Circular Economy Principles in Building Construction Management: Pathways to Sustainability

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1. Introduction

The building construction sector is one of the most resource intensive industries worldwide, accounting for approximately 36% of global energy consumption, 37% of energy-related CO_2 emissions, and 40% of raw material use (IEA, 2022; UNEP, 2020). It also generates vast amounts of construction and demolition waste, estimated at nearly one-third of global solid waste, much of which is landfilled rather than reused or recycled (Sheen, 2024; Husgafvel & Sakaguchi, 2021). These figures highlight the sector's central role in resource depletion, environmental degradation, and climate change, underscoring the urgent need to transition from a linear "take–make–dispose" model to a more regenerative, circular economy (CE).

The circular economy has gained increasing attention in construction research as a pathway to minimize waste, extend asset lifespans, and optimize resource use (Chammout & El-Adaway, 2025). Core principles include resource efficiency, design for adaptability and disassembly, material reuse, recycling, and lifecycle thinking (Kumah et al., 2023). Life cycle is an approach that aims to optimize sustainability, efficiency and environmental impacts (Çelebi & Arpacıoğlu, 2025). Resource consumption and environmental emissions, as well as recycling and reuse potential, are important factors affecting the life cycle of a building (Çelebi and Arpacıoğlu, 2023). At the policy level, initiatives such as the European Union Circular Economy Action Plan (European Commission, 2020) and the United Nations Sustainable Development Goals (United Nations, 2015) have positioned the built environment as a priority domain for circular transitions. Yet, despite this momentum, the integration of CE in practice remains fragmented. Much of the literature emphasizes technical aspects such as recycling technologies, modular construction, or material passports (Gondak et al., 2025; Eze et al., 2024), while giving less attention to the managerial processes that determine how circularity is embedded in building projects.

Recent studies have begun to explore CE adoption during early project phases, suggesting that decisions in planning and pre-construction strongly shape lifecycle outcomes (Wijewansha et al., 2021; Katipe Arachchige et al., 2025). For example, incorporating CE requirements into project briefs, procurement strategies, and design coordination can set a trajectory toward more sustainable delivery (Abadi & Sammuneh, 2020). However, these contributions tend to focus on specific subdomains rather than offering a comprehensive framework for embedding CE across all phases of building construction management.

Moreover, existing holistic frameworks often highlight the importance of systemic thinking (Alotaibi et al., 2024; Sheen, 2024) but do not explicitly translate CE principles into construction management processes. The result is a gap between conceptual ambition and managerial practice. Agyekum et al. (2024) further note that professionals across the built environment sector differ in how they prioritize CE principles, revealing inconsistencies that hinder effective implementation. This underlines the need for structured approaches that integrate CE into decision-making, resource allocation, and stakeholder engagement throughout the project lifecycle.

While technical CE strategies such as modular design, design for disassembly, and material recycling have been widely examined in the literature (Kumah et al., 2023; Sheen, 2024), their practical implementation depends fundamentally on management processes, contractual frameworks, and stakeholder coordination (Agyekum et al., 2024; Chammout & El-Adaway, 2025). Without these mechanisms, even the most innovative technical solutions remain fragmented or underutilized. Building construction management therefore provides a critical lens through which CE principles can be operationalized across the building lifecycle**,** ensuring that decisions made in early phases are translated into coherent design, construction, and operational practices (AIA, 2017; ISO, 2008; RIBA, 2020). Positioning construction management at the center of this discussion sharpens the research motivation of this study and ensures stronger alignment with its focus on lifecycle pathways to sustainability.

This study addresses these gaps by adopting a structured literature review and thematic synthesis to explore CE principles in building construction management. The study is guided by the following research questions:

- What are the key circular economy principles relevant to building construction management?
- How can these principles be applied across the different phases of the building construction process?
- What are the major barriers and enablers influencing the adoption of CE in building projects?
- How can building construction management contribute to advancing sustainability through circular practices at the lifecycle level?

The aim of this study is to provide a structured overview of CE in building construction management, clarifying its applications, challenges, and opportunities. The ultimate targets are threefold: to synthesize and categorize CE principles, to demonstrate their relevance across lifecycle phases, and to identify barriers and enablers shaping adoption. By reframing CE as a management-oriented strategy rather than a purely technical concern, this chapter contributes to both scholarship and practice. It argues that building construction management holds a decisive role in operationalizing circularity, enabling the sector to reduce environmental impacts while delivering long term value.

