification agency currently being formed, the presence of construction codes, and well-defined inspection and penal codes. Although unapproved, the presence of a local green building certification system and patent innovation (using recycled materials) helped the data management and knowledge and capacity domains to score very high. The institutional process and finance scored moderately due to better monitoring mechanisms, local procurement of construction materials, and the presence of research and development agencies at the national level. Stakeholder engagement scored moderately low, due to a section of building owners' and users' familiarity with green buildings and their benefits. However, the policy environment scored the lowest without recycling and reuse, longevity focus of building codes, environmental and social impact assessment, embodied carbon assessment, incentives for low-carbon material adaptable design, and low-carbon focus of building codes (see figure 9).

Institutional arrangements

The Bangladesh Standards and Testing Institution (BSTI) is in charge of general certification. Recently, the Building Energy Efficiency and Environmental Rating (BEEER) 2023 designates the Sustainable and Renewable Energy Authority (SREDA) as the agency responsible for green building certification. Earlier, HBRI also prepared GreenARCH Certification for Habitats 2024. Scores are assigned for key circularity dimensions, including material certification, reuse and recycling of materials, CDW management, use of renewable materials, and embedded and operational carbon footprint. No certification has been issued yet, since it is awaiting approval.

Figure 9: State of new buildings in Bangladesh's buildings and construction sector in 2024



In terms of building quality, BNBC 2020 outlines hazard- and zone-wise design criteria for the structural integrity of new buildings. Public buildings designed under Government agencies (e.g. PWD) and private buildings in metropolitan cities are well monitored, as are those for private buildings designed by professionals. But for most non-metropolitan buildings, monitoring remains weak from the authority's and owner's sides. The Government's engineering departments like PWD and LGED have their approval (quality control) and monitoring arrangements for public buildings. The importance of building and construction quality is also highlighted by the Implementation Monitoring and Evaluation Division (IMED). On the other hand, buildings approved by metropolitan development control agencies (like RAJUK, and KDA) have poor post-construction inspections, although they have the legal mandate. Non-metropolitan private buildings do not have any legal bindings for post-construction inspection, although this is highlighted by BNBC 2020. The Building Construction Act of 1952 outlines three punishment provisions for violations of the building code: imprisonment, monetary fine, as well as removal and demolition. In this light, BNBC 2020 clearly outlines this legal provision in its *Form for Sanction or Refusal of Land Use/Development/ Building Permit*.

Policies, laws and regulations

There are not any specific policies for incentivizing the reuse and recycling of materials. Although BEEER 2023, BNBC 2020 and Bangladesh Bank's credit policies of 2012 implicitly hint at Government support for recycling, BNBC 2020 does not mention any incentives for building longevity in the activity. There are not dedicated sections in BNBC 2020 that allow or incentivize the use of local, recycled, new and innovative low-carbon materials, as the code does not set any limitation on the embodied carbon intensity of new building projects.

In terms of certification, the Environmental Conservation Act of 1995 requires environmental clearance certification, including a project's waste management plan. National 3R Policy 2010 highlights the importance of managing and recycling construction waste through waste segregation, recycling and monitoring. BNBC 2020 requires the development and implementation of waste management plans that include measures to reduce, reuse and recycle waste. BNBC 2020 tacitly talks about certain principles like recycling, reuse and waste management. However, the code is not founded on the principles of circularity. Circularity is not explicitly mentioned in any such policy, despite many touching upon elements of circularity separately. BNBC 2020 set standards on health, safety, and environmental issues, but nothing specifically on social well-being, although various issues like social viability and social impact have been highlighted concerning building design. Social impact assessments are typically conducted for public infrastructure and building projects. However, life cycle assessment (LCA) is not common in such instances, although its importance is acknowledged. Only large infrastructural and hazardous industrial building projects require an environment impact assessment (EIA). It is not required for residential and commercial buildings. However, EIAs do not include the LCA approach.

Institutional processes

Sustainability and circularity-based performance criteria have not been incorporated into the public procurement framework for new buildings and construction processes. However, in late 2023, the Central Procurement Technical Unit and IMED (Ministry of Planning) prepared a Draft Sustainable Public Procurement Policy to promote a procurement process that must consider whole-life costs of materials, including manufacture, delivery and installation; operating costs, including energy, water usage and maintenance; and end of life costs, including decommissioning and disposal.

