Leveraging Digital Platforms for Circular Economy Implementation in the AECO Industry: Insights from Public-Private Partnerships

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Abstract
Digital platforms are increasingly adopted in the built environment to advance circular economy goals, yet their capacity to align policy and technology remains unclear. This paper examines how platforms enable or obstruct alignment in Public-Private Partnership (PPP) projects. A mechanism-oriented systematic literature review (SLR) of 24 studies identifies three alignment failures: lifecycle misalignment, platform–governance decoupling, and mobility-driven flow disruption. A three-tier coding framework—covering lifecycle stages, governance roles, and data flows—supports the analysis. Rather than calling for more platforms, the paper argues that circular transformation requires viewing platforms as institutional infrastructures that coordinate actors, data, and policy. It concludes with a conceptual alignment model, inviting empirical validation and adaptation, especially in regions with limited capacity and fragmented governance.

Keywords: Digital Platforms, Circular Economy, Public-Private Partnerships (PPPs), Policy–Technology Alignment, Governance

1.Introduction

The building sector, as a major contributor to global carbon emissions and resource depletion, is facing mounting pressure to transition toward circular economy practices (D'Amico et al., 2022). While digital tools such as Building Information Modeling (BIM), the Internet of Things (IoT), and Digital Twins have proliferated across the Architecture, Engineering, Construction, and Operations (AECO) industry, their deployment remains fragmented—mostly concentrated in early lifecycle stages and lacking systemic integration across the full project timeline (Dervishaj and Gudmundsson, 2024). More recently, generative AI and parametric design systems have emerged to support scenario-based optimisation and lifecycle-informed circular strategies in the design phase, yet their integration into platform-level governance remains limited.

Public-Private Partnerships (PPPs), increasingly adopted for large-scale infrastructure delivery, offer institutional leverage and cross-sector governance potential (Hueskes, Verhoest and Block, 2017). However, much of the current literature treats digital tools and policy frameworks in isolation, overlooking how digital platforms—within which these tools operate—can function as integrative infrastructures. In this study, digital platforms are conceptualised as socio-technical systems that coordinate policies, actors, and data flows throughout the building lifecycle. Digital tools (e.g. BIM, IoT, parametric design software) are understood as operational components embedded within these platforms, enabling specific functions such as simulation, traceability, or design optimisation. Governance refers to the institutional arrangements (e.g. PPP contracts, procurement mandates) that shape how platforms distribute roles, authority, and accountability. Alignment denotes the functional coherence between policy intentions and technological execution. Rather than focusing on tool adoption alone, this study foregrounds the platform as the central mechanism through which policy–technology coordination is structured (Figure 1).

