

Key Characteristics of Project Delivery Methods and Their Influence on Project Performance: Research Gaps for Emerging Performance Areas

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Research Problem Statement

Project Delivery Methods (PDMs) define how construction projects are procured, governed, and executed through specific contractual, organisational, and managerial arrangements [1], [2]. They shape how risk and responsibility are allocated, when key stakeholders are involved, the degree of collaboration that is enabled or constrained, and how decisions are made across the project lifecycle [1], [3], [4]. As a result, PDMs have a material influence on project performance outcomes, traditionally discussed in relation to cost, time, quality, and risk [2], [5], [6], and increasingly in relation to collaboration [3], [7], [8].

In literature, the terms *project delivery method* and *project delivery model* are often used interchangeably. Project delivery methods generally refer to specific contractual and organisational arrangements through which projects are delivered (e.g., Design–Bid–Build, Design–Build, Construction Management, Integrated Project Delivery). In contrast, the term *project delivery model* is sometimes used more broadly to describe an integrated framework that also includes governance structures, collaboration mechanisms, risk and reward sharing, and supporting digital practices. Some approaches—such as Integrated Project Delivery or partnering arrangements—can therefore be interpreted both as delivery methods and delivery models, contributing to terminological inconsistencies within the literature. Design–Build further illustrates this ambiguity: it can be understood both as a method of project delivery and as a contractual model, yet in practice it may range from highly integrated, contractor-led configurations with early design influence to largely sequential, client-controlled processes that differ only marginally from traditional Design–Bid–Build delivery. This variability indicates a deeper issue: delivery labels are not analytically stable and do not consistently represent the underlying configuration of project delivery systems.

Although numerous studies examine individual PDMs, such as Design–Bid–Build (DBB), Design–Build (DB), Construction Management variants (CM/CMAR), Integrated Project Delivery (IPD), and Public–Private Partnerships (PPP), the knowledge base remains fragmented and predominantly structured around comparisons between labelled delivery approaches [1], [3], [9]. Much of the existing literature reports performance implications of different PDMs based on surveys, case studies, or empirical observations [2], [8]. However, relatively few studies systematically examine the underlying characteristics of these delivery methods that explain why certain PDMs lead to specific performance outcomes [9], [3]. Consequently, the causal mechanisms linking PDMs to project performance remain insufficiently articulated, limiting cross-study comparability and evidence-based selection of delivery approaches.

This limitation becomes particularly relevant for the emerging performance areas of sustainability, innovation, and circularity. These areas require intensified collaboration, earlier stakeholder integration, transparent information exchange, and a stronger focus on lifecycle value creation. While it is widely acknowledged that PDMs can enable or constrain such practices, explicit evidence linking specific PDM characteristics to these emerging performance areas remains limited and scattered [10]. Without a structured understanding of the characteristics that define delivery approaches and their relationship to project outcomes, attempts to align PDMs with emerging performance dimensions such as sustainability, innovation and circularity may remain conceptual and label-driven.

Accordingly, this study addresses the following research question:

Which PDMs and variants are reported in the construction literature, which key *characteristics* define them, and how are these methods and *characteristics* qualitatively associated with key project performance areas and the emerging areas of sustainability, innovation and circularity?

To address this question, the study develops a structured synthesis of PDMs using a characteristic-based analytical perspective. Specifically, it (1) identifies and consolidates PDMs reported in both scientific and practice-oriented literature, including synonyms, variants, hybrids, and emerging approaches; (2) extracts and structures their defining *characteristics* using consistent analytical dimensions; and (3) maps the qualitative strength of associations between core PDMs, their characteristics, and project performance outcomes, enabling systematic comparison across differently labelled delivery approaches. Reflecting today's shifting priorities in policy and praxis [11], [12], the study considers the emerging performance areas of *sustainability, innovation, and circularity* in addition to the established performance areas of *cost, time, quality, risk and collaboration*. Through this analytical lens, the current evidence base can be examined, highlighting where empirical knowledge is robust, limited, or still emerging. By shifting the analytical focus from labelled PDMs to their underlying characteristics, the study aims to establish an explanatory basis for understanding how delivery methods influence project performance.

Research Methodology and Approach

This study applies a structured, exploratory research design to establish a traceable baseline of PDMs in construction. The analysis follows a directed qualitative content analysis of documentary sources [13], guided by a predefined analytical specification and implemented through a human-in-the-loop, Large Language Model, LLM-assisted workflow (Figure 1). Specifically, the research design integrates (i) systematic literature curation to identify and consolidate relevant publications into a curated corpus; (ii) research structuring and specification to define the analytical framework, scope of research, and evaluation criteria; (iii) synthesis and mapping (LLM-supported), including a two-part thematic analysis to (1) identify and link PDMs to their key characteristics, while consolidating overlapping concepts into a unified set of characteristics, and (2) link both PDMs and their key *characteristics* to project performance areas; and (iv) human-led refinement and validation to generate a characteristic-led theoretical framework for future research. This study does not aim to quantitatively evaluate LLM performance, but rather to demonstrate a controlled and reproducible workflow for LLM-assisted literature analysis.

