CHAPTER 33

Circular Economy Strategy for Construction Material Reuse through Deconstruction Methods in India

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ABSTRACT

The construction industry in India is experiencing significant growth, yet it is also one of the largest contributors to environmental degradation due to the extensive use of non-renewable resources and the generation of substantial waste. This research explores the adoption of circular economy principles, specifically focusing on construction material reuse through deconstruction methods, to address sustainability challenges in the Indian context. Primary data was collected through surveys and interviews with industry professionals, including construction managers, architects, and waste management experts, across key cities in India. The findings reveal that while there is growing awareness about the benefits of material reuse, there is a lack of infrastructure, policies, and knowledge to support effective deconstruction practices. The study highlights the barriers to implementation, such as high upfront costs, limited availability of skilled labor, and the fragmented nature of the construction industry. Still, it also points out areas for development, especially with regard to the combination of technical advancements, sustainable construction methods, and government incentives. This study offers a road map for legislators and industry players to move toward more sustainable, resource-efficient building techniques in India and offers insightful analysis of the possibility for circular economy initiatives to encourage material reuse in construction.

Keywords: Circular economy; Deconstruction; Design for deconstruction (DfD); Waste management; India.

1.0 Introduction

India's construction industry is being driven by a gigantic boom, led by government spending on infrastructure (US$ 120.5 billion in Budget 2023) and urbanization. The size of the sector's market is $778 billion in 2023 and is anticipated to reach $1.393 trillion by 2033. This boom, however, has an environmental cost. Conventional demolition methods produce humongous amounts of building and demolition waste (C&D waste) – an eye-popping 150

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million tonnes every year, as per the Building Material Promotion Council with projections estimating a concerning increase to 250 million tonnes by 2030.And with an official nominal capacity of recycling a paltry 6,500 tonnes per day (TPD), recycling a mere 1% of the C&D waste, the balance to landfills, contaminating the environment and losing valuable resources. Moreover, the construction sector is a hungry consumer of virgin raw materials globally, with India alone consuming a huge quantity annually Sand: 750 million, Stone (aggregate): 2 billion tonnes, Cement: 297 million tonnes. This widespread application generates environmental pollution via resource extraction and treatment.

1.1 The need for a circular economy approach

The construction industry's present waste route adheres to the "take-make-dispose" linear economy. In growing nations, there is a serious risk from both laxer environmental rules and the generation of CDW throughout the planning, designing, procurement, site management, deconstruction, and disposal phases of the building life cycle. In order to reduce waste and resource consumption, the circular economy (CE) promotes techniques including reuse, recycling, and refurbishing. By ensuring that materials are used for as long as feasible, CE aims to prolong their life cycle. The linear economy, in which resources are harvested, employed, and then discarded, contrasts sharply with this strategy.

The circular economy (CE), which emphasises resource conservation and waste reduction throughout a product's lifecycle, offers a remedy. In order to extend their lifespan and reduce reliance on virgin resources, CE promotes recycling, reuse, and the refurbishment of building materials during construction. By attempting to close the resource loop, this tactic aims to minimise waste production and protect valuable natural resources. As a structure nears the end of its life, there is an opportunity to address waste problems by recycling or reusing construction components. End-of-life salvage must be considered throughout the design phase, which necessitates a shift in the construction industry. When a building reaches the end of its useful life, there are two primary options for disposal: building and destruction.

Through the careful disassembly of structures for material collection and reuse, deconstruction provides a sustainable alternative for demolition. The emphasis on quick removal and disposal in conventional demolition stands in contrast to this. For India's building industry, deconstruction has many benefits, including reduced waste, resource conservation, and alignment with the circular economy.

1.2 Deconstruction as a key circular economy strategy

Deconstruction promotes a circular economy by reducing trash, which saves resources, and creating new business opportunities in the reuse industry. Deconstruction is gaining popularity in countries like the United States and across Europe because to concerns about sustainability and the resource economy. The Dutch government has established a "Green Deal Demolition" program that encourages deconstruction and material reuse, in contrast to Japan's

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well-established deconstruction industry with clear regulations and infrastructure. Even while there are still many obstacles to overcome, advancements in technology, sound laws, and more awareness are encouraging wider adoption. Deconstruction methods are still relatively new in India. However, the need for environmentally friendly alternatives to traditional demolition is growing in significance. Deconstruction has great promise for transforming India's construction industry, waste management approach, and circular economy trajectory. It addresses pressing issues such resource scarcity, waste management, and environmental sustainability. Despite ongoing challenges, a concerted effort by lawmakers, corporations, and the scientific community might create an atmosphere that is conducive to the development of deconstruction methods.