Bangladesh Bank decreed that all commercial banks provide a discounted financing rate of 9 per cent for the extra cost of green measures for light industry buildings. It set a fixed 5 per cent mandatory credit quota for green finance on the total amount of the loan. To support environment-friendly technology, the bank established a refinancing project focused on 50 products under 11 categories, including brick alternative and waste recycling.

Stakeholder engagement

There is increased awareness of green buildings and technologies in Bangladesh, especially among urban dwellers. Awareness is also growing in rural areas due to the efforts of various stakeholders. However, the specific focus on circularity is absent.

Financial resources and funding

BSTI, HBRI and public universities receive dedicated funds (although often inadequate) for designing and testing materials and technologies for new buildings. Specific incentives for using eco-labelled building materials or components with green certification building materials are absent, as most focus has been on equipment and infrastructure on renewable energy. However, Green Tax is now strongly considered and is practised, as about 6 per cent corporate tax exemption for green readymade garments factories (e.g. Leadership in Energy and Environment Design, or LEED, certified) has already been exercised in the 2017/18 budget. Such incentives (e.g. tax reduction) are unavailable for local, reused and recycled materials. Incentives targeting local, reused and recycled materials are unavailable.

Knowledge and technical capacities

Patents based on recycled construction material technology have been scarce. Only about 8 per cent (2 out of 24) of the entire approved patents from 2013 to 2022 involved the use of recycled materials of some sort.

Data management and reporting

SREDA's BEEER 2023 certification system is based on 49 credits divided into 10 categories. The total number of aggregated credit points is 115. The building applicant needs to provide an assessment report and the final score will depend on the provided data.

Challenges and opportunities

nb.	Challenges	Description	Enabling Domain
1	Lack of circularity-focused policies, laws and regulations	Policies and codes to promote reuse and recycling, longevity, local and lower embodied carbon materials, incentives, and adoption of the LCA approach for assessing environmental impact are absent Policies do not make social and environmental impact assessment of buildings mandatory	2. Policies, laws and regulations
2	No sustainability or circularity criteria in public procurement	Public procurement guidelines (schedule of rates) do not contain sustainable low-carbon recycled material and appliance specifications	3. Institutional processes
3	Weak stakeholder engagement	Local communities and building users lack information about the benefits of circular building techniques and sustainable building practices	4. Stakeholder engagement
4	Very high use of virgin materials	For the mainstream building industry, there is little scope for reusing secondary materials; such materials are unavailable. There is no innovation in recycling waste into good quality new building materials	2. Policies, laws and regulations
nb.	**Opportunities**	**Description**	**Enabling Domain**
1	Update existing policies, codes and by-laws	Familiar, well-structured and well-practised codes like BNBC can be updated using circularity/sustainability/green principles and criteria	1. Institutional arrangement 2. Policies, laws and regulations
2	Local procurement of building materials	Local procurements will reduce embodied carbon footprint significantly and will promote innovation and market entry	3. Institutional processes
3	Policy enforcement to control toxic and hazardous building material use	This should prohibit or limit the consumption of LBC Red List materials and reduce the risks of environmental hazards and pollution	2. Policies, laws and regulations

Construction supply chain

The construction supply chain action area focuses on the system of activities that enable the extraction, manufacture, transport, use and end-of-life management of materials across the construction supply chain. In a circular economy, it is important to consider the types of materials that are used within construction activities, the environmental impacts of such materials, and the socioeconomic influence of such activities.

The physical environment

The physical environment assessment aims to establish an understanding of the current state of Bangladesh's construction supply chain, from extraction and imports, to end-of-life and the ecosystem of suppliers and manufacturers.

Ratio of nationally produced and imported construction materials

Generally, Bangladesh does not import its construction materials directly. However, among the imported inorganic raw materials with the highest carbon footprint, clinkers, steel (crude, billet, scrap) and stone have remained topmost. Despite structured and furnished data being generally unavailable, a review of non-academic sources shows a 27 per cent, [68] 10 per cent [69] and 5 per cent [70] ratio of local production of steel, clinker and stone, respectively. Taking account of a total of 160 million tons of raw materials consumed in 2019–2020, as mentioned above, and the respective quantity of imported and raw materials being 29.6 million tons and 127.54 million tons, the ratio of nationally produced and imported materials is calculated to be approximately 4:1.