2. Literature Review

2.1. Circular Economy (CE) and Its Applications in the Construction Industry

The construction industry has increasingly been recognized as a critical domain for the transition toward a CE, given its significant contributions to global energy use, greenhouse gas emissions, and raw material consumption (Sheen, 2024; UNEP, 2020). Unlike the linear “take–make–dispose” model, CE emphasizes resource efficiency, waste minimization, and value retention across the lifecycle of materials and assets (European Commission, 2020). Applications in the built environment typically include strategies such as design for adaptability and disassembly, reuse and recycling of materials, modular and prefabricated construction, and the adoption of digital tools to improve traceability (Kumah et al., 2023; Çelebi & Arpacıoğlu, 2024; Gondak et al., 2025).

A substantial body of research demonstrates that CE principles can reduce construction waste, extend asset lifespans, and improve overall sustainability outcomes. For example, Kumah et al. (2023) emphasize design for circularity as a fundamental approach, highlighting strategies for adaptability, modularity, and material recovery. Similarly, Husgafvel and Sakaguchi (2021) show how CE practices in Japan have advanced through adaptive reuse and systemic approaches to waste reduction. Studies focusing on digitalization, such as those by Eze et al. (2024) and Gondak et al. (2025), highlight the role of building information modelling (BIM), internet of things (IoT), and material passports in enabling data-driven management of material flows, thus enhancing transparency and lifecycle accountability.

At the policy and regulatory level, CE in construction has been shaped by international initiatives such as the European Union Circular Economy Action Plan (European Commission, 2020) and the United Nations Sustainable Development Goals (United Nations, 2015), which explicitly identify the built environment as a priority sector for sustainability transformation. These frameworks encourage strategies like extended producer responsibility and lifecycle costing pushing the industry toward more holistic resource management practices (Çelebi & Arpacıoğlu, 2025).

Despite this growing body of work, challenges remain in mainstreaming CE practices in construction. Research often highlights barriers such as high upfront costs, limited client awareness, fragmented supply chains, and the absence of standardized tools for design and material management (Agyekum et al., 2024; Chammout & El-Adaway, 2025). Moreover, much of the literature has concentrated on specific technical aspects, such as recycling technologies or modular systems (Katipe Arachchige et al., 2025; Abadi & Sammuneh, 2020), leaving a gap in understanding how CE can be systematically embedded in broader managerial processes.

2.2. Building Construction Management and Lifecycle Phases

Building construction management is a structured process that organizes and coordinates activities across the entire lifecycle of a project. Rather than being limited to the construction stage alone, it encompasses a sequence of phases that provide continuity from initial project definition to long-term operation. Professional standards developed by organizations such as the American Institute of Architects (AIA), the International Organization for Standardization (ISO), and the Royal Institute of British Architects (RIBA) provide widely recognized frameworks for defining and managing these phases.

The AIA standard documents, including AIA Document A201: General Conditions of the Contract for Construction (AIA, 2014) and the AIA Handbook of Professional Practice (AIA, 2017), outline responsibilities and contractual frameworks for design, construction, and post-construction processes. These documents emphasize the interdependence of planning, contractual arrangements, and execution, highlighting the role of the construction manager as a coordinator of multiple professional inputs.

The ISO 22263:2008 standard complements this perspective by defining project management processes in terms of structured information flows across feasibility analysis, design development, execution, and operation (ISO, 2008). These standard underscores the importance of systematic information management and stakeholder communication throughout the building lifecycle.

Similarly, the RIBA Plan of Work 2020 provides one of the most detailed breakdowns of project stages, beginning with strategic definition and concept design, continuing through technical design and construction, and concluding with handover and in-use phases (RIBA, 2020). Its stage-based structure emphasizes the progressive elaboration of project objectives, technical requirements, and performance targets.

