



Evaluating Circular Economy and Waste Management Frameworks for Application in Design Higher Educational Institutions (HEIs): A Review-Based Framework Synthesis

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ABSTRACT

As per the report by Sustain Your Style (2023) the fashion and design industry is the 2nd largest pollutant in the world, therefore necessitating sustainable practices at both pre and post-consumption levels. Design HEIs are the hub to develop fresh minds into strategic agents to work towards fostering conscious professionals. However, their pedagogical approach relies on material-intensive methods that involve prototyping, and explorations produce diverse and complex waste streams. Currently, the existing circular economy (CE) and waste management frameworks remain fragmented, that are primarily operating at a macroeconomic or industrial focus perspective, and lack the operational flexibility that is essential when applied in an academic setting. Furthermore, transitioning to circularity on campus is frequently hindered by prominent factors such as physical infrastructural constraints and behavioural barriers amongst all the stakeholders across the campus.

This paper addresses this gap by evaluating twenty prominent theoretical frameworks across economic, ecological, behavioural, and pedagogical domains that underwent a rigorous multistage thematic analysis. The frameworks are lacking academic applicability awareness, are eliminated, and ultimately narrowed to isolating two core models that possess a high operational synergy for these HEIs.

The Research concluded that achieving true circularity requires moving beyond basic waste segregation by synthesizing physical material management with a shift in human behavioural attributes. Consequently, the paper proposes a contextualized “**Dual-Pillar Approach.**” The first pillar works on the 10R Framework to establish strict waste hierarchies and integrate circularity into grading & second pillar employs the Pro-Circular Change Model to overcome psychological barriers and embed sustainable stewardship into the curriculum. By bridging physical waste management with a cultural mindset shift, this approach aligns with UN Sustainable Development Goal 12 of Responsible Consumption and Production, ensuring future designers are trained as conscious professionals within regenerative systems.

Keywords: Circular Economy, Waste Management, Design Education, Material Recirculation, Sustainability, Conscious Consumption

1. Introduction

Design is a form of self-expression. Every morning, when an individual gets dressed, it is like a painter with a canvas, and those canvases reflect their values, which often serve as an overview of their cultural essence and social norms. Fashion plays a crucial role in shaping social interactions and cultural norms across various geographical regions. Despite being one of the most versatile industries, it is troubling that it continues to generate significant waste by producing large quantities of low-durability clothing, catering to a **'throwaway society'** (UNEP, 2025).

Being a prominent part of our lifestyle, as per a report of Fashion and Environment by SustainYourStyle in 2023, the fashion Industry remains the 2nd largest polluting industry, responsible for approximately 8% - 10% of the global greenhouse gas emissions, which is a significant indicator of an alarming situation (Guterres, 2025; UNEP, 2025). In India, Textile waste has escalated to approximately 7.8 million tonnes annually, accounting for roughly 8.5% of the global total (Fashion for Good, 2024; TERI, 2025). Sustainable pre- and post-consumption waste management practices are integral to a designer's responsibilities, as mentioned within this volume, mentioned 51% is post-consumer waste. In comparison, 42% is generated as pre-consumer trash during design and prototyping (IDR, 2025).

Waste is an integral aspect of the design process; it is crucial to understand the origins of waste generation and its impacts. A fundamental basis of how design is being inculcated amongst individuals and practiced later leads to essential reduction and efficient use of resources (Tangwanichagapong et al., 2024). The journey of every designer commences the moment they enter the design school. These nascent minds, brimming with enthusiasm and creativity, can be shaped into responsible professionals committed to conscious practices.

HEIs for design are focused on imparting education, conducting research, and fostering innovation across the fields of design. These institutes are spaces that cultivate fresh minds into creative innovators for the near future that directly make them “strategic agents” for the circular transition moving away from the traditional linear patterns towards responsible consumption and production. Studies have shown that waste generated on campus quantifying waste, such as hard materials, e-waste, and paper, on campus can lead to a huge recovery rate where only a small fraction (<3%) of the total waste is sent to landfills Chennai Institute of Technology, 2025). During this phase of teaching and learning, these design-oriented students are observed to generate an average amount of 0.19 ± 0.21 kilograms per person per day (Rodríguez-Guerriero et al., 2024) as students are primarily involved in prototyping, exploration and ideating through studio-based pedagogical learning. Currently, there are institutions that have not given enough attention to incorporating internal waste management frameworks that allow the stakeholders to effectively work on recycling the waste with the mission of “Your trash is your treasure” within the campus ecosystem.

In order to address this issue, a shift towards the circular economic (CE) approach is essential to be practiced globally to encourage a regenerative-reuse-recover approach (Geissdoerfer et al., 2017; Korhonen et al., 2018). CE principles and waste management have been strengthening resource efficiency in various sectors in the industry, but their role in the educational sector remains fragmented. This is extremely problematic for design-oriented HEIs due to their material-intensive activities and project-based learning methods; design institutes generate diverse forms of waste and thus face a unique set of sustainability challenges.