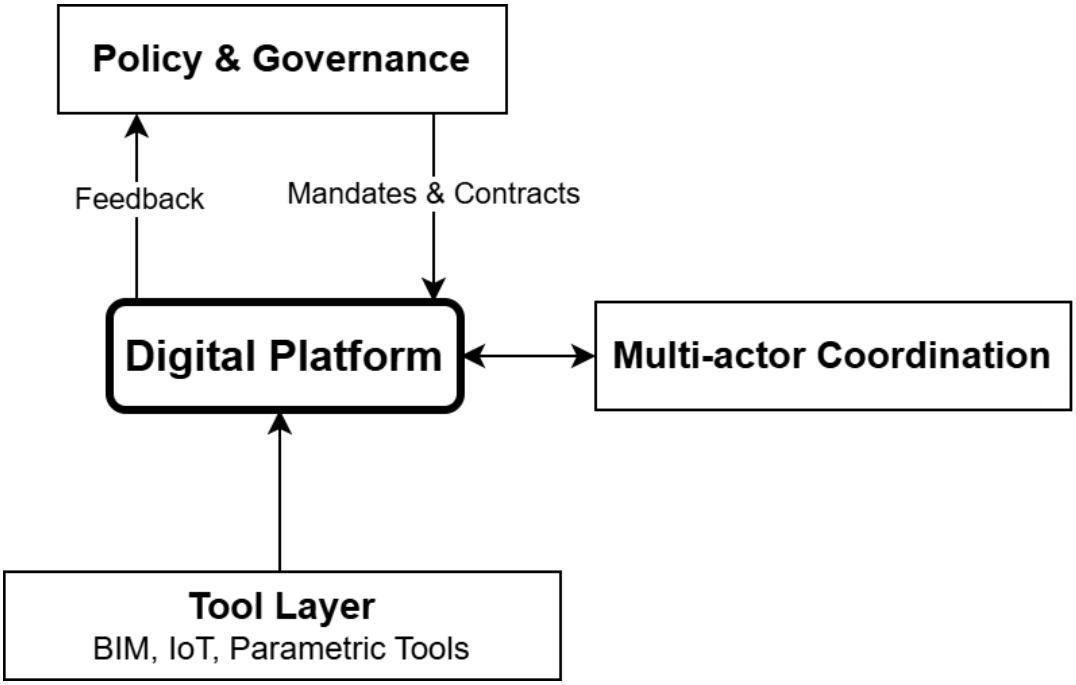

Figure 1. Platform–Tool–Policy Alignment Pathway

This paper introduces the concept of a Platform-enabled Policy–Technology Alignment Mechanism—a structural lens to examine how digital platforms mediate the interface between policy goals and technological interventions. It posits that structural misalignments between policy intentions, platform capabilities, and digital tool deployments are a key barrier to circular economy implementation in PPP-driven construction projects.

Drawing on a mechanism-oriented systematic literature review (SLR) (Pati and Lorusso, 2018), this study addresses the following questions: (1) how platform-embedded tools are distributed across different lifecycle stages in PPP contexts? (2) To what extent do platforms enable or constrain the alignment between policies and technologies? (3) What coordination bottlenecks and governance asymmetries emerge among stakeholders?

The findings provide a structured synthesis of alignment failures and coordination patterns, offering both a conceptual framework and actionable insights to support circular transformation in PPP-led AECO systems. This paper develops a policy–platform–technology alignment model to map structural mismatches and propose mechanisms for coordination in circular infrastructure governance.

2. Methodology: A Mechanism-Oriented Systematic Literature Review

This study adopts a mechanism-oriented systematic literature review (SLR) to explore how digital platforms mediate alignment between policy objectives and technological deployments in Public-Private Partnership (PPP) projects pursuing circularity in the AECO sector. Unlike traditional reviews that catalogue tools or trends, this approach focuses on identifying structural patterns of misalignment and coordination, with the aim of building a conceptual model of policy–platform–technology alignment.

2.1 Search Strategy and Screening Process

This study adopted a structured search strategy targeting the intersection of circularity practices, digital tools, lifecycle stages, and PPP governance frameworks. Four search strings were constructed (see Appendix A) to identify publications addressing either technological integration or collaborative mechanisms in the context of the built environment. The search was conducted across Web of Science, Scopus, and ScienceDirect, covering the

period 2014–2024. Only peer-reviewed journal articles and review papers in English were retained.

An initial pool of 184 articles was retrieved. After deduplication, title and abstract screening was conducted based on the following criteria: focus on the AECO sector, clear emphasis on circular economy practices (e.g., reuse, efficiency), mention of digital technologies (e.g., BIM, IoT, digital platforms), Reference to PPPs or multi-stakeholder coordination.

This stage resulted in 106 articles, which were further subjected to full-text screening. The final inclusion criteria required the study to: analyse digital tool deployment across lifecycle stages, discuss platform functions or governance roles, provide sufficient methodological and empirical detail to enable coding. After full-text assessment, 24 studies were retained for in-depth analysis and mechanism construction (see Figure 2).

2.2 Literature Screening Process

The review process followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) four-step model: identification, screening, eligibility, and inclusion (D'Amico et al., 2022). Full-text evaluation was conducted on 78 articles, leading to the selection of 24 core studies for detailed coding and mechanism abstraction.

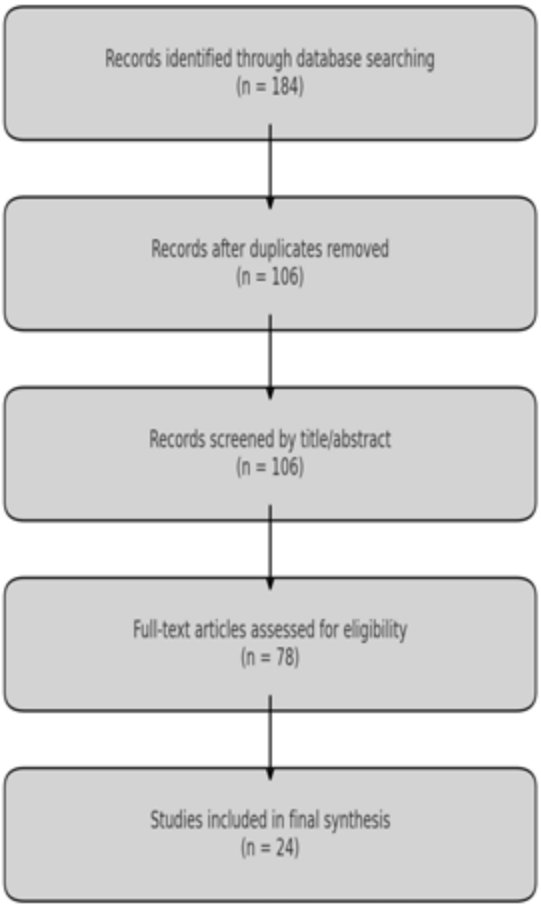

Figure 2. The PRISMA Flowchart

2.3 Data Extraction and Coding Framework

To go beyond static descriptions of digital tool usage, this study draws on Mobility Theory (Urry, 2007) as a conceptual lens to identify dynamic coordination mechanisms in PPP-based circular construction. Urry conceptualises modern systems as constituted by various forms of "flows"—including people, policies, materials, and information—which shape how institutions interact and evolve. In this context, platforms are not merely technical infrastructures but dynamic orchestrators of flow-based alignment across lifecycle stages and stakeholders.