Synthesizing across these professional frameworks, building construction management can be reasonably divided into four overarching phases that provide clarity and consistency for both academic research and professional practice:

Briefing and Planning covering strategic definition, feasibility studies, cost estimation, and project initiation, as emphasized in the *RIBA Plan of Work 2020* and supported by ISO guidelines on feasibility and project initiation (ISO, 2008; RIBA, 2020).

Design encompassing conceptual, schematic, and technical design, as well as coordination among architectural and engineering disciplines, as defined in AIA Document A201 (AIA, 2014), the AIA Handbook of Professional Practice (AIA, 2017), and the RIBA Plan of Work (RIBA, 2020).

Construction involving procurement, on-site management, quality control, and coordination of labor and materials, responsibilities outlined extensively in AIA A201 (AIA, 2014) and supported by ISO standards for execution and information flow (ISO, 2008).

Operation and Maintenance extending from handover through the long-term use, maintenance, and adaptation of the building, as described in the RIBA Plan of Work 2020 (RIBA, 2020) and ISO 22263:2008 (ISO, 2008)

This phase-based understanding provides a systematic lens for analyzing how managerial processes structure the delivery and performance of building projects. It also establishes a foundation for subsequent sections of this chapter, where these phases serve as the reference framework for mapping thematic insights.

2. Material and Method

This study employs a qualitative research design based on a structured literature review and thematic synthesis of academic, industry, and policy sources. The methodological purpose is to construct a framework for embedding CE principles into building construction management processes. This is achieved not through new empirical data, but through a secondary data strategy that consolidates insights from multiple domains into a conceptual model that is academically rigorous and practically applicable.

The source material comprises three categories. First, peer-reviewed academic publications were retrieved from Web of Science and Scopus databases, with a focus on studies published between 2020 and 2025 that address CE in construction, sustainability in building projects, and lifecycle management (e.g., Wijewansha et al., 2021; Katipe Arachchige et al., 2025; Chammout & El-Adaway, 2025; Alotaibi et al., 2024). Second, policy and industry documents such as the European Union Circular Economy Action Plan (European Commission, 2020) and the United Nations Sustainable Development Goals (United Nations, 2015) were reviewed to capture the broader sustainability imperatives shaping CE discourse in the built environment. Third, professional practice standards were considered to structure the lifecycle perspective, particularly the AIA Document A201 and the AIA Handbook of Professional Practice (AIA, 2014; AIA, 2017), ISO 22263:2008 (ISO, 2008), and the RIBA Plan of Work 2020 (RIBA, 2020). These standards provided the basis for classifying project phases according to internationally recognized practice.

From these sources, a set of six CE principles was identified on the basis of recurrence and emphasis across multiple references: design for adaptability and disassembly (Kumah et al., 2023), resource efficiency and waste minimization (Sheen, 2024), material reuse and recycling (Husgafvel & Sakaguchi, 2021), lifecycle costing and risk assessment (Abadi & Sammuneh, 2020), extended stakeholder and producer responsibility (Agyekum et al., 2024), and digital enablement through tools such as BIM, IoT, and material passports (Gondak et al., 2025; Eze et al., 2024).

To operationalize the analysis, these principles were aligned with four phases of building construction management briefing and planning, design, construction, and operation and maintenance defined according to the combined guidance of AIA, ISO, and RIBA frameworks. This ensured that the classification of phases reflects both standardized lifecycle definitions and professionally practiced workflows (Figure 1).

As illustrated in Figure 1, the CE principles were then mapped to the lifecycle phases, producing a conceptual framework that demonstrates how circularity can be embedded across the managerial processes of building projects. This mapping exercise constitutes the analytical core of the study, as it translates broad CE principles into phase-specific practices applicable to building projects.