Numerous circular economy (CE) and waste management frameworks have been conceptualized towards systemic sustainability (Kirchherr et al., 2017). Their operational translation into practical systems for design campuses remains inherently flawed and fragmented. Current institutional practices of these HEIs are mainly working on conscious practices such as basic segregation and end-of-life

recycling, which is clearly not a holistic, closed-loop approach of material circulation (Ellen MacArthur Foundation, 2013). Furthermore, implementation of these frameworks in HEIs is frequently hindered by institutional constraints, including a lack of circular infrastructure and behavioural challenges among diverse stakeholder groups on campus (Ajzen, 1991). A review of the existing literature focuses mainly on the needs of the industry, and limited emphasis is placed on strategies that handle waste during academic material consumption with a closed-loop re-circulation model within the academic ecosystem (Bocken et al. 2016).

To build a more meaningful, context-driven understanding of the problem, this paper aims to analyse and evaluate existing theoretical frameworks related to waste management, the circular economy, and sustainable practices, assessing their relevance and applicability in design-oriented HEIs. A rigorous secondary data-based review and comparative analysis of 20 prominent frameworks, identifying significant gaps and HEI-specific performance indicators, ultimately seeks to demonstrate the critical need for a contextualized conceptual framework tailored specifically for design HEIs. Developing such a tailored approach is essential to support integrated circular waste management, achieve measurable circularity outcomes, and drive comprehensive responsible resource efficiency and mindful consumption across academic institutes.

Furthermore, a shift of these HEIs towards circularity is closely aligned with the United Nations' Sustainable Development Goal 12 - Responsible Consumption and Production. By rethinking waste as a resource and prioritizing upstream prevention, design education institutes can actively contribute to this global mandate of substantially reducing waste generation at the root level.

2. Methodology

2.1 Research Design

The study is done using a systematic method of evaluating the existing frameworks based on the core concept of circular economy (CE) and waste management strategies that have been developed to work towards responsible and conscious consumption, SDG 12. This comprehensive analysis examines the establishment of all these theoretical frameworks and their operational viability in academic environments, further understanding the need for a conceptual framework specific to the needs of these HEIs in order to manage waste effectively, leading to mindful and conscious consumption practices within the academic ecosystem.

2.2 Data Collection

A rigorous literature review was conducted across academic databases, including Scopus, Web of Science, Google Scholar, Science Direct, and SpringerLink. The retrieval process was guided by a structured keyword strategy utilizing terms such as "circular economy framework," "waste management," "zero waste campus," "resource efficiency," "material recirculation," and "HEIs waste management." Inclusion measures specifically focused on frameworks that exhibited a clear theoretical or operational structure relevant to CE and institutional sustainability.

2.3 Multi-stage comparative analysis

Step 1: Initial purposive sampling of 20 frameworks: Based on the literature review, 20 prominent frameworks were chosen purposely. This broad selection was done to ensure comprehensive coverage of all the relevant keywords related to foundational sustainable system frameworks, i.e., behavioural and change models, operational and institutional management frameworks, and pedagogical frameworks.

Step 2: Comparative Analysis and shortlisting 8 frameworks: The initial set of 20 frameworks was subjected to a comparative evaluation based on that applicability in an academic institution and the breadth of their conceptual scope. The frameworks that lacked relevance and actionable operational guidance were eliminated. This narrowed down the research to 8 highly relevant frameworks that addressed institutional resource efficiency, stakeholder integration, and material recirculation on campus.

Step 3: Final selection of 2 core frameworks for conceptual development: In order to understand the need to build a conceptual framework specific to design-oriented HIEs, it was important to build a targeted contextual framework for design education. The remaining 8 frameworks were critically assessed against the unique parameters of design HEIs, such as studio-based learning, intensive material exploration, diverse material waste, along with high turnover of varied waste streams. Through this stringent assessment, two foundational frameworks were selected. These two models were seen as the most transferable elements that hold operational synergy that is required to form the theoretical baseline of a fresh strategy to be implemented in the design-based HEIs.

2.4 Data Analysis Approach

To conduct a robust evaluation across all the stages of data collection, data was extracted in order to maintain a standardized comparative layout. This template systematically captured the core components around circularity (reduce, reuse, recycle, and recover), specific to the roles of stakeholders, monitoring indicators, and overall relevance in HEIs. Finally, the extracted data were subjected to qualitative analysis and compared to identify operational gaps and the specific limitations of these frameworks when applied to the unique, material-intensive ecosystem of teaching and learning in a design institution.

3. A thematic analysis of frameworks

In order to build a well-thought-out conceptual framework, the 20 identified frameworks were systematically assessed based on five core thematic domains. This thematic structuring has provided a comprehensive theoretical base to slowly shift these institutions from a traditional linear approach towards a sustainable closed-loop educational environment.