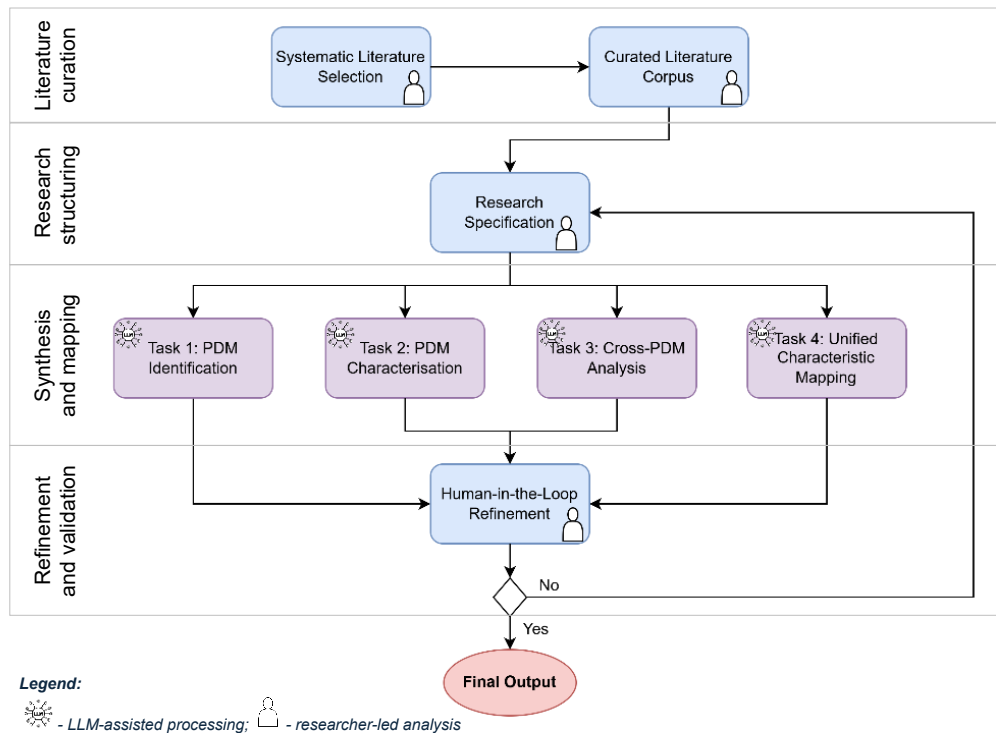


Figure 1 Specification-Driven Research Workflow

The work began with a systematic literature selection combining scoping and screening across major academic and professional databases, including ScienceDirect, Web of Science, Taylor & Francis, SpringerLink, and ResearchGate. The search focused on explicitly named delivery methods ("Design-Bid-Build" OR "Design Build" OR "Integrated Project Delivery" OR "Public Private Partnership" OR "Alliance Contracting" OR "Project Alliancing" OR "Project Partnering" OR "Construction Management at Risk") AND (construction). Where available, filters related to engineering, construction, and project management were applied, together with a 2002–2026 timeframe. After removing duplicate entries, 6156 unique records remained. These records were first screened at title level, excluding publications outside the construction domain, unrelated uses of delivery or procurement terminology, and papers containing only incidental mention of the search terms without analytical relevance to project delivery. Of the remaining results, titles were retained where they explicitly referred to project delivery methods or models comparative and performance-related discussions, procurement routes, contracting arrangements, as well as where relevance remained plausible but required verification at abstract stage. Due to the strict inclusion criteria this screening step significantly reduced the set to 673 papers. A subsequent title-and-abstract screening retained 154 potentially relevant documents. Finally, cursory full-text reading was conducted to determine inclusion, selecting only those studies that provided substantive material on PDM definitions, characteristics, selection criteria, performance, or comparative analysis across delivery methods. This process resulted in a final curated corpus of 45 documents for in-depth analysis.

To ensure analytical completeness and reproducibility, research specification was developed as a formal protocol. The specification defines what constitutes a PDM (including synonyms, variations, hybrids, and emerging/rare methods), prescribes standard analytical dimensions (risk allocation, contract and governance structure, timing of involvement, collaboration type, project team organisation, geographic prevalence, and sector application), and requires explicit evidence tracing for all extracted findings. Within these analytical dimensions, *characteristics* of a PDM are understood as recurring features across differently labelled PDMs that shape how projects are delivered. They include contractual, governance, process, timing, financial, lifecycle, and technology-related features and are treated as the main analytical unit for

comparing delivery approaches beyond their labels. *Characteristics* therefore operate at an intermediate analytical level: more specific than a PDM label, but broader than an isolated feature such as a single contractual clause or process step.