Guided by this theoretical perspective, the coding framework integrates both structural and dynamic variables to capture how policy–platform–technology alignment is realised or constrained in practice. To capture both static structures and dynamic interactions underlying alignment processes, a three-tier coding framework was developed. Each retained study was analysed across the following dimensions (Table 1):

(1) System Structure Dimension — capturing technological deployment across the lifecycle;
(2) Platform Governance Dimension — capturing institutional design and platform functions;
(3) Mobility Flows Dimension — capturing dynamic flows of data, policy, and human coordination.

Table 1. Coding framework for analysing digital-platform-enabled alignment mechanisms

Dimension	Sub-Dimension	Examples
STRUCTURE	Lifecycle Stage	Design / Construction / Operation / Renovation / Demolition
	Digital Tool Type	BIM / IoT / Digital Twin / GIS / Blockchain
PLATFORM GOVERNANCE	Circular Economy Goal	Reuse / Efficiency / Emission Control
	PPP Model	Housing / Infrastructure / Public Works
	Platform Function	Monitoring / Coordination / Data Sharing
MOBILITY FLOWS	Policy Flows	Green Procurement / Policy Feedback / Regulatory Embedding
	Data Flows	Transparency / Traceability / Real-time Sensing via IoT
	Human Flows	Multi-stakeholder Collaboration / Cross-sector Teams / Role Integration

This coding framework enabled the abstraction of empirical patterns into a three-layer mechanism model: policy intentions, platform functions, tool deployments, which serves as the analytical structure for Section 3.

3. Results: Mechanism Construction from Literature Synthesis

This section presents the three core mechanisms derived from the systematic coding of 24 selected studies. Moving beyond thematic summaries, these mechanisms reflect structured patterns of alignment and misalignment between policy intentions, platform functions, and digital tool deployments in circular Public-Private Partnership (PPP) projects.

Based on the three-tier framework (Figure 3), the mechanisms are constructed through variable convergence across structural layers (e.g., tool type, lifecycle stage), governance design (e.g., PPP role, platform coordination), and flow dynamics (e.g., policy, data, and stakeholder mobility).

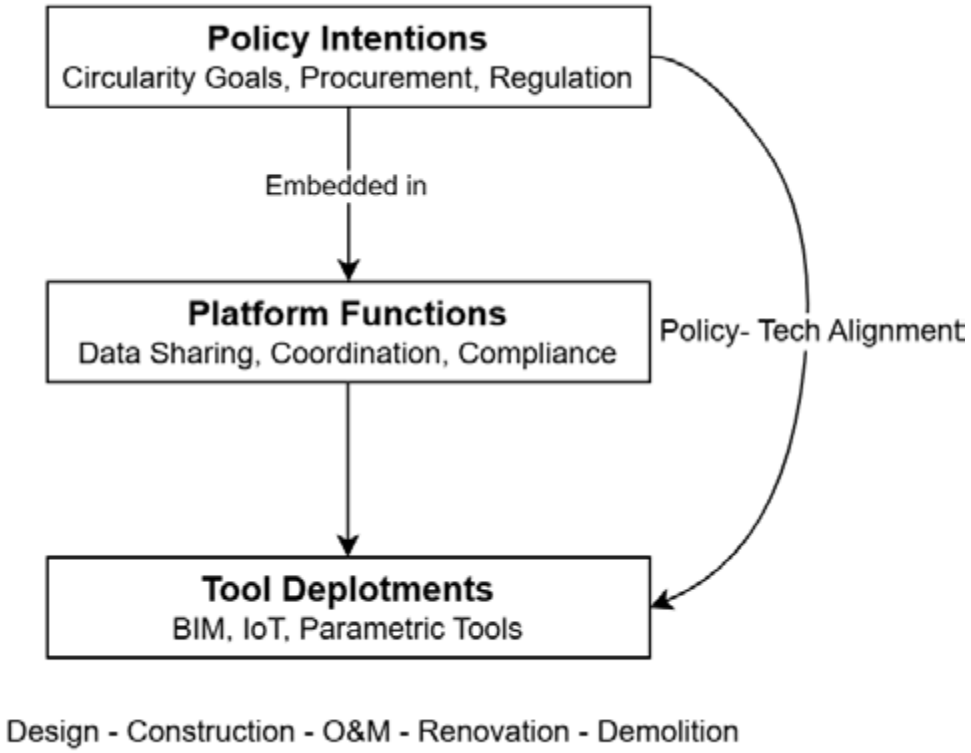

Figure 3. Platform-Enabled Alignment Model. This conceptual framework illustrates how digital platforms mediate structural alignment across policy intentions, technological tools, and governance mechanisms

Table 2. Mapping of extracted mechanisms to coding dimensions and empirical patterns in the literature

Mechanism	Key Misalignment / Enabler	Relevant Coding Dimensions	Empirical Support (n/24)
Lifecycle Misalignment	Tools heavily concentrated in early stages; renovation/demolition under-digitised	Lifecycle Stage, Digital Tool Type	20+ mention early-stage tools; <5 mention demolition/renovation
Platform–Governance Coupling	PPP structure and governance roles often unclear or missing	PPP Project, Governance Role, Policy-Tech Alignment	Only 4 explicitly focus on PPPs; 11 specify governance
Mobility-Driven Synchronisation	Policy, data, and human flows poorly integrated across lifecycle	Mobility: Policy Flows, Data Flows, Human Flows	Mobility flows rarely co-occur; dynamic feedback poorly explored

The mechanisms are summarised in Table 2. Together, these mechanisms illustrate that digital platforms are not merely technical infrastructures, but dynamic governance intermediaries that shape the success or failure of circular transformation in PPP settings. The details are elaborated in the following subsections.

3.1 Lifecycle Misalignment Mechanism

This mechanism captures the structural misalignment between digital tool deployment and the full building lifecycle in circular construction projects. While circularity principles advocate a closed-loop system across all lifecycle stages, from design to demolition, the analysis reveals a strong front-end concentration of technological interventions.

Based on the coding of 24 studies, over 80% mention tool applications in design, construction, or operation stages, while fewer than 5 papers explicitly reference refurbishment or demolition phases. Table 1 shows that tools such as BIM, IoT, and GIS dominate the early lifecycle, while end-of-life stages are largely under-digitised. This lifecycle asymmetry results in "digital blind spots", particularly where traceability and material recovery are critical to achieving circularity goals (Dervishaj and Gudmundsson, 2024).

For instance, although BIM is extensively used for planning and coordination during design and construction, very few studies explore its integration into disassembly modelling or deconstruction logistics. Similarly, Digital Twins—while theoretically suited for long-term lifecycle tracking—are rarely applied beyond building operation phases (Azcarate-Aguerre et al., 2022; Benedetti et al., 2022).

This misalignment is reinforced by two structural gaps: (1) a lack of regulatory mandates linking demolition data to material reuse policies, and (2) the absence of platform-level integration strategies that span the full lifecycle. As a result, even advanced digital platforms struggle to support closed-loop feedback, since critical end-of-life data never enters the system.

The Lifecycle Misalignment Mechanism thus reflects a fundamental weakness in circular PPPs: unless digital tools are embedded across the entire lifecycle—including post-use and reuse phases—policy objectives related to material recovery and traceability will remain aspirational and structurally unsupported.

3.2 Platform–Governance Coupling Mechanism

This mechanism highlights how the absence of robust governance structures within PPP projects weakens the ability of digital platforms to function as alignment mechanisms between policy objectives and tool deployments. While digital platforms are widely recognised for their technical capabilities, their actual performance in circular construction depends on how well they are embedded in the institutional and contractual fabric of PPP governance.

Among the 24 studies analysed, only 4 explicitly focus on PPP projects, and merely 11 provide any detail on the governance configuration (e.g., public-led, private-led, or joint arrangements). In many cases, the role of digital platforms is reduced to data repositories or coordination layers, with little attention to how they enforce contractual compliance, stakeholder incentives, or data sovereignty. As a result, platforms often fail to translate policy ambitions into enforceable lifecycle practices (Yu et al., 2023; Chartier and Pot, 2024)integrated information systems that are capable to identify, coordinate, and evaluate CE collaborations across heterogeneous projects are in demand. A digital collaborative hub, Circularity Information Platform (CIP. This is illustrated in Figure 4.

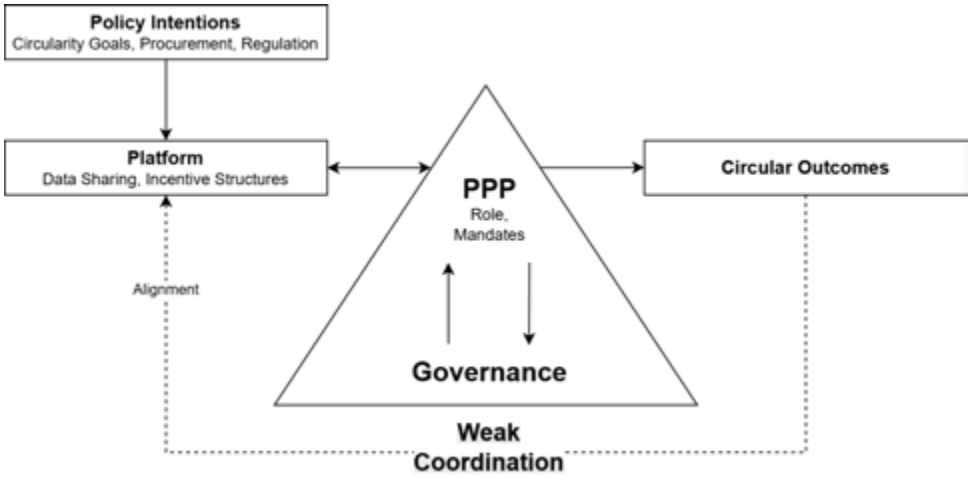

Figure 4. Platform–Governance Coupling Mechanism: illustrating weak contractual and institutional integration between platform, public authority, and private sector

For instance, Serrano (2022) show that platform efficacy in circular PPPs depends on contractual clauses that define responsibilities, access rights, and data transparency rules among actors. Without such governance scaffolding, platforms remain technically functional but politically inert. Similarly, Teigiserova and Schraven demonstrate that circularity outcomes in Dutch PPP housing projects were only achieved when platforms were backed by formal procurement mandates and institutional incentives (Teigiserova and Schraven, 2024).

The mechanism is further complicated by fragmentation between policy design and platform development. Many digital systems are developed by technology vendors or municipalities in silos, while policy makers and regulators are not involved in platform logic. This leads to implementation gaps—platforms that track data but lack authority, or policies that demand outcomes with no tool-based enforcement mechanism.

The Platform–Governance Coupling Mechanism thus reveals that alignment failure is not a technological problem, but a governance one. Without embedded authority, platforms cannot coordinate actors, distribute accountability, or translate circular goals into operational mandates.

3.3 Mobility-Driven Synchronisation Mechanism

3.3 Mobility-Driven Synchronisation Mechanism

This mechanism builds on Mobility Theory (Urry, 2007), which views modern systems as constituted through flows—of people, policies, information, and goods. In the context of circular PPPs, platform efficacy depends not only on structural deployment and institutional design, but also on the ability to synchronise multiple flows across the lifecycle and actor network.

However, the analysis reveals significant flow decoupling in the literature. Although 18 studies mention policy–technology alignment in some form, very few articulate how policy updates are operationalised through platforms, or how real-time data is used for feedback into regulatory processes. Furthermore, only a minority of studies (Yu et al., 2023; Teigiserova and Schraven, 2024) discuss cross-organisational collaboration as an embedded feature of platform logic.

For instance, in the Dutch "Circular Information Platform" case, Yu et al (2023) describe how material databases, LCA tools, and design software were interconnected, while the system relied on external incentives rather than integrated flow coordination. Similarly, Chartier & Pot observed that while policy dashboards existed in Nijme-

gen's PPP platform, there was little integration of citizen feedback or inter-departmental data exchange (Chartier and Pot, 2024).

Urry's framework helps explain why platforms often fail despite high technical capacity: these coordination breakdowns are illustrated in Figure 5, where policy, data, and human flows are depicted as interdependent but weakly synchronised. Solid arrows indicate desired coordination pathways (e.g., data flows enabling policy feedback), while dashed lines represent fragmentation. For instance, data from BIM/IoT platforms is often not fed back into procurement criteria (policy flow), and human collaboration across design, regulatory, and contracting units lacks institutional support (human flow). This weak synchronisation undermines the platform's potential to enable adaptive and circular outcomes.

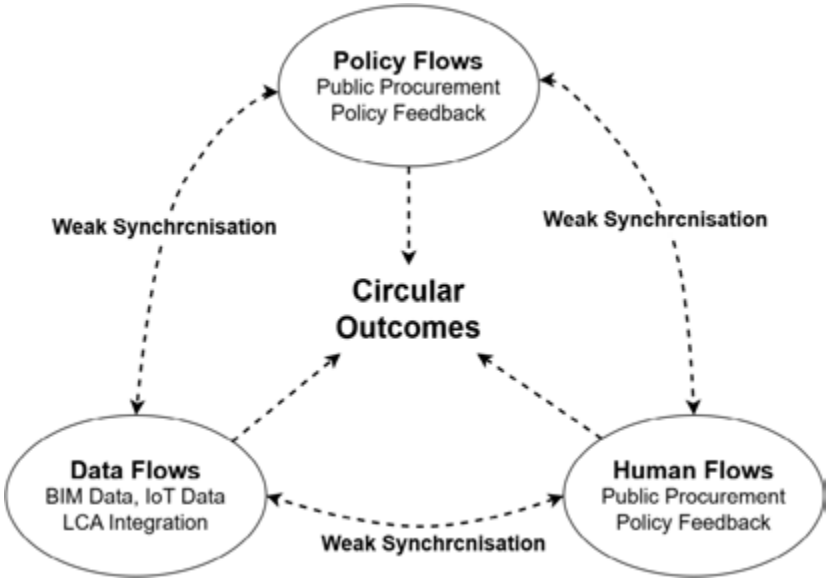

Figure 5. Mobility-Driven Synchronisation Mechanism. The diagram illustrates how circular outcomes depend on the effective synchronisation of policy flows, data flows, and human collaboration via digital platforms

The Mobility-Driven Synchronisation Mechanism therefore captures a dynamic misalignment: unless platforms are designed as multi-flow synchronisation infrastructures—connecting policy intentions, real-time data, and actor actions—they will fail to deliver system-wide circularity, regardless of governance or tool sophistication.

These three mechanisms collectively reveal that platform-based circularity in PPPs cannot be achieved through technical deployment alone. Structural coverage, institutional anchoring, and dynamic flow synchronisation are all necessary conditions for meaningful alignment between policy ambitions and material outcomes.

4. Discussion: Toward Mechanism-Informed Circular Governance

4.1 Translating Alignment Mechanisms into Design Challenges

This study identifies three systemic misalignments—lifecycle concentration, governance fragmentation, and flow decoupling—that collectively limit the capacity of digital platforms to support circular outcomes in PPP contexts. Each mechanism signals a distinct but interdependent research challenge:

(1) Lifecycle misalignment: The concentration of digital interventions in early building phases leaves end-of-life

stages under-digitised. Research should explore platform functionalities that support downstream activities, such as design-for-disassembly, demolition-data feedback, and reuse tracking.

(2) Platform–governance decoupling: Platforms often lack formal authority, operating as passive repositories rather than active coordinators. Future work should investigate how PPP contracts, institutional mandates, and platform governance roles can be re-designed to embed platform authority.

(3) Mobility-driven flow disruption: Digital platforms rarely synchronise the dynamic flows of policy, data, and people across lifecycle stages. Platform design must evolve to support cross-department data exchange, real-time feedback mechanisms, and contractual incentives for collaboration.

Together, these challenges call for a shift from platform deployment to platform architecture design—not just what platforms do, but how they govern, integrate, and learn across time and scale. Moreover, the three mechanisms do not operate in isolation—lifecycle gaps amplify governance ambiguities, while both undermine the potential for flow synchronisation. Understanding these interdependencies is key to platform redesign.

4.2 Regional and Conceptual Research Gaps

Despite the growing attention to circular platforms, the literature remains skewed toward Western European case studies, often situated in digitally mature, policy-rich contexts. These insights require adaptation to regions where PPPs face limited digital infrastructure, fragmented governance, or weaker enforcement environments.

Conceptually, terms like “integration” or “participation” are used rhetorically without institutional detail, and “digital tools” are often assumed to support circularity without tracing their role in material recovery or end-of-life planning. Future research should clarify the conceptual boundaries between sustainability and circularity, and explicitly link platform functionality to measurable circular outcomes. Moreover, most existing studies lack methodological frameworks capable of linking platform design choices to traceable circular performance outcomes. Addressing this gap should be a key priority for future empirical research.

4.3 From Diagnosis to Research Design: A Mechanism-Oriented Agenda

Based on the misalignments identified, this study proposes three strategic research directions. First, there is a need for cross-contextual validation to understand the conditions under which alignment mechanisms succeed or fail. Comparative research across different policy environments, contractual models, and lifecycle stages can reveal how asymmetries and disconnections in material and information flows manifest across various PPP regimes. Second, digital platforms should be prototyped not merely as coordination tools, but as flow-oriented infrastructures that synchronize policy feedback, enable traceable data exchanges, and distribute responsibilities across actors. Such prototypes can help bridge gaps between high-level circular ambitions and operational realities. Third, the integration of AI into platform governance presents both opportunities and risks. While AI can enhance predictive capabilities and dynamic alignment, it should be embedded within accountable and inclusive frameworks. Governance sandboxes or contractually bounded testbeds may offer controlled environments to evaluate AI’s performance not only in terms of efficiency but also in terms of equity and transparency. Ultimately, achieving alignment in circular PPPs is not solely a technical challenge—it is a matter of thoughtful design and responsible governance.

4.4 Visualising Alignment Architecture

To synthesise these findings, this paper proposes an Alignment Mechanism Model (Figure 6), mapping how misalignments across lifecycle, governance, and flows intersect to obstruct circular goals in PPPs. Rather than

treating platforms as neutral infrastructures, the model reframes them as governance-intensive systems whose performance depends on their institutional embedding, temporal continuity, and functional coherence. As such, the model offers both a diagnostic lens and a design heuristic—guiding empirical validation and informing future platform architectures tailored to circular goals.

Figure 6 synthesises these dimensions into a unified model, illustrating how circular governance failures emerge from the intersection of lifecycle asymmetry, governance fragmentation, and unsynchronised flows. At the core of the model is platform-based circular governance, which acts as a mediating mechanism between structural lifecycle phases and the need for flow-based coordination. Lifecycle misalignment is associated with coordination failures across different project stages, while mobility-driven synchronisation highlights the importance of aligning material and data flows across actors and timeframes. The figure underscores the importance of embedding authority within platforms to mitigate fragmentation and enable synchronised, circular outcomes.

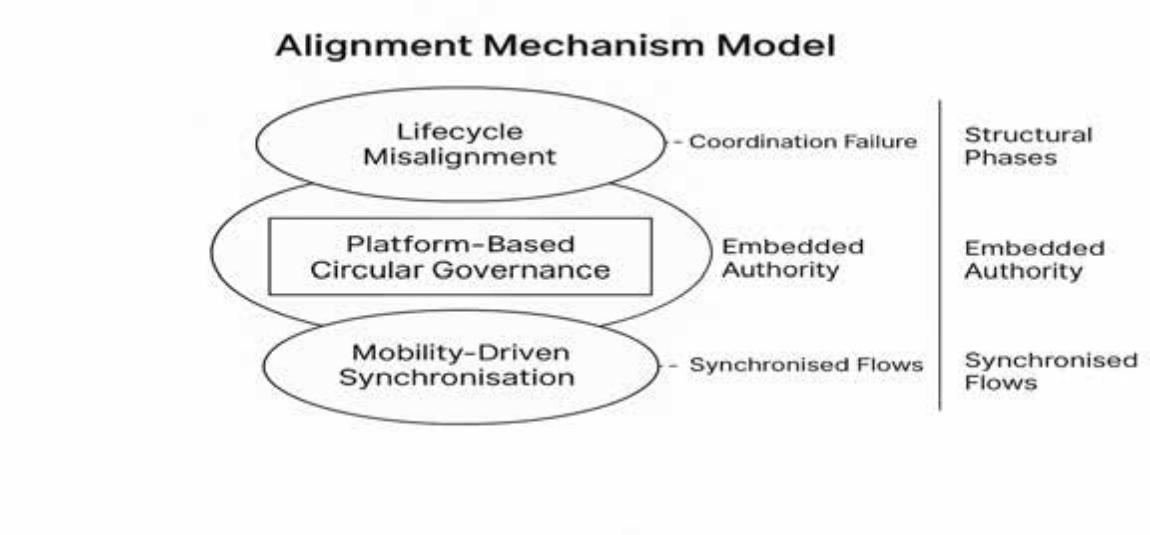

Figure 6. Alignment Mechanism Model

5. Conclusion and Policy Implications

This study set out to investigate how digital platforms mediate the alignment between policy goals and technological interventions in circular Public-Private Partnership (PPP) projects. Through a mechanism-oriented systematic literature review (SLR) of 24 core studies, it identified three interdependent misalignments, which are lifecycle asymmetry, governance fragmentation, and flow disruption, that collectively constrain the systemic capacity of platforms to enable circular outcomes. These findings suggest that digital circularity is not merely a matter of tool adoption, but a governance challenge that demands institutional integration, lifecycle coherence, and flow-based coordination.

Looking forward, platform-enabled circularity requires a shift from tool cataloguing to mechanism construction. Future research should validate the three mechanisms across diverse PPP contexts by examining how alignment breakdowns manifest under varying governance maturity, policy enforcement capacity, and infrastructural conditions. Experimental prototypes of digital platforms should be developed not just for integration, but also for synchronisation by embedding features such as real-time policy feedback, traceable data architectures, and incentive-compatible actor coordination. Equally important is the investigation of platform performance across scales: how effectively can platforms translate national circularity mandates into localised, lifecycle-informed interventions?

Ultimately, alignment is not a technical state. It is a design and governance achievement. As AI-enhanced platforms gain prominence, future studies must critically examine how algorithmic coordination tools can be embedded in transparent, inclusive, and adaptable institutional frameworks. Only through such systems-oriented experimentation can platform-based circularity advance from conceptual promise to operational transformation.