Theme 1: Foundational sustainable, economic, and ecological models

These foundational frameworks outline the systematic transformation at a macro level that is necessary to achieve institutional resource efficiency and closed-loop circulation of resources.

1. **Economy in Loops/ Performance Economy (Stahel,1982):** According to the research by Walter, which focuses on the idea of “**resource longevity**,” it focuses on increasing the product lifecycle by systematically reusing, repair and reconditioning to reduce raw material procurement. In contemporary academic and industrial domain this concept has evolved into a functional service-based economy where a product is recognized as a service (PaaS) model that shifts the institutional focus from the ownership of physical goods to the leasing of performance and utility.
2. **Industrial Ecology (Frosch and Gallopoulos,1989):** This model revolves around a systems thinking approach of applying human production networks. It operates on the core principle of industrial symbiosis, where waste produced by one process acts as a raw material for another. In recent years, industrial ecology has evolved to guide micro-level institutional networks utilizing digital traceability to map and exchange material flows across the ecosystems.

3. **Triple Bottom Line:** This model is an evaluation of the traditional success by assessing the organisation's performance across three major pillars that are interlinked: People, Planet, and Profit (Elkington, 1997). This model is designed to ensure that sustainable interventions remain economically feasible while being socially unbiased and ecologically sound. In 2018, John Elkington issued a “management recall” on the framework, arguing its adoption as a basic accounting tool would not bring systemic change (Elkington,2018). It further shifted towards a “Green Swan” economic approach, demanding that industry actively pursue exponential, regenerative breakthroughs (Elkington, 2020).
4. **Zero Waste:** Operating at both a strategic and operational base, this framework seeks to achieve a complete elimination of waste by managing product redesign and material recirculation by strictly prioritizing the idea of upstream prevention over downstream landfilling (ZWIA,2009). This framework has continuously evolved and refined to address the needs of the hour. In June 2025, the Zero Waste International Alliance released version 8.1 of the zero waste hierarchy, introducing fresh mandates such as the “**Do No Harm**” & “**Do Not Export Harm**” agenda. This aligns with the zero-waste goals of the broader circular economy by holding institutions accountable for the global lifecycle impact and toxicity of their materials (ZWIA, 2025).
5. **Circular Economy:** Serving as the leading model towards modern sustainability, the circular economy (CE) is built on three practical goals, i.e., to eliminate waste right from the design stage, keep products and materials in use at their highest value, and actively restore systems (Ellen MacArthur Foundation, 2013). This framework has grown beyond its focus on simplifying reusing materials. A recent update highlights that a true circular economy must be "**nature-positive by design**" (Ellen MacArthur Foundation, 2024). It directly connects resource efficiency with the protection of biodiversity at a global level, also working on achieving the UN's Sustainable Development Goals (SDGs), aligning with SDG 12 of Responsible Consumption and Production.

Theme 2: Design and Material Strategies

This theme focuses on the physical development of products and materials, where design schools play a highly valuable position because they directly apply to what happens in their labs, offering a clear and actionable rule for conscious and mindful learning through hands-on experiences.

1. **Regenerative Design (Lyle,1994)** - This model works on focusing on creating systems that actively work on the principles of nature, where “**waste**” for one source becomes valuable and healthy as a resource for another. Today, regenerative design is not just a theoretical concept for landscapes or architecture; it is being actively applied to textiles (Wahl, 2016), but it is more of a practice, turning the design process into a tool for ecological healing.
2. **Biomimicry:** Biomimicry is defined by biologist Janine Benyus in 1997 in her book “**Biomimicry: Innovation Inspired By Nature**” that has evolved from the traditional observational practice towards a more rigorously explaining scientific and economic discipline (Benyus,1997).In the context of designing HEIs, biomimicry is transitioning from a niche elective subject towards a foundational curriculum requirement. It is often taught via nature's “**Life’s Principles,**” which provides evolutionary design strategies 3.8 billion years of research and development, where ultimately it would foster innovations that are adaptable, regenerative, and deeply align with sustainable practices (Lepora, Verschure, & Prescott, 2013).

3. **Design for Circularity:** This framework categorizes strategies to make products more circular. It focuses on three main goals: “**Slowing**” loops of making products last longer, “**Closing**” loop of recycling materials, and “**narrowing**” loops of using fewer resources overall (Bocken et al., 2016). As time passed, circularity has become more mainstreamed this framework is extremely dependent on digital technology.
4. **Biodesign:** The cutting-edge field that is blending biological sciences with design processes. It involved organisms from the environment to grow products that can safely decompose back into the earth perfectly aligning with the idea of zero waste targets (Oxman, 2016). There is a rise in this concept where it is growing from experimental labs to commercial viability. In the coming years, futuristic thinking in design education

Theme 3: Behavioural Change and Social Psychology

While establishing physical waste management infrastructure is essential, these frameworks emphasize the human element of institutional sustainability. These models help HEIs identify psychological barriers and design interventions to foster a mindset shift in campus.

1. **Theory of Planned Behaviour (TPB):** A foundational psychological framework used to understand and predict human behaviour. It argues that an individual's actions are driven by three core factors: their personal *attitudes* toward the behaviour, the *subjective norms* (peer pressure or campus culture), and their *perceived behavioural control* (how easy or difficult it is to perform the action) (Ajzen, 1991). In contemporary academic settings, TPB has shifted from merely analyzing behaviour to actively altering it through "choice architecture" and nudging (Thaler & Sunstein, 2008). In a design studio context, this means strategically redesigning the environment—such as placing textile recycling bins immediately next to cutting tables while moving landfill bins to the hallway—thereby increasing students' perceived behavioural control and making circular practices the path of least resistance (White et al., 2019).
2. **Value-Belief-Norm Theory (VBN):** This model links an individual's underlying personal values and ecological beliefs directly to their moral obligation to act. It serves as a strong predictor for pro-environmental behaviours, suggesting that students will act sustainably if they believe their actions actively prevent harm to things they value (Stern, 2000). VBN has evolved within design education from promoting general environmental awareness to fostering specific "**material stewardship**." Modern pedagogical applications use this theory to align a student's emerging professional identity with sustainability. By embedding ecological beliefs deeply into the curriculum, educators establish a new subjective norm where wasting material is not just an operational flaw, but a fundamental breach of professional design ethics (Manchiraju & Sadachar, 2014).
3. **Pro-Circular Change Model:** A highly specific behavioural model designed to identify and systematically overcome the psychological, cultural, and institutional barriers that prevent effective material reuse and recycling, ultimately fostering a pro-circular mindset (Muranko et al., 2018). This model is increasingly being used to bridge the infamous "**intention-behaviour gap**" in educational environments. Recent evolutions of the framework focus on removing the "inconvenience barrier" associated with material reuse. For example, modern HEIs are applying this model by integrating digital, peer to peer material sharing apps on campus, which normalizes the use of second hand prototyping materials and heavily reduces the stigma or perceived difficulty of sourcing them (Borg et al., 2020).

Theme 4: Educational and Institutional Frameworks

These models focus on the pedagogical and administrative structures necessary for knowledge transfer. For design HEIs, these frameworks are critical for ensuring that sustainability is not just a campus operations initiative, but a core component systematically integrated into the academic curriculum and institutional culture.

1. **Eco-Schools Framework:** A hierarchical, systems-based educational model that relies on a whole-institution approach to integrate environmental sustainability into school curricula. It actively uses participatory learning, campus waste audits, and project-based education to drive systemic change (FEE, 1994). Originally designed for primary and secondary education, this framework has evolved into the "Living Lab" concept for higher education institutions (Leal Filho et al., 2018). In modern design schools, the campus itself becomes the testing ground. Students do not just learn about waste in theory; they conduct physical waste audits of their own studios and use that data to propose and prototype campus-wide, closed-loop interventions.
2. **Circular Knowledge Reuse:** Rather than focusing purely on physical materials, this framework emphasizes the recirculation of intellectual assets. It promotes the systematic sharing of design case studies, insights, and tools to make future design processes significantly more informed and resource-efficient (Nonaka & Takeuchi, 1995). In contemporary design education, this concept has evolved from physical archives to highly integrated digital material libraries and open-source repositories (Ceschin & Gaziulusoy, 2016). By documenting the life-cycle analysis and material experiments of past cohorts, institutions ensure that current students can iterate on existing sustainable solutions rather than continuously "reinventing the wheel" and wasting fresh prototyping resources.
3. **ThreeC Didactical Approach:** A competence-oriented educational methodology focused specifically on three pillars: Circular, Collaborative, and Creative learning. It trains students to apply systems thinking to identify critical intervention points and co-create viable circular solutions (UNESCO, 2017). This framework has shifted from theoretical pedagogy to active, interdisciplinary studio practice (Lozano et al., 2017). Recognizing that true circularity cannot happen in silos, modern design HEIs use the ThreeC approach to mandate cross-departmental collaboration. For example, fashion students may collaborate directly with industrial design or biomaterial students to upcycle textile offcuts into new composite materials, mimicking real-world industrial symbiosis.

Theme 5: Supply Chain and Lifecycle Management

These models expand the scope of circularity beyond the immediate boundaries of the campus. For design HEIs, these frameworks are essential for teaching students how to map the broader systemic impacts of their work, ensuring transparency from raw material sourcing all the way through to reverse logistics and end-of-life recovery.

1. **Sustainable Supply Chain Management (SSCM):** This framework embeds reverse logistics, closed-loop product lifecycle strategies, and ethical labor standards directly into supply chain operations. It focuses heavily on transparency and the ability to track materials comprehensively from initial sourcing through to end-of-life disposal or recovery (Seuring & Müller, 2008). In the context of modern design HEIs, SSCM has evolved from a theoretical business concept into a strict institutional procurement mandate. Forward-thinking campuses are now utilizing blockchain and digital traceability tools to audit their own supply chains, ensuring that the raw materials purchased for student studios—such as fabrics, dyes, and prototyping polymers—are ethically sourced and verifiable (Kouhizadeh et al., 2021).

2. **Extended Producer Responsibility (EPR):** A policy approach that holds producers legally and financially accountable for the entire lifecycle of their products. It specifically focuses on mandating product take-back systems and forcing manufacturers to fund the infrastructure required for downstream recycling (Lindhqvist, 2000).
3. **DISRUPT Framework:** This model provides a multi-tiered system of strategies to facilitate the transition to circular business models: **Design for the future, Incorporate digital technology, Sustain what's there, Rethink business models, Use waste as a resource, Prioritize regenerative resources, and Team up** (Bocken et al., 2014). The DISRUPT framework has transitioned into a highly effective evaluative matrix for academic juries and design critiques. Rather than merely grading the aesthetic or physical outcome of a garment or product, educators use the seven pillars of DISRUPT to assess the systemic viability of a student's project, pushing them to consider digital integration and collaborative business models alongside material choices.
4. **Circular Pathway:** An 8-step, project-based methodology that actively guides designers through the process of redesigning linear value chains into circular ones. It includes distinct operational phases such as context mapping, reframing the problem through a circular lens, co-creation, and prototyping systemic interventions (Geissdoerfer et al., 2017). This framework has become the backbone for highly structured, challenge-based studio courses. It moves students away from abstract sustainability theories and provides a practical, step-by-step roadmap. In design HEIs, it is frequently used to structure semester-long collaborative projects where students partner with local industries to solve real-world, localized circularity bottlenecks.

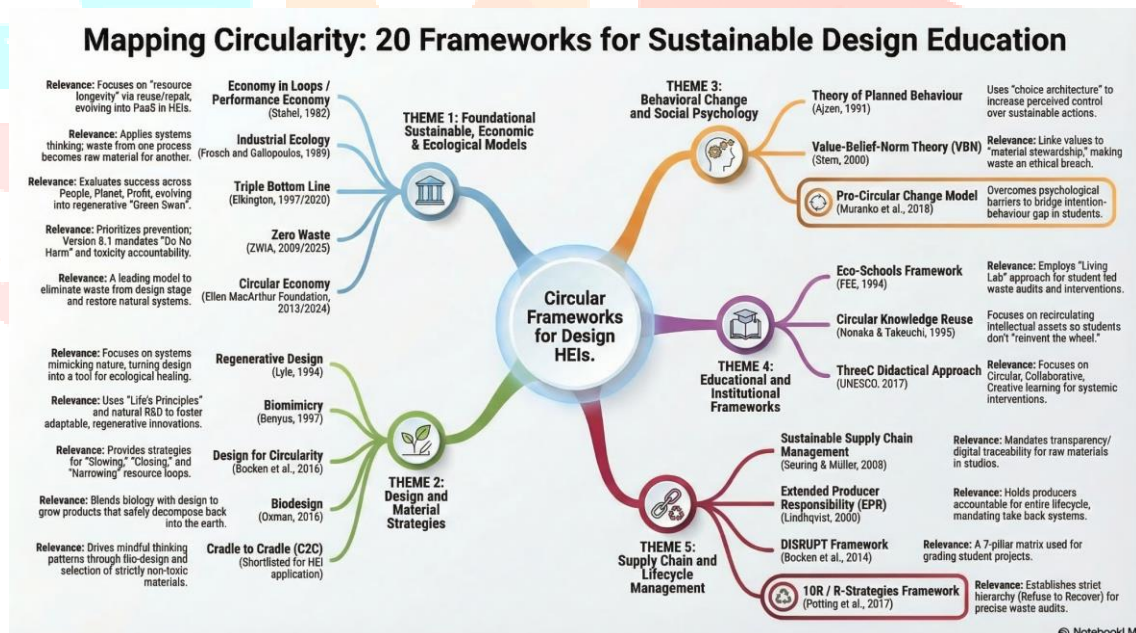


Figure 1: Thematic classification of existing frameworks

5. Results and Discussion: Framework Evaluation and Conceptual Synthesis

5.1 Shortlisting the Frameworks: The review was initially systematic and identified 20 foundational frameworks that included economic, ecological, and psychological factors. However, a thematic analysis demonstrated that most of these models function at a macroeconomic level, lacking the operational granularity that is required in an academic setting. By closing, evaluating these models and frameworks, and analysing them in an industrial ecosystem in terms of applicability, pedagogy, and campus operation viability, 12 frameworks were eliminated. The result shortlisted 8 frameworks that demonstrated

The resulting shortlist of 8 frameworks demonstrated high relevance to Higher Education Institutions (HEIs). This selection included models such as the **ThreeC Didactical Approach**, are focusing on collaborative learning in studios with material-intensive explorations, **Regenerative Design**, and **Cradle to Cradle (C2C)**, which drives bio-design and non-toxic material selection for mindful thinking patterns, the **Triple Bottom Line** for project evaluation, and the broad umbrella of the **Circular Economy Model**. These 8 frameworks provided the crucial stepping stone linking a broad sustainability approach to actionable campus interventions.

5.2 The Final Step: Finalizing the Dual-Pillar Approach Although the 8 shortlisted frameworks offered relevant and valuable inputs in the institutes' development of a highly contextualized conceptual framework of HIEs that are design-focused, which revolve around exploration, ideation, rapid prototyping, and high turnover of waste streams with complex diversities. Evaluating the 8 frameworks against all these factors showcases that in order to achieve circularity across all the departments on campus, a synchronized approach addressing both physical material management and behavioural attributes of all the stallholders. Further, this paper narrowed down to two foundational frameworks through analysis that serve as the baseline for a new conceptual framework for design-oriented HEIs. The **10R/R-Strategies Framework** (Potting et al., 2017) and the **Pro-Circular Change Model** (Muranko et al., 2018). The stringent assessment process identified that these two frameworks possess the highest degree of operational synergy, effectively bridging the implementation gap between infrastructure and engagement stakeholders across the educational institute.

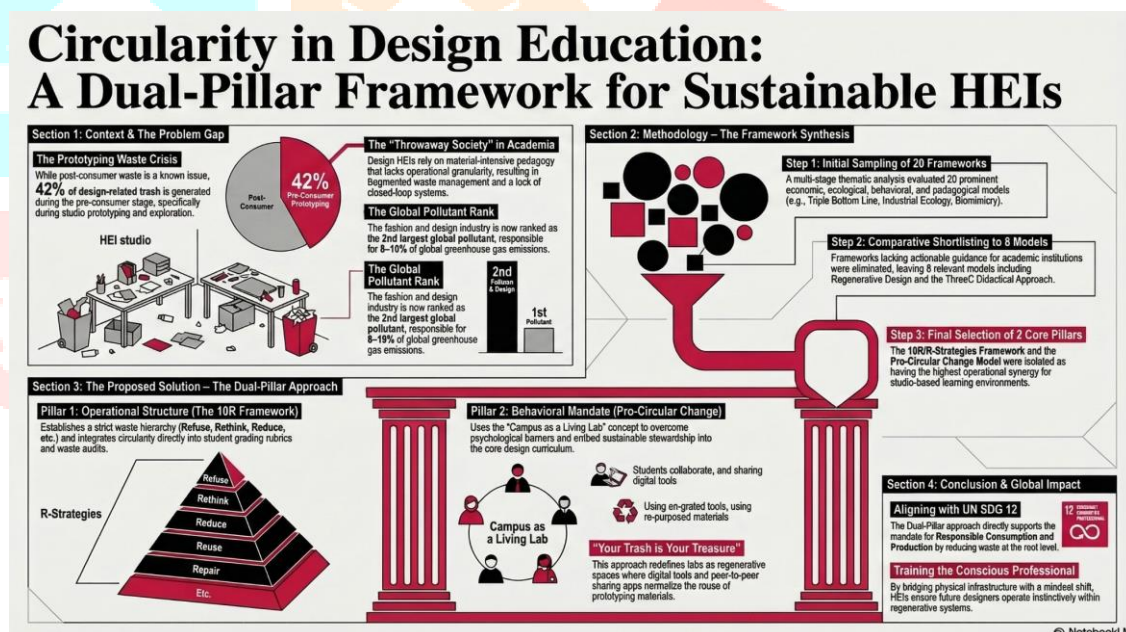


Figure 2: A Dual-pillar framework for Sustainable HEIs (Infographic made by AI-NotebookLM)

6. Conclusion

This shift towards conscious consumption and responsible production, moving towards a transition of a sustainable ecosystem in High educational Institutes (HEIs), is the need of the hour based on specified strategies forming a conceptual framework working on the requirements of the stakeholders. This paper has initiated a thematic analysis of existing frameworks around waste, where it provides a structured understanding of the needs and gaps that are in the HEIs and factors that would affect consumption and production practices that can be applied to academic environments. In order to achieve this, the transition from theoretical frameworks to practical strategies was systematically filtered down based on pedagogical and institutional relevance. These frameworks offer actionable ways that can be integrated into the curriculum throughout learning and teaching. However, developing a targeted

conceptual framework for design-oriented HEIs is required with even more stringent evaluation against the unique demands of project based learning in labs, which involves diverse, rapid, and intensive material waste being generated. This final assessment concluded that true circularity in design education cannot be achieved through physical waste management alone, but it also needs to be coupled with a fundamental shift in the mindsets of all the stakeholders.

Therefore, this research establishes that a successful, highly professional conceptual framework for design HEIs must be constructed upon two interconnected pillars, synthesizing the distinct strengths of the final two selected models:

- **“Your trash in your treasure”:** Utilizing the **10R / R-Strategies Framework** (Potting et al., 2017), this pillar provides the critical operational structure around the campus. By implementing strict hierarchy as of Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle, Recover, it systematically redefines labs. This allows design institutions to execute precise waste audits, establish circular strategy planning, and implement grading rubrics based on the highest level of circularity achieved by students.
- **The Campus as a Living Lab:** Physical infrastructure is entirely ineffective without active, culturally ingrained user participation. Drawing from the institutional methodology as a whole of the framework, this second pillar provides the behavioural and structural mandate to embed circularity directly into the academic curriculum of HEIs. It transforms the physical campus into an active testing ground where sustainable material handling becomes a competency based on ethics as designs, actively driving the mindset shift required for all the stakeholders to embrace conscious consumption and collaborative resource-efficient sharing.

Ultimately, the development of a blend of the structural waste preventive hierarchy of the 10R framework with the behavioural and psychological factors of the Pro-Circular Change Model creates a comprehensive foundation. The dual pillar approach directly fulfils the primary objective of this paper: to develop an actionable conceptual framework that also promotes the **Responsible Consumption and Production (SDG 12)** within design-focused HEIs. Also, ensuring that future designers are inherently trained to operate within a closed-loop, regenerative system, becoming conscious and mindful professionals in the industry.

8. Limitations and Future Scope

This paper identifies several constraints and gaps, such as a macro-level focus, where the thematic analysis of 20 existing frameworks revealed that the models are functioning at a macroeconomic and industrial level, lacking their capabilities of operational granularity to be applicable in academic settings. Moreover, while circular economy (CE) principles are strengthening in the various industrial sectors, their role in the educational sector remains extremely fragmented, also lacking a holistic, closed-loop approach of recirculating materials. Design HEIs are more inclined towards material-intensive pedagogy in studio-based learning that relies on exploration and prototyping, with intensive consumption of materials, which these traditional frameworks do not address effectively.

The research establishes a strong foundation for future scope towards development, as there is a critical need to develop and incorporate a contextual framework specific to the environment of design HEIs. This is possible by a tailored approach of a **“Dual Pillar Approach”** likely to focus on synthesizing the 10R/R-Strategies Framework for operational structure, along with the Pro-Circular Change Model for behavioural shifts to create a comprehensive institutional strategy. Furthermore, there is an opportunity to transform physical campuses into **“A living Lab”** where students conduct waste audits and look at waste as a resource through a closed-loop intervention by increasing digital tools such as

peer to peer material sharing approaches and blockchain-based trackability. Finally, the future implementation aims to fulfil the global concern of United Nations SDG12- Responsible consumption and Production—by reducing waste at the root level within the academic ecosystem of design-oriented HEIs.

References

Journals (Academic Journal Publications)

- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179-211.
- Bocken, N. M. P., de Pauw, I., Bakker, C., & van der Grinten, B. (2016). Product design and business model strategies for a circular economy. *Journal of Industrial and Production Engineering*, 33(5), 308-320.
- Bocken, N. M. P., Short, S. W., Rana, P., & Evans, S. (2014). A literature and practice review to develop sustainable business model archetypes. *Journal of Cleaner Production*, 65, 42-56.
- Borg, D., Mont, O., & Schoonover, H. (2020). Consumer acceptance and participation in circular business models: A systematic literature review. *Journal of Cleaner Production*, 258, 120896.
- Camere, S., & Karana, E. (2018). Fabricating materials from living organisms: An emerging design practice. *Journal of Cleaner Production*, 186, 570-584.
- Ceschin, F., & Gaziulusoy, I. (2016). Evolution of design for sustainability: From product design to design for system innovations and transitions. *Design Studies*, 47, 118-163.
- Elkington, J. (2018). 25 years ago I coined the phrase "triple bottom line." Here's why it's time to rethink it. *Harvard Business Review*, 25, 2-5.
- Frosch, R. A., & Gallopoulos, N. E. (1989). Strategies for manufacturing. *Scientific American*, 261(3), 144-153.
- Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The circular economy: A new sustainability paradigm? *Journal of Cleaner Production*, 143, 757-768.
- Kennedy, E., Fecheyr-Lippens, D., Hsiung, B. K., Niewiarowski, P. H., & Kolodziej, M. (2015). Biomimicry: A path to sustainable innovation. *Design Issues*, 31(3), 66-73.
- Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation & Recycling*, 127, 221-232.
- Korhonen, J., Honkasalo, A., & Seppälä, J. (2018). Circular economy: The concept and its limitations. *Ecological Economics*, 143, 37-46.
- Kouhizadeh, M., Saberi, S., & Sarkis, J. (2021). Blockchain technology and the sustainable supply chain: Theoretically exploring adoption barriers. *International Journal of Production Economics*, 231, 107831.
- Laszlo, A., & Castro, K. (1995). Technology and values: Interactive learning environments for future generations. *Educational Technology*, 35(2), 7-13.
- Leal Filho, W., Shiel, C., Paço, A., Mifsud, M., Ávila, L. V., Brandli, L. L., ... & Caeiro, S. (2018). Sustainable Development Goals and sustainability teaching at universities: Falling behind or getting ahead of the pack? *Journal of Cleaner Production*, 232, 285-294.
- Lozano, R., Merrill, M. Y., Sammalisto, K., Ceulemans, K., & Lozano, F. J. (2017). Connecting competences and pedagogical approaches for sustainable development in higher education: A literature review and framework proposal. *Sustainability*, 9(10), 1889.

- Manchiraju, S., & Sadachar, A. (2014). Personal values and ethical fashion consumption. *Journal of Fashion Marketing and Management*, 18(3), 357-374.
- Oxman, N. (2016). Age of entanglement. *Journal of Design and Science*.
- Rodríguez-Guerreiro, M., et al. (2024). Higher Education Institutions and Waste Generation: A Global Analysis. *Journal of Environmental Management*, 350, 119-130.
- Seuring, S., & Müller, M. (2008). From a literature review to a conceptual framework for sustainable supply chain management. *Journal of Cleaner Production*, 16(15), 1699-1710.
- Stern, P. C. (2000). New environmental theories: Toward a coherent theory of environmentally significant behavior. *Journal of Social Issues*, 56(3), 407-424.
- White, K., Habib, R., & Hardisty, D. J. (2019). How to SHIFT consumer behaviors to be more sustainable: A literature review and guiding framework. *Journal of Marketing*, 83(3), 22-49.

Articles (News, Web, or Magazine Articles)

- Blunkett, D. (1998, July 24). Cash for competence. *Times Educational Supplement*, p. 15.
- Indian Textile Journal. (2019, March 20). Textile waste and sustainability. *ITJ*.
- SustainYourStyle. (n.d.). Fashion & environment. Retrieved from *SustainYourStyle.org*.

Papers (Reports, Policy Papers, and Conference Papers)

- Ellen MacArthur Foundation. (2013). Towards the circular economy: Economic and business rationale for an accelerated transition (Vol. 1). Ellen MacArthur Foundation.
- Ellen MacArthur Foundation. (2017). A new textiles economy: Redesigning fashion's future. Ellen MacArthur Foundation.
- Ellen MacArthur Foundation. (2024). Building Prosperity: Unlocking the potential of a nature-positive, circular economy. Ellen MacArthur Foundation.
- European Commission. (2014). Ecodesign your future: How ecodesign can help the environment by making products smarter. Publications Office of the European Union.
- European Commission. (2022). Ecodesign for Sustainable Products Regulation (ESPR): Digital Product Passport. Publications Office of the European Union.
- Foundation for Environmental Education (FEE). (1994). Eco-Schools framework and methodology. FEE.
- Lindhqvist, T. (2000). Extended producer responsibility in cleaner production: Policy principle to promote environmental improvements of product systems. IIIIEE, Lund University.
- Muranko, Z., Andrews, D., Chaer, I., & Newton, E. J. (2018). Circular economy and behaviour change: Using theory to design a behavioral intervention. *Design Research Society*.
- Potting, J., Hekkert, M., Dijk, M., & Hanemaaijer, A. (2017). Circular economy: Measuring innovation in the product chain. PBL Netherlands Environmental Assessment Agency.
- Stahel, W. R. (1982). The product life factor. Mitchell Prize.
- UNESCO. (2017). Education for Sustainable Development Goals: Learning objectives. UNESCO Publishing.
- United Nations Environment Programme (UNEP). (2015). Global waste management outlook. UNEP.
- United Nations Environment Programme (UNEP). (2018). Putting the brakes on fast fashion. UNEP.

- Zero Waste International Alliance (ZWIA). (2009). Zero waste definition. ZWIA.
- Zero Waste International Alliance (ZWIA). (2025). Zero Waste Hierarchy of Highest and Best Use (Version 8.1). ZWIA.

Books

- Barnhart, R. K. (Ed.). (1988). *Chambers dictionary of etymology*. New York, NY: The H. W. Wilson Company.
- Benyus, J. M. (1997). *Biomimicry: Innovation inspired by nature*. William Morrow & Co.
- Brown, S. & McIntyre, D. (1993). *Making sense of teaching*. Buckingham, England: Open University.
- Elkington, J. (1997). *Cannibals with forks: The triple bottom line of 21st-century business*. Capstone.
- Elkington, J. (2020). *Green swans: The coming boom in regenerative capitalism*. Fast Company Press.
- Lyle, J. T. (1994). *Regenerative design for sustainable development*. John Wiley & Sons.
- Nonaka, I., & Takeuchi, H. (1995). *The knowledge-creating company: How Japanese companies create the dynamics of innovation*. Oxford University Press.
- Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decisions about health, wealth, and happiness*. Yale University Press.
- Wahl, D. C. (2016). *Designing regenerative cultures*. Triarchy Press.