It further operationalises “impact” by mapping both PDMs and their key *characteristics* to eight project performance areas. Coding and consolidation were carried out in two steps. First, *characteristics* were identified within individual studies and PDMs based on source text, tables, and figures. Second, these *characteristics* were compared across the corpus and merged only when differently worded expressions referred to the same functional delivery feature; where wording implied materially different timing, governance, contractual, risk, financial, lifecycle, or technology-related arrangements, *characteristics* were retained as distinct. Correlation strength was initially assigned within the LLM-assisted workflow using the qualitative rubric and then reviewed by the researchers. The rubric distinguished four levels: (1) Strong: consistently and explicitly linked across multiple sources; (2) Moderate: linked in several sources, but with conditions or mixed evidence; (3) Limited: mentioned only sporadically or supported by weak or indirect evidence and *NA* where no supporting evidence is found. The study did not employ parallel independent coders; however, coding ambiguities and interpretive differences were addressed systematically through iterative researcher review against the analytical specification and the original source context. Where contradictory findings appeared across studies, the relevant excerpts were revisited, and the evidence-strength rating was reduced accordingly.

The eight project performance areas were derived through a combination of inductive coding of recurring outcome constructs in the reviewed corpus and specification-driven inclusion of emerging areas relevant to the study. The first five areas—*cost*, *time*, *quality*, *risk*, and *collaboration*—represent well-established and consistently reported dimensions of project performance. *Sustainability* is defined in a literature-informed manner, reflecting how the concept is operationalised in the reviewed corpus, where it is associated with environmental and lifecycle-related outcomes such as resource efficiency and waste minimisation. *Innovation* refers to novelty in processes, technologies, organisational arrangements, or delivery practices; however, its relevance depends on project type, complexity, and client objectives. While it is therefore not a universal requirement on all construction projects, innovation has been recognized as a key enabler for the other emerging performance areas. *Circularity* refers to outcomes related to reuse, recovery, adaptability, and lifecycle value retention within the broader context of circular construction. These three emerging performance areas are included for comparative analysis, but they are not treated as fully equivalent to conventional project-bounded KPIs. Rather, they also function as analytical lenses through which the relationship between delivery methods and evolving project objectives can be examined.

Implementation followed four interlinked tasks: (1) PDM identification, capturing all explicitly named and implicitly described PDMs and consolidating synonyms into canonical methods; (2) PDM characterisation, extracting and describing key characteristics, grouping them into consistent categories (e.g., governance, contracting, risk, timing, collaboration, finance, lifecycle scope and responsibilities); (3) cross-PDM analysis, unifying near-duplicate *characteristics* across methods and synthesising shared versus distinguishing delivery logics, resulting in a unified set of characteristics, which are then (4) mapped to the eight project performance areas.

ChatGPT-5.2 was used as an extraction and synthesis engine in the Cursor environment within a human-in-the-loop workflow guided by a predefined analytical specification. Researchers monitored the process, refined prompts when needed, and manually verified the outputs against

the original sources. Only outputs that could be traced back to source excerpts, tables, or figures were retained in the analytical matrices; unsupported or ambiguous outputs were discarded during human review. Sources were normalised into selectable text and page-level visual snapshots to capture figures, tables, and diagrams without OCR. This workflow ensured evidence traceability, terminology consistency, and rubric coherence, while interpretation and synthesis remained under direct researcher control.

Figure 2 illustrates Task 1 (PDM identification) as a condensed example of how the analytical specification guided the LLM-assisted workflow. For brevity, detailed subtask wording, illustrative examples, operational definitions, detailed evidence-formatting rules (including surrounding context requirements), thresholds for testimonies, and extended narrative deliverables are omitted. The full specification guided the LLM-assisted extraction and human validation process throughout the analysis.

TASK 1 – Identify all Project Delivery Models (PDMs)					
Objective	Input	Subtasks		Outputs	Definitions
Systematically identify, classify, and document all PDMs	Curated literature corpus on PDMs	Identify Project Delivery Methods (explicit & implicit PDMs; emerging/rare models)	Provide Methods Definition (concise definition; distinguishing vs shared features)	Produce structured tables and narrative synthesis to support cross-model comparison and further analysis.	PDM, Hybrid, Variation, Emerging/Rare, Project Area, Contribution, Correlation Strengths: Strong, Moderate, Limited
		Classify Models (risk; contract; timing; collaboration; geography; sector)	Capture Number of Mentions and Trace Sources (frequency; source files; traceable evidence)		
		Capture Synonyms (alternative labels; terminology standardisation)	Capture Supporting Inventory Data (supporting data; grouping; taxonomy development)		
		Capture Variations and Hybrid Methods (variations; hybrids; combined delivery logics)	Identify PDM Contribution to Project Areas (performance areas; qualitative strength (S/M/L/NA))		
		Provide Methods Details (risk; contract; team structure; collaboration level)	Trace Evidence for Contributions (quotations; fragments; keywords; source attribution)		

Figure 2 Specification-driven LLM Task 1 execution

Results and Discussion

The findings are presented in three complementary analytical layers across three tables, progressing from *method identification* (Table 1), to *method-level performance mapping* (Table 2), and finally to *characteristics-level mapping* (Table 