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Appendices

Appendix A. Search Strings Used in the Systematic Review

Search Focus	Search String
Part 1: Identifying Digital Technology	(circularity) AND (public spaces OR community spaces OR urban infrastructure OR built environment) AND (digital tools OR smart technology OR digital twin OR BIM OR IoT OR decision support tool*)
Part 2: Governance and Participation in PPPs	(circularity) AND (public spaces OR community spaces OR urban infrastructure OR built environment) AND (public-private partnership OR PPP)
Part 3: Resource and Material Management	(circularity) AND (material reuse OR waste management OR resource efficiency) AND (built environment) AND (digital tools OR BIM OR IoT OR digital twin)
Part 4: Intersectional Integration	(circularity) AND (built environment) AND (digital tools OR smart technology OR BIM OR IoT) AND (material reuse OR waste management OR resource efficiency) AND (PPP)

Databases: Web of Science, Scopus, ScienceDirect

Time span: 2014–2024
Language: English
Document Type: Peer-reviewed articles and review papers

Appendix B. Inclusion and Exclusion Criteria

B1. Abstract Screening Criteria

Inclusion	Exclusion
Mentions the **AECO sector** (architecture, engineering, construction, operations)	Focuses on unrelated domains (e.g., agriculture, generic urban policy)
Refers to **circular economy practices** (e.g., reuse, efficiency, low-carbon)	Only discusses sustainability in broad or undefined terms
Includes **digital tools or platforms** (e.g., BIM, IoT, Digital Twin, DSS)	Lacks any mention of digitalisation or technological intervention

B2. Full-Text Evaluation Criteria

Inclusion	Exclusion
Provides **empirical or analytical detail** enabling coding of mechanisms	Theoretical papers without clear empirical basis or methodological transparency
Discusses **digital tool deployment** across one or more lifecycle stages	Describes tools in abstract without lifecycle integration
Addresses **platform functions** (e.g., coordination, traceability, monitoring)	Mentions tools but omits platform-level architecture or governance discussion

Inclusion	Exclusion
Contains reference to **PPPs or multi-actor collaboration or governance mechanisms**	No indication of stakeholder interaction, public-private dynamics, or PPPs or governance dimension or stakeholder role specification

Appendix C. Coding Framework Variables

Dimension	Sub-Dimension	Examples
STRUCTURE	Lifecycle Stage	Design, Construction, Operation, Renovation, Demolition
	Digital Tool Type	BIM, IoT, Digital Twin, GIS, Blockchain
	Circular Goal	Reuse, Efficiency, Emission Control
PLATFORM & GOVERNANCE	PPP Model	Housing, Infrastructure, Public Works
	Platform Function	Monitoring, Coordination, Data Sharing
MOBILITY FLOWS	Policy Flows	Green Procurement, Policy Feedback, Regulatory Embedding
	Data Flows	Transparency, Traceability, IoT-based Monitoring
	Human Flows	Multi-Stakeholder Collaboration, Cross-Sector Teams

(Refer to Table 1 in the main text for operationalisation.)

Appendix D. List of Included Studies (n=24)

(Sorted by year of publication)

Author(s)	Year	Title	Source
Mangialardo, Alessia & Micelli, Ezio	2018	Rethinking the Construction Industry Under the Circular Economy: Principles and Case Studies	European
Maye, Damian	2019	'Smart food city': Conceptual relations between smart city planning, urban food systems and innovation theory	Europe
Antoniol, Emilio & Ferrari, Margherita	2021	From Crisis to a Sustainable Future: Processes of Technology Transfer from Europe to the MENA Region	MENA Region, Italy
Hirvensalo, Antero et al.	2021	Agency in Circular City Ecosystems—A Rationalities Perspective	Finland
D'Amico, Gaspare et al.	2021	Digital Technologies for Urban Metabolism Efficiency: Lessons from Urban Agenda Partnership on Circular Economy	European Union
Abadi, Mohamed & Moore, David	2022	Selection of Circular Proposals in Building Projects: An MCDM Model for Lifecycle Circularity Assessments Using AHP	United Kingdom
Casini, Marco	2022	Chapter 1 - Toward a new building era	Not Specified
Shukla, Saurabh & Hait, Subrata	2022	25 - Smart waste management practices in smart cities: Current trends and future perspectives	India
Azcarate-Aguerre, Juan F. et al.	2022	Facades-as-a-Service: The Role of Technology in the Circular Servitisation of the Building Envelope	Netherlands

Serrano, Will	2022	Verification and Validation for data marketplaces via a blockchain and smart contracts	United Kingdom (Newcastle Urban Observatory, UCL PEARL Project)
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