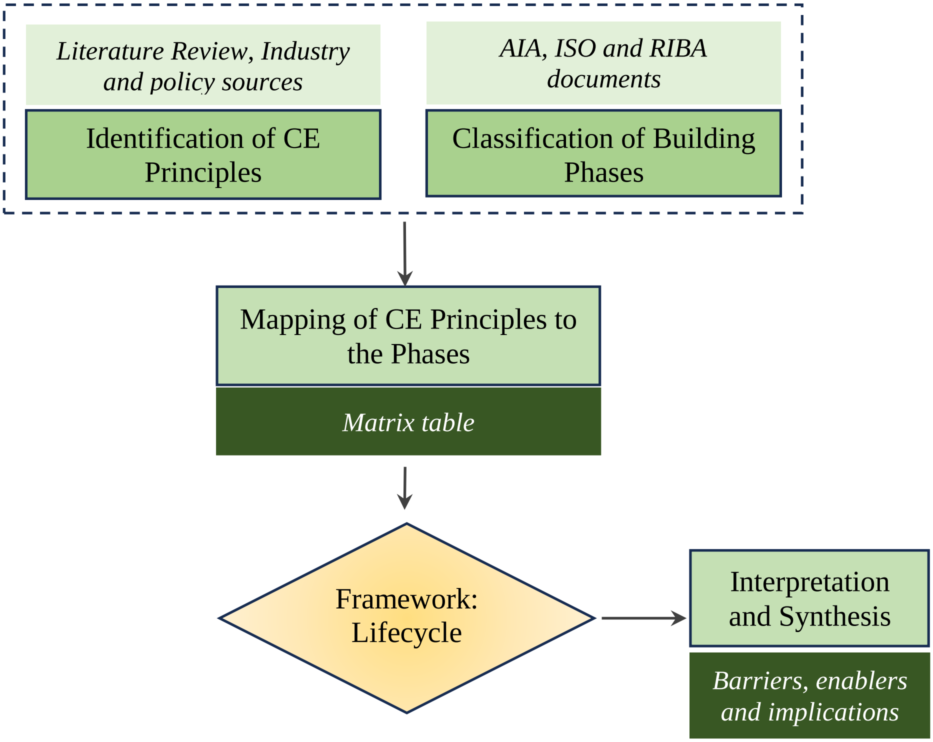

Figure 1. Research methodology flow (Created by the author)

In the final step, possible drivers and enablers were distilled through thematic synthesis of the reviewed literature and linked to the mapped CE principles across phases (Figure 1). These are not presented as empirical findings but as discussion-oriented insights that indicate potential pathways for adoption or obstacles to implementation.

3. Findings and Discussion

3.1. Findings

The analysis resulted in a conceptual framework that maps six CE principles across four key phases of building construction management: briefing and planning, design, construction, and operation and maintenance. This framework (Table 1) illustrates how CE principles can be systematically embedded in the managerial processes that govern the building lifecycle, highlighting that circularity is not solely a matter of technical solutions but also of coordinated decision-making and project management.

Table1. Mapping CE principles into building construction management phases (created by the author).

	Building Construction Phases			
CE Principles	**Briefing & Planning**	**Design**	**Construction**	**Operation & Maintenance**
Design for adaptability & disassembly	Set project goals for adaptability	Architectural / structural design for disassembly	Implement modular/adapt-able methods	Enable adaptability in use/renovations
Resource efficiency & waste minimization	Identify resource efficiency targets	Optimize designs for material efficiency	Minimize waste via site logistics	Maintain efficiency in building operations
Material reuse & recycling	Plan for material recovery at project scope	Specify recyclable /reusable materials	Recover and reuse onsite materials	Recover/recycle during renovations
Lifecycle costing & risk assessment	Integrate lifecycle cost & risk models	Embed lifecycle analysis in design decisions	Track costs vs. lifecycle benefits	Evaluate lifecycle performance
Extended stakeholder & producer responsibility	Assign stakeholder responsibili ties in contracts	Facilitate collaboration across design teams	Ensure contractor compliance with CE	Ensure user/owner awareness & responsibility
Digital enablement (BIM, IoT, material passports)	Define digital strategy for circular data	Apply BIM-based circular design tools	Use IoT for real-time resource monitoring	Maintain digital passports for building components

In the briefing and planning phase, the integration of CE is particularly critical as this stage sets the overall direction of the project. Principles such as lifecycle costing and risk assessment ensure that resource efficiency, adaptability, and reuse are embedded into project objectives and procurement strategies from the outset (Abadi & Sammuneh, 2020). Early stakeholder engagement provides an opportunity to align client ambitions with circular practices, although lack of awareness and perceived higher costs remain common obstacles (Wijewansha et al., 2021; Agyekum et al., 2024).