2.0 Literature Review

2.1 Principles of circular economy in construction

Construction circular economy approaches adhere to the concept of closing the material loop through reduction, reuse, and recycling. At the centre of the approaches is the process of deconstruction, which presents an alternative to conventional demolition through dismantling care that facilitates recovery of materials. Research has shown that lean processes integration into deconstruction processes greatly enhances material recovery and reduces wastes (Boukherroub *et al.*, 2024; Benachio *et al.*, 2021). Technologies like Building Information Modeling (BIM) that include material passports offer more convenience through material tracking throughout its life cycle (Neyra & Celoza, 2024; Atta *et al.*, 2021). The systems enable design-for-disassembly (DfD) practices where buildings are prepared upfront for future deconstruction and reuse (Derikvand & Fink, 2023; Olugbenga Akinade & Owolabi *et al.*, 2020). The environmental consequences of this process are overwhelming. Reducing construction waste sent to landfill and lower reliance on virgin materials, deconstruction saves natural resources and lowers greenhouse gases (Bertino *et al.*, 2021; Sehnem *et al.*, 2019). Indications are also shown through evidence of long-term economic gains through the early implementation of deconstruction principles during design (Lima *et al.*, 2023; Ganiyu *et al.*, 2020). In addition, the transition towards circularity is also accompanied by policy interventions and regulations favouring sustainable construction (Ahmed *et al.*, 2024; Arruda *et al.*, 2021).

2.2 Global best practices in construction material reuse

Across the world, a number of case studies demonstrate the effective application of circular economy measures in the construction industry. In Canada, for instance, lean-based deconstruction methods have illustrated how stakeholder engagement at a system level and process optimization can overcome operational challenges to realize higher material recovery rates (Boukherroub *et al.*, 2024; Lynch, 2022). Equally, Han *et al.* (2024) inform that visual demolition waste management systems based on BIM improve decision-making and curtail both

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carbon emissions and the cost of waste management considerably. These innovations in digital technologies resonate with European research, where superior practices like 6D BIM have been successfully utilized to improve material traceability and recycling (Mrad & Frölén Ribeiro, 2022; Bertin *et al.*, 2019). Case studies from the United States further underline the potential of deconstruction. Research by Sanchez, Rausch, and Haas (2019) and Cruz-Rios and Grau (2020) studies reveal how disassembly design and adaptive reuse help to generate economic value while minimizing environmental effects. These studies identify that embracing modular design strategies and prefabrication can lead to more effective deconstruction processes and increased circularity (Korde & Jaglan, 2023; Piñones *et al.*, 2023). The use of new procurement methods and digital platforms has also been found to stimulate collaboration between stakeholders and the implementation of circular practices among various projects (Ahmed *et al.*, 2024; Cho, El Asmar, & Aldaaja, 2022). In addition, there is an increased recognition of these strategies by emerging economies. For instance, Bao (2023) records effective circular actions in China, where economic incentives, smart technologies, and government interventions have worked together to advance construction waste recycling and material reuse. Likewise, research in the UAE shows that the adoption of circular practices in Construction and Demolition Waste (CDW) management during the initial stages can drive faster transition towards sustainable construction frameworks (Nie, Dahanayake, & Sumanarathna, 2024).

2.3 Challenges and barriers in India's construction sector

Even with the promise of circular economy practice, India's construction industry has much to learn regarding the adoption of deconstruction practices. The industry is ridden with the dominance of unorganized waste management and a weak market for recycled materials, hence discouraging systemic adoption of deconstruction (Bhavsar *et al.*, 2023; Singhal, Jain, & Jain, 2019). In addition, there is a prevalent broad gap between theoretical benefits of deconstruction and actual application due to inadequate early planning and failure to incorporate advanced technology such as BIM (Swetha *et al.*, 2022; Rahigude *et al.*, 2022). Economic considerations are also a part of the issue. Greater initial cost with deconstruction compared to traditional demolition, along with weak monetary incentives and subsidies, discourage parties to implement such green strategies (Singhal *et al.*, 2019; Tleuken *et al.*, 2022). Furthermore, the absence of inclusive regulatory systems and weak practitioner knowledge discourage widespread application of circular strategies (Johns, Talebi, & Kagioglou, 2022; Eberhardt & Birgisdottir, 2022). For overcoming such challenges, multi-dimensional interventions are required. Policy reforms that include tax incentives, subsidies, and enhanced controls over waste management can prove effective in spurring deconstruction (Rausch *et al.*, 2022; Asante *et al.*, 2022). Training and capacity-building interventions of a specialized type can also create industry capability and competence and thus bridge the theory-practice gap (Smitha & Thomas, 2024; Basta *et al.*, 2020). Government, industry, and academia need to collaborate also in the creation of an enabling environment for circular economy practice (Allam & Nik-Bakht, 2023; Zaman *et al.*, 2018).