National reuse and recycling rate of construction and demolition waste

Despite scarce national level study and data, it has been estimated that in Dhaka city only about 2 per cent of the entire construction and demolition waste is "officially" recycled, while about 4–15 per cent of inorganic waste is recycled informally and generally remains unaccounted.[71] It has also been demonstrated that in Mymensingh city 31 per cent of CDW is reused, 26 per cent is recycled, about 21.5 per cent (mostly concrete waste) is used for filling low-lying lands and raising pavements and plinths, while the remaining 21.5 per cent is subject to open disposal.[72]

From this, it becomes clear that "formal" waste recycling practices are non-existent in Bangladesh. In fact, only about one fourth of the total construction and demolition waste is dumped; the rest are used to a degree. But this also underscores three clear challenges of present (limited) recycling activities: first, absence of innovation (through research and development) in the CDW sector; second, linking and mainstreaming of innovated and recycled materials with the construction (material) production industry and market; and third, the unaccounted and underexplored contributions of the informal sector in recirculating (recycling and reusing) of almost three quarters of the CDW. These challenges, however, also present opportunities for the circular economy. Innovation with the residual waste (especially concrete and mortar) should limit the production of new embedded carbon materials and reduce environmental pollution. A new, value-added supply chain will also create new employment opportunities.

Share of materials from renewable natural sources

Despite the use of locally extracted timber and bamboo in the building industry, the assessment of the renewability status of construction materials shows an overreaching use of non-renewable materials. It is estimated that in 2023, about 33 million tons of cement, 480 million tons of sand, 57 million tons of brick, about 5 million tons of stone and 6 million tons of steel were used in the building industry, totalling an annual amount of 581 million tons. Against these, approximately 7.3 million tons of timber and 7.6 million tons of bamboo, totalling about 15 million tons, were used during the same period. In percentile terms, renewable materials

constitute a meagrely 2.6 per cent of the entire material stock annually.

From a circular economy perspective, such low use of bio-based materials indicates higher embodied carbon emissions. However, looking at the currently available stocks of timber and bamboo respectively, which are 30 and 3 times higher than the quantities used annually, there is ample opportunity for their increased (and sustainable) harnessing and value addition through research and development, with simultaneous reduction of the use of high-carbon non-renewable materials like cement and steel.

Carbon emissions of construction materials nationally produced and consumed

As of 2023, the total quantities of carbon dioxide emissions through the national production of construction materials stands at 36 tons of carbon dioxide equivalent (Bangladesh's total is over 100 million tons), [73] which at the current rate would reach 133 MtCO2e by 2050.[74] This quadrupling of emissions will be an outcome of the construction activities of the 200 million population that will reside in the country in 2050.[75] Although Bangladesh's current per capita emission of 0.5 tCO2e [76] is significantly lower than the current global average of 4.76 tCO2e,[77] the projected 2050 figures highlight the growing trend of national emission over global emission.

This projected increasing trend of emission, especially considering the annual demand of 87 million tons clay (for brick production), 480 million tons sand, 7.3 million tons of timber and 7.6 million tons of bamboo will keep exerting additional burden on their respective local raw material stocks. With their finite quantities, additional demand will force increased import, and hence the increase of embedded carbon of these building materials. The possibilities for future progress are research and development, innovation on more sustainable and low-energy materials using the same raw materials, and increased recycling of locally produced materials.

Number of suppliers of certified non-toxic building materials

Data is scarce for this section. However, a review of cement and cement-block (brick alternative) industries provides a glimpse of the overall scenario. In the cement industry, nine companies that collectively provide for 85 per cent of the domestic market have recently shifted to production processes based on the Vertical Roller Mill and Roller Press Mill, reducing energy consumption by 25 per cent; these technologies are also considered environmentally friendly, which cut pollution by around 70 per cent compared to the traditional technologies.[79] However, no certification above ISO 9100 is available, despite BEEER's endorsement of ISO 14025, 14040, 14044, 21930, and EN 15804 as acceptable environmental certifications for new construction materials.[80] In contrast, within the concrete block industry, none of the five major companies that produce more than 20 per cent of the national products conform to the non-toxic, environmental and ecological standards of their product. Recently, a new autoclaved aerated concrete (AAC) block-producing company has claimed to be energy-certified but does not provide further details. Overall, all sectors lack any significant efforts in this direction. Improvement and enforcement of certification on non-toxic and high-performance materials should hence significantly improve embedded carbon of building materials and reduce impacts of the supply chain on the environment.

Patents related to circular economy practices in construction

Patenting, in general, has not been widespread; in fact, Bangladesh ranks 106th in the world. Analysis by the World Intellectual Property Organization shows an overall decline in local patenting applications compared between 2013 and 2022 data. In these 10 years, innovations in building or any other materials have been scarce, [81] as the top technical fields being computer technology, information technology management, pharmaceuticals, food security and transport. However, a review of the total approved patents [82] during the same period (24 numbers) shows the occurrence of four items (17 per cent) that are material-related. Among these,

none of the items is building material related, while two of them (8 per cent) are on recycling of industrial waste into finished material production. A 15-year review (2008–2022), however, shows a 5 per cent occurrence of materials (20 out of 376), among which, at least six (about 2 per cent) are on construction materials. This reveals patents on indigenous materials (jute and jute stick, bamboo, leather, husk ash, silica, eggshell and vegetables), whose concentrations revolved around biological, organic, and renewable materials, roof and wall technology, waste recycling and improving material durability.

Regarding the circularity of the supply chain, the number of innovations is unsatisfactory. Yet two trends become obvious: first, increasing interest of contemporary researchers in recycling; and second, local researchers' interest in indigenous, organic, and renewable materials in innovation.

Share of employment in circular economy construction

According to ILO data, there are some 3.38 million people employed in Bangladesh's construction sector. **At least 94 per cent of this workforce is employed informally.** In this sector, about 43,200 professionals, 186,400 technicians and associate professionals, 12,300 managers, 7,300 clerical staff, and 3,527,300 workers of various sorts are involved. [83] On the other hand, more than 400,000 waste pickers are informally employed in Bangladesh.[84] By using the 30 per cent thumb rule for CDW generation,[85] it can be assumed that about 120,000 of these waste pickers are presently involved in CDW recycling activities. Using the same ILO source above, it is found that the indirect sector also employs about 31,100 service and sales personnel. Therefore, about 150,000 personnel are likely to be involved in waste-recycling activities. This accounts for only about 4 per cent of the total construction workforce that is involved in some sort of circularity practices.

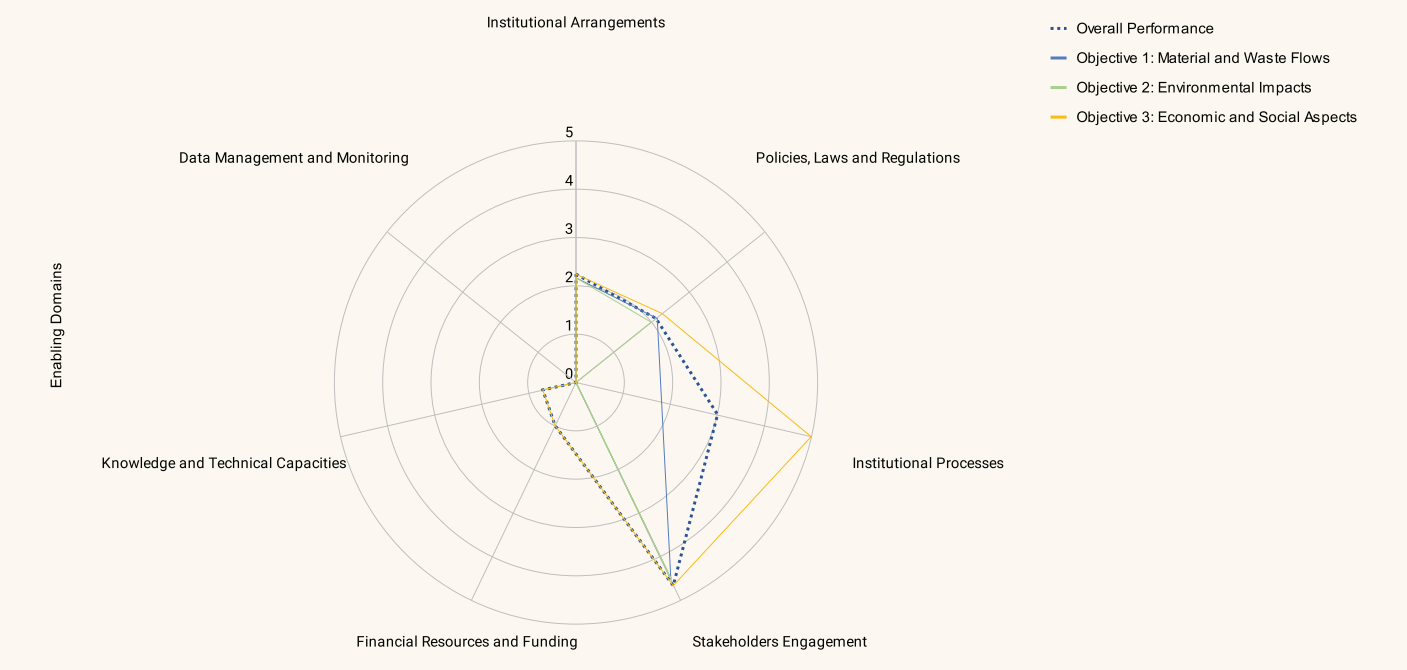
New market demand and employment opportunities could be created by innovating new materials, especially out of the vast quantity of concrete and mortar waste that usually ends up in landfills. Novel approaches like refurbishment and remanufacturing of waste, alongside their typical recycling and reuse, could also create many new jobs. As part of circularity, these would require new and improved technical (e.g. digital), technological and entrepreneurial skills alongside more efficient waste collection, sorting, and picking practices. [86] There is also a need for educating the sector on circular knowledge and its relation with climate change mitigation.