The design phase translates circular ambitions into concrete specifications. At this stage, design for adaptability and disassembly, alongside material reuse and recycling strategies, become operationalized through architectural and engineering decisions (Kumah et al., 2023). The increasing use of digital tools such as BIM, material passports, and modular design systems facilitates the adoption of CE principles by simulating resource flows and future adaptability (Gondak et al., 2025; Eze et al., 2024). Nevertheless, resistance to unfamiliar practices and the absence of standardized tools remain significant barriers.

During the construction phase, CE principles are enacted through procurement, resource management, and on-site practices. Emphasis is placed on minimizing waste, recovering materials, and applying modular and prefabricated systems to reduce inefficiencies (Sheen, 2024). Digital monitoring tools, including IoT-enabled platforms, enhance real-time tracking of resources. Yet, challenges persist due to supply chain immaturity, limited contractual obligations for circular compliance, and cost-driven decision-making (Chammout & El-Adaway, 2025).

Finally, in the operation and maintenance phase, CE practices focus on extending building lifespan and preparing for future adaptability. Preventive maintenance, adaptive reuse, and refurbishment strategies are essential to retaining value over time (Husgafvel & Sakaguchi, 2021). Digital enablement through BIM and material passports supports long-term tracking of components, allowing for more efficient maintenance and eventual recovery of resources (Alotaibi et al., 2024). Despite this potential, weak regulatory enforcement and limited owner incentives remain barriers to consistent adoption.

Overall, the findings emphasize that CE integration is most effective when approached from a lifecycle perspective, with early phases serving as the foundation for long-term success. While design and construction phases allow for operationalization of circular principles, it is the briefing and planning phase that provides the strategic leverage for embedding circular objectives. The operation and maintenance phase, in turn, ensures that these principles are sustained and translated into long-term environmental and economic benefits.

3.2. Discussion

While the framework illustrates opportunities for embedding CE principles across the building lifecycle, the extent of their implementation is shaped by a combination of institutional, managerial, and technical conditions. These factors may act as drivers that facilitate adoption or as barriers that hinder progress, depending on the context in which projects are delivered. To acknowledge the conceptual scope of this study, they are presented as “possible drivers” and “possible enablers” distilled from the literature and professional standards. Table 2 summarizes these dynamics, showing how such conditions influence outcomes at each phase of building construction management.

Table 2. Possible drivers and enablers influencing the integration of CE principles across building construction phases (created by the author)

Phase	Possible Barriers	Possible Enablers
Briefing & Planning	Limited client awareness of CE benefits (Agyekum et al., 2024)	Early stakeholder collaboration (Wijewansha et al., 2021)
	Perceived higher upfront costs	Lifecycle costing and risk assessment (Abadi & Sammuneh, 2020)
	Fragmented roles and unclear responsibilities	Policy drivers (European Commission, 2020)
Design	Lack of familiarity among professionals (Kumah et al., 2023)	Design for adaptability and disassembly (Kumah et al., 2023)
	Limited standardized CE design tools	BIM and material passports (Gondak et al., 2025)
	Resistance to non-conventional methods	Integrating modular and flexible design strategies
Construction	Supply chain immaturity (Chammout & El-Adaway, 2025)	On-site waste reduction and recovery (Sheen, 2024)
	Cost-driven contractor decisions	Digital monitoring (IoT, BIM) (Eze et al., 2024)
	Absence of contractual CE mechanisms	Modular construction practices
Operation & Maintenance	Lack of incentives for owners (Husgafvel & Sakaguchi, 2021)	Adaptive reuse and refurbishment strategies (Husgafvel & Sakaguchi, 2021)
	Weak regulatory enforcement	Preventive maintenance practices
	Limited user awareness	Digital enablement for long-term data accessibility (Alotaibi et al., 2024)

This study's findings are consistent with prior research emphasizing the importance of early project phases in setting trajectories for circularity (Wijewansha et al., 2021; Katipe Arachchige et al., 2025). The identification of briefing and planning as the strategic entry point confirms earlier observations that lifecycle costing, procurement criteria, and stakeholder alignment are decisive in shaping outcomes (Abadi & Sammuneh, 2020). By mapping circular economy principles across all four phases, however, this study contributes a comprehensive lifecycle-oriented perspective that highlights how managerial process structure opportunities for circular adoption.

The findings also align with scholarship that highlights design for adaptability and disassembly as a cornerstone of circularity (Kumah et al., 2023), while adding nuance by illustrating how this principle interacts with digital enablers such as BIM and material passports (Gondak et al., 2025; Eze et al., 2024). In the construction phase, the emphasis on waste reduction and modular approaches resonates with Sheen's (2024) systems analysis of resource flows. Yet, unlike purely technical accounts, this study underscores the managerial mechanisms—contractual frameworks, procurement models, and supply chain coordination—that determine whether such practices are effectively realized. Similarly, in the operation and maintenance phase, the results confirm the importance of adaptive reuse and refurbishment (Husgafvel & Sakaguchi, 2021) but also draw attention to persistent institutional barriers, including limited client incentives and weak regulatory enforcement, which continue to constrain long-term circular practices.

Revisiting the research objectives, the study demonstrates that CE in building construction management is anchored around six recurring principles: adaptability, resource efficiency, material reuse, lifecycle costing, extended responsibility, and digital enablement. These principles are not isolated but interact across all project phases, with briefing and planning emerging as the most critical entry point, since early decisions set trajectories for design, procurement, and long-term performance. The analysis further shows that barriers to adoption are largely systemic and institutional, such as low client awareness, inadequate regulatory support, and immature supply chains, whereas enablers are primarily managerial and technological, including lifecycle costing approaches, modular design strategies, and BIM-based material tracking. By synthesizing these insights into a phase-based framework, the study positions building construction management as the integrative mechanism through which circular practices are operationalized, thereby advancing both sustainability and long-term value creation across the building lifecycle.

Overall, this research supports recent calls for holistic and managerial perspectives on CE in construction (Chammout & El-Adaway, 2025; Alotaibi et al., 2024), while advancing the debate by offering a phase-based conceptual framework grounded in professional standards (AIA, 2017; ISO, 2008; RIBA, 2020). It argues that circularity cannot be achieved by isolated design innovations or recycling technologies alone but requires embedding CE principles systematically into the managerial processes of building projects.

4. Conclusion and Suggestions

This study set out to examine how circular CE principles can be embedded across the phases of building construction management, responding to the urgent environmental and resource challenges faced by the construction sector. By conducting a structured literature review and thematic synthesis, six recurring CE principles were identified adaptability, resource efficiency, material reuse, lifecycle costing, extended responsibility, and digital enablement and mapped across four lifecycle phases defined by professional standards: briefing and planning, design, construction, and operation and maintenance.

The findings demonstrate that CE adoption is not limited to technical innovations but depends critically on managerial processes that structure decision-making, procurement, and lifecycle coordination. Briefing and planning emerged as the most influential stage, where early decisions set the trajectory for project sustainability. Design operationalizes these ambitions through specifications and digital tools, construction enacts them through resource efficiency and on-site practices, and operation and maintenance sustain circularity through adaptive reuse and long-term performance monitoring.

The study makes three main contributions. First, it provides a phase-based framework that clarifies how CE principles can be integrated throughout the building lifecycle. Second, it highlights the barriers and enablers that shape implementation, showing that systemic and institutional challenges must be addressed in parallel with technological and managerial enablers. Third, it positions building construction management as the coordinating mechanism through which circularity can be operationalized, bridging the gap between conceptual ambition and practice.

Like all conceptual research, this study has limitations. The framework was developed based on literature, policy documents, and professional standards, without direct empirical testing. As a result, while it provides a structured theoretical contribution, its practical applicability may vary across different regional, cultural, and regulatory contexts. Furthermore, the reliance on secondary sources may omit emerging practices not yet widely reported in academic or industry literature.

From a practical perspective, the study underscores the importance of early-phase integration of CE objectives, the use of digital tools to enhance traceability, and the need for contractual and policy frameworks that incentivize lifecycle responsibility. For academia, it points to the value of holistic, management-oriented approaches in CE research, complementing existing technical studies.

Future research could extend this framework by testing it empirically in real project contexts, comparing regional differences in CE adoption, and exploring how digital innovations such as digital twins and AI-enabled lifecycle assessment may further support circular practices. Such work would provide the empirical depth needed to refine the framework and support its translation into practice.

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