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3.0 Research Methodology

The research method was formulated to critically analyze the adoption of circular economy methods for material reuse in the construction industry of India through deconstruction techniques. The research aimed to determine the effectiveness, issues, and opportunities associated with material reuse processes in the construction sector. For attaining comprehensive outcomes, a systematic research approach was adopted, encompassing both primary and secondary data.

3.1 Research design

Using a descriptive research approach, this study deepened knowledge of present behaviors, attitudes, and difficulties related with deconstruction techniques in India. This allowed the gathering and examination of quantitative data to identify trends and patterns in the adoption of the circular economy among the building sectors.

- *Primary data:* Structured questionnaires of construction industry players such as architects, engineers, contractors, and legislators helped to gather much of the data. The comments provide a window into the pragmatic constraints, financial viability, and degrees of approval for material reuse depending on deconstruction.
- *Secondary data:* Secondary data came from academic publications, industry reports, government papers, case studies on circular economies and environmentally friendly building techniques. These materials provide a contextual framework and help understand main data.

Table 1: Respondents Profile (Years of Experience)

Years of Experience	Frequency	Percentage (%)
1-5 years	58	38.7
6-10 years	41	27.3
11-20 years	29	19.3
21 years or more	22	14.7
Total	**150**	**100.0**

3.2 Sampling method and sample size

To ensure an unbiased selection of respondents from the building industry, a random sampling method was employed. The study targeted experts who were actively engaged in sustainable building, demolition, and material reusing policies. There were discovered to be 150 respondents in the sample, ensuring sufficient representation of stakeholders and maintaining data collecting and analysis feasibility.

3.3 Questionnaire design and respondents' profile

The questionnaire had 27 statements corresponding to various dimensions of deconstruction practice and the perceived impact on economic development and sustainability.

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Cronbach's Alpha was used to determine the reliability of the questionnaire, and it scored 0.800, which accounted for superior internal consistency.

4.0 Data Analysis Results and Discussions

The data analysis in this study explores the implementation of circular economy strategies in the Indian construction sector, specifically focusing on material reuse through deconstruction methods. It examines key barriers, including policy, legal frameworks, and cultural attitudes, while highlighting the potential economic and environmental benefits of adopting deconstruction techniques. This analysis provides insights into the feasibility and challenges of integrating sustainable practices in India's rapidly growing construction industry. The data analysis was performed using Descriptive Statistics, Reliability Analysis (Cronbach's Alpha), and One-Sample T-Test Analysis to understand the perceptions, attitudes, and challenges associated with deconstruction methods in India.

Table 2: T-Test

One sample statistic				
	N	**MEAN**	**Std deviation**	**Std error mean**
There is sufficientawareness among construction industry Stakeholders about deconstruction methods.	150	2.10	1.079	.088
Do you believe that government Incentives such as taxrebates or subsidies can help to promote deconstruction techniques	150	3.17	1.368	.112
Cultural attitudes towardwaste management and sustainability in India hinder the adoption of deconstruction practices	150	3.45	1.272	.104
Public perception of sustainability affects the demand for deconstructed materials	150	3.23	1.297	.106
Education and public awareness campaigns can contribute to the acceptance of deconstruction practices	150	3.33	1.257	.103
For deconstruction initiatives to be implemented successfully, community involvement is essential.	150	3.39	1.413	.115
Policy inadequacies are a serious hurdle to the implementation of deconstruction in India	150	3.55	1.334	.109

One-sample t-test reveals stakeholders are unaware of deconstruction methods (Mean = 2.10) and also possess different opinions on the effectiveness of incentives provided by the

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government (Mean = 3.17). Cultural mindset is revealed to be a barrier to adoption (Mean = 3.45), while public opinion and awareness campaigns have moderate effects on acceptance (Means = 3.23 and 3.33, respectively). Community involvement is considered necessary for successful implementation (Mean = 3.39). Policy loopholes are of utmost concern (Mean = 3.55), and they are also the biggest barrier. The research suggests policy loopholes must be plugged, public awareness must be boosted, and community participation must be increased to make deconstruction methods effective in India.