The enabling environment

With the current low scores of the other enabling domains, the overall low score of the construction supply chain sector was expected. Among these, only the stakeholder engagement domain scores very well, due to the excellent performance of the informal sector and its role in informal recycling and enterprises. In addition, institutional processes, policy, law, and regulations domains scored moderately. This is mainly due to the moderate presence of quality control activities by designated agencies, some level of industrial symbiosis, and a moderate level of sustainable material and appliance production criteria, local sourcing and production of materials and appliances, hazard listing of materials and regulations, affordability and extraction, as well as production limits for the purpose of environmental protection.

The institutional arrangements scored quite low due to the absence of any circularity focus, materials standards and sustainable extraction. Similarly, the financing domain scored quite poorly in the near absence of funding for material innovation, a market mechanism for the promotion of green materials, and support for MSMEs. Without any knowledge, awareness and education on circularity and life cycle value of materials, the knowledge and technical capacity indicators also score very low. The lack of data availability and

Figure 10 : State of construction supply chain in Bangladesh's building and construction sector in 2024



tracking of recycling and reuse information, the data management and monitoring domain, scored nil (see figure 10).

Institutional arrangements

The Ministry of Lands prepares material extraction policies. BSTI prepares and maintains national standards for building materials, systems and appliances. Both lack circularity focus. However, BSTI's sustainability focus is expected to improve after the publication of the Sustainable Procurement Policy. PWD and LGED regularly prepare and update their Schedule of Rates with material specifications. In 2023, the Ministry of Finance's IMED prepared Bangladesh's first Draft Sustainable Public Procurement Policy, which is awaiting approval. Hence, its commercialization impact is yet to be realized. In terms of raw material extraction, the Ministry of Land's district-level agency lacks the capacity and resources to monitor. Moreover, there is not a sustainability-focused law or directive to support monitoring. PWD's study defines material quality specifications, which lack a circularity and sustainability focus. BSTI, under the Ministry of Industry, establishes national standards for building materials, systems and appliances, including imported products. In contrast, HBRI, under the Ministry of Housing and Public Works, conducts research, testing, capacity-building, technical assistance and policymaking, which could play a key role in building material standardization.

Policies, laws and regulations

SREDA's Standard and Labelling Regulation 2018 outlines rules and procedures for mechanical, electrical and plumbing systems, as well as labelling appliances and equipment. However, there is not anything found in the building material market or the procurement process. There are no comprehensive and integrated standards or technical regulations with circular economy criteria for the production of construction products. However, there are certain sectorial policies like the Manufacturing and Brick Kiln Establishment (control) Act 2013 to govern the extraction of natural resources, although it does not speak much of limiting extraction. This act also promotes the use of eco-blocks. However, there is no policy that supports reusable material extraction from existing buildings during demolition, nor is there any on the Recycling Building Material Ordinance. But the National 3R Strategy for Waste

Reduction 2010 focuses on the need for general recycling of all wastes (including CDW). About three quarters of the CDW is informally recirculated into formal and informal construction markets by informal businesses. There are not any green public procurement minimum environmental criteria for materials in public building contracts available. Nonetheless, the Draft Sustainable Public Procurement Policy 2023 mentions the environmental criteria that those bidding for tenders must meet during procurement.

Bangladesh Bank implemented its Green and Sustainable Finance Policy in 2012 and made it mandatory for banks to include at least 15 per cent of their loan portfolios in sustainable projects. They are also required to reserve at least 5 per cent for green initiatives to increase the uptake of green businesses. All local industries need to produce an environmental impact assessment and renew approvals from DoE; but monitoring remains weak. NGO-supported green jobs (e.g. autoclaved aerated concrete and compressed stabilized earth blocks) are gaining momentum.

SREDA, at the national level, drafted regulations for electric appliances, but nothing similar is found on construction materials. BNBC 2020 outlines similar construction codes in Occupancy J-type buildings under "Chemical Hazard Buildings". BNBC 2020 outlines this under "Hazardous Materials" like asbestos, glass fibre, or injurious and intoxicating fluids, corrosive and explosive materials. There are not any specific OHS policies and regulations for extractive or building material manufacturing, except for the general ones in the Labour Act 2006 (2018 amendment). National Housing Policy 2016, under "Building construction material and technology", tacitly talks about affordable materials, while the Bangladesh Bank 2012 policy supports their commercialization.

CDW management is centred around the predominantly informal market, run by poor informal pickers and businessmen. There are disclosure practices by the cement industry, but no regulating policy is known. National standards do not specify grades for reused and recycled materials, along with their corresponding application scenarios. Regulations that require raw materials to be certified or conform to national standards to ensure sustainable extraction practices do not exist. Although inadequate, the Infrastructure Development Company Limited, IDCOL, has its clean development mechanism project supported by the United Nations Framework Convention on Climate Change for carbon credit and revenue; but it does not have a focus on building materials. The BSTI Act 2018, and the Sand Quarry and Soil Management Act 2023 require raw materials to be certified or to conform with national standards to ensure sustainable extraction practices.

Institutional processes

Without adequate resources (human, capacity, legislative) and an informal nature, effective implementation is affected. Buildings, construction materials, and products do not have extended producer responsibility schemes. BSTI's and the Bangladesh University of Engineering and Technology certifications are used. But their services are centralized in Dhaka. They also cannot test the quality of items imported by unlicensed firms. There are processes to ensure that the quality of locally produced building materials, systems and appliances conform with BSTI's regulations. However, the effectiveness of these regulations is compromised by a lack of institutional capacities to develop policies as well as enforce and monitor their application. Industrial symbiosis exists informally; for example, Bangladesh's largest ship-breaking industry is linked to steel re-rolling, fuel, metal, plastic, wood and appliances.

Stakeholder engagement

Marketplaces exist informally. There are online places and Facebook marketplaces that are used for trading. Usually, informal markets are found in every town and city but not all types of materials are always available in a single market, especially in small towns. Locations of these markets are often quite remote. Online platforms are easily accessible. There is no evidence of it, but if the markets are formalized, taxes will be imposed and overhead cost will increase, which could lead to unaffordable secondary materials.

Financial resources and funding

Dedicated national-level funding for recycling and reuse is absent. However, funding is allotted, separately, to the Housing and Building Research Institute (HBRI), BSTI and universities. The budget is provided based on requisitions from various Government departments and agencies (BSTI), research institutions (HBRI) and universities. Capacity-building budgets remain scarce. There are public financing mechanisms (Bangladesh Bank, IDCOL) for green products and appliances, but nothing dedicated to recycled and reused materials. So far, there have not been any market instruments designed to bolster market readiness for regeneratively produced building materials and products. The Small and Medium Enterprise (SME) Policy of 2019 and the SME Foundation's objectives aim to support new SMEs but they do not make any mention of innovation, sustainability and recycling and reuse.

Knowledge and technical capacities

Awareness among stakeholders across the life-cycle value chain of material regarding the recycling, reusing and reduction of consumption of building materials and products remains weak. Stakeholder awareness across the life-cycle value chain of building materials, while prioritizing local sustainable materials, remains weak. There is not any national-level campaign on CDW. Some donors, local government bodies (city corporations, *pourashavas*) and non-governmental organization (NGO) programmes (e.g. ROSATOM) carry out local-level campaigns on plastic recycling. National-level objective is absent. But a few local-level donors and NGO initiatives (e.g. SWITCHASIA) demonstrate the benefits of sustainable materials (like AAC blocks). Although scarce, granted patents are found for products developed from recycling [glass ceramic tiles using industrial waste (rice husk ash and waste glass), IGCRT, 20.11.18]. Knowledge dissemination on circular economy is scarce. Circularity principles are not included in university curricula, let alone primary schools. Environmental pollution and climate change are mere mentions in the primary school syllabus.

Data management and reporting

Material flow and life-cycle data are not available or collected by any agency. There is not a system in place to track the recycling or reuse of materials and building components within Bangladesh.

Challenges and opportunities

nb.	Challenges	Description	Enabling Domain
1	Lack of innovation using CDW	No research and development activities by private or public sectors using CDW	6. Knowledge and technical capacities
2	Lack of market linkage	No linkage and mainstreaming of innovative and recycled materials with the construction (material) materials market	3. Institutional process 5. Financial resources and funding
3	Lack of data availability on building material flow	There is no material flow monitoring data throughout the life cycle of the building and construction process Contributions of the informal sector in recirculating (recycling and reusing) nearly a quarter of the CDW remain unaccounted for and underexplored	7. Data management and reporting
4	Lack of knowledge and technical capacities	It is affected by awareness among stakeholders across the life-cycle value chain of building materials regarding recycling, reuse and reduction of building materials and product consumption. There are no national-level awareness-raising activities, either	6. Knowledge and technical capacities
5	Dearth of finance	Presently, there are no dedicated finance mechanisms available for developing and incentivising green businesses and MSMEs in this sector. Market instruments are not available to boost market readiness for regeneratively produced building materials and products	5. Financial resources and funding
nb.	**Opportunities**	**Description**	**Enabling Domain**
1	Innovation with the residual waste (especially concrete and mortar)	This will reduce demand for new (raw) materials, explore possibilities with more local limit environmental pollution, create an alternative construction material market with new employment opportunities, and add value to the overall supply chain	6. Knowledge and technical capacities
2	Policy amendment	Emission disclosure, market regulation low-carbon certification etc. can be integrated into the policy framework to initiate a low-carbon trajectory	2. Policies, laws and regulations
3	Promote material circularity	These processes and arrangements can promote material circularity by initially facilitating circular, green and /sustainable procurement in public sector building constructions	3. Institutional process
4	Knowledge dissemination from early education	Circular economy principles (reduce, recycle, reuse, repurpose etc.) can be included in the education curriculum at elementary level	6. Knowledge and technical capacities

Summary and recommendations

This document aimed to assess the baseline status of Bangladesh's circular economy in the buildings and construction sector, focusing on material and waste, socioeconomic aspects, and environmental impacts structured through five action areas and seven enabling domains. Recommendations are made for action areas and objectives for future iterations.

In the strategic priorities area, an absence of circular economy principles in national policy documents is evident. National documents and plans (e.g. Perspective Plan, five-year plans) lack circularity focus and affect the Nationally Determined Contributions. There is also an absence of circularity-focused visions, policies, rules and laws for this sector, without any recognition of the building and construction sector's role and potential for reducing carbon emission. Construction supply chain data remain absent; for example, on extraction, production, construction, renovation and reuse, and CDW generation in national databases like BBS. However, a positive culture of involving stakeholders in the institutional processes creates a positive opportunity. There is also ample scope to prioritize the building construction sector strategically in national policy discourses and mainstreaming circular economy principles. These should reinforce and improve the present enabling environment, trickle down and translate into local-level plans, rules and laws, and facilitate implementation and actions towards attaining NDCs.

Spatial and urban development is characterized by an inadequate translation of circularity principles into urban and land-use planning and practices. Without any specific national discourse on circularity, this concept remains unharnessed and unexplored, and translates into non-responsive building codes and practices. This is further compounded by the lack of plan implementation and the absence of regional planning. Despite the availability of DAPs and master plans in many urban centres, ground-level execution and monitoring remain scarce. Planning policies are not sufficiently comprehensive to deal with out-of-city extraction sites, sites of pollution or informal settlements. However, there are significant achievements in the formulation of numerous sectorial policy and legal frameworks, which can be updated easily with circularity principles. Simultaneously, research institutions can be provided regular and dedicated resources to research this sector.

Key challenges in the existing buildings sector involve the lack of data availability and accessibility, and weak stakeholder participation and awareness. Data on the number of permits for renovation, repair demolition, for example, are unavailable, nor is there any comprehensive data on the overall building sector. Lack of awareness about circularity principles (renovation, repurposing, reuse, recycling) by building owners also impacts policymaking. On the brighter side, a better CDW collection should increase reuse and recycling opportunities, raise higher economic prospects, and lower environmental pollution. Proper use of vacant buildings and spaces, monitoring and maintenance of existing buildings, including heritage structures, will also significantly reduce the need for new construction.

The new buildings sector lacks circularity-focused policies, laws and regulations, supplemented by weak institutional processes (e.g. sustainability criteria yet to be considered in PWD and LGED schedules). Local communities and building users also lack information about the benefits of circular building techniques and sustainable building practices. There are, however, opportunities to update existing policies, codes and by-laws. For example, well-practised and well-structured codes like the Bangladesh National Building Code can be updated using circularity, sustainability, green principles and criteria. Local procurement of building materials can be improved, while the use of toxic and hazardous building materials can be prohibited. These will reduce embodied carbon footprint significantly and risks of environmental hazards and pollution.

In the construction supply chain, material flow data are not monitored throughout the building and construction

life cycle, while knowledge and technical capacities are affected by stakeholders' awareness level about the life-cycle value chain of building materials including production, consumption, reduction, waste generation and recycling. No national-level awareness-raising campaigns are found, either. Furthermore, dedicated finance mechanisms are not available for developing and incentivising green businesses and micro-, small and medium-sized enterprises in this sector, neither are any market instruments to boost market readiness for regenerative building materials and appliances. However, the possibility of policy amendments through emission disclosure, market regulation low-carbon certification through their integration into existing policy frameworks seems realistic. There are also opportunities for knowledge and education by including circular economy principles (reduce, recycle, reuse, repurpose etc.) in the various curricula from even elementary and primary levels.

Concerning raw material extraction and waste production, urban population concentration (and density) in smaller urban centres need to be improved, while derelict and vacant land utilization is to be maximized (through compact development) before acquiring virgin land for urbanization. Instead of demolition and new construction, building renovation, reuse and repurposing can be prioritized and incentivised. With the per capita CDW rate increasing (presently insignificant), the consumption of secondary and recycled materials remains quite low, while the per capita material footprint rate has been increasing despite its present acceptable level. There is still a very high dependence on imported raw materials, further affected by the very low availability of locally sourced renewable raw materials. Despite an excellent informal recycling economy, formal sector recycling and innovation remain quite insignificant.

The land consumption rate shows a decreasing tendency. The annual new building stock embodied carbon emission is still low, despite showing an increasing tendency over the last decade. There are a good number of Red List (environmentally harmful) materials whose use is still not prohibited. Carbon emission from locally produced construction materials is still insignificant and shows a mixed tendency (COVID and inflation). The number of suppliers for certified non-toxic materials is also quite low, although their numbers are increasing (low data).

The nature of informality and the high proportion of the informal settlements' population remain grave concerns, despite their decreasing percentage with an absolute increase. Housing affordability for most people, including informal dwellers, remains very low, with a decreasing tendency. Despite inadequate data, many building floors (especially technology parks) remain vacant, as new buildings continue to rise. About a quarter of the overall informal sector workers are somewhat involved in informal circular economy activities. Innovation and new patents in this sector are very low, with their numbers decreasing.

Overall, emissions from the building sector are fairly low compared to global standards, but demonstrate an increasing tendency. In the physical environment, the use of local organic materials, inadequate CDW management, widespread informality, environmental pollution, and low innovation remain challenges.

Concerns remain with the gradual increase in all emission parameters, despite their current low score. Mainstreaming circularity principles in policy and legal documents, lack of stakeholder knowledge and awareness, proper plan implementation, data availability, certification of low-carbon materials and market incentives have been the key concerns for the enabling environment. Ample opportunities remain in the form of good institutional and governance culture, the presence of policy and legal foundations, and an overwhelming quantity of unaccounted (informal) waste collection and recycling.

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