One-Sample T-Test Analysis: The One-Sample T-Test was conducted to assess whether the mean responses differ significantly from a neutral point (test value = 0).

One-sample t-test results indicate that all statements have statistically significant mean differences with p-values less than 0.05. The results indicate low awareness of deconstruction methods among stakeholders (Mean = 2.10), moderate agreement that government incentives can facilitate deconstruction (Mean = 3.17), and high agreement that cultural attitudes hinder adoption (Mean = 3.45). Public perception of sustainability (Mean = 3.23) and educational campaigns (Mean = 3.33) are observed to enhance acceptance. Community participation (Mean = 3.39) is found to be a prerequisite for effective implementation, while policy gaps (Mean = 3.55) are observed to be the most critical barrier.

Table 3: One-Sample T-test

Statement	Mean	t-value	p-value (Sig.)	Interpretation
There is sufficient awareness among construction industry stakeholders about deconstruction methods.	2.10	23.835	0.000	Low awareness of deconstruction methods.
Government incentives (e.g., tax rebates or subsidies) can help promote deconstruction techniques.	3.17	28.351	0.000	Mixed responses; moderate agreement.
Cultural attitudes toward waste management and sustainability hinder adoption of deconstruction.	3.45	33.187	0.000	Cultural factors are barriers.
Public perception of sustainability affects demand for deconstructed materials.	3.23	30.521	0.000	Positive perception; but needs improvement.
Education and public awareness campaigns contribute to acceptance of deconstruction.	3.33	32.484	0.000	Education plays an important role.
Community involvement is essential for successful implementation of deconstruction.	3.39	29.350	0.000	Strong agreement on community involvement.
Policy inadequacies are a serious hurdle to deconstruction in India.	3.55	32.561	0.000	Policy issues are significant challenges.

The findings reveal a number of challenges and opportunities for promoting deconstruction practice in India. The majority of the respondents are of the view that government incentives,

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technological innovation, and policy reforms are essential to drive the adoption of deconstruction. While most of the respondents are aware of the economic and environmental benefits of deconstruction, there are cultural attitude challenges, technological limitations, and policy loopholes. Policy reforms, fiscal incentives, public awareness, and technological innovation would greatly enhance the adoption of deconstruction practices in India.

5.0 Conclusion

This Study "Circular Economy Strategy for Construction Material Reuse through Deconstruction Methods in India" presents the increasing awareness of the utilization of circular economy principles as a primary strategy to enhance India's sustainability of the construction sector. Research findings state that while a substantial majority of players in the construction sector are aware of the potential economic and environmental gains of the utilization of deconstruction methods, a number of barriers discourage their utilization. These include low awareness, policies, regulatory constraints, a lack of favourable financial support, and weak capacity for technology. Furthermore, most respondents are of the opinion that the intervention of the government by way of incentives and reforms is critical to advocate the use of circular economy principles due to the inefficiency of current waste management structures to enable the large-scale processes of deconstruction. While most respondents acknowledge the potential of deconstruction in minimizing harm to the environment and maximizing economic growth, they still acknowledge the reality that India's infrastructure, laws, and awareness-raising policies all require major improvement. A further effort is required to address existing barriers and build a framework that favours circular economy strategies in the construction sector based on the excellent match of deconstruction methods and sustainability objectives.

5.1 Limitations

The research is limited by sample prejudice in the sense that it applies to just a single region or type of professional who might not represent all shades of opinion among the construction professional community. Since there is neither primary data and real case study of deconstruction in India, conclusions are also mostly derived in terms of views and impressions and therefore can turn out to be speculative or preconceived ones. Additionally, the study ignores regional differences within India—where local legislation, infrastructure, and industrial practices vary—and does not explore detailed technological solutions or broader political, economic, and educational factors.

5.2 Recommendations

To promote circular economy strategies through deconstruction in India, the study recommends enhancing awareness and education via government-led campaigns and industry workshops aimed at builders, architects, policymakers, and the public. The research is limited by

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sample prejudice in the sense that it applies to just a single region or type of professional who might not represent all shades of opinion among the construction professional community. Since there is neither primary data and real case study of deconstruction in India, conclusions are also mostly derived in terms of views and impressions and therefore can turn out to be speculative or preconceived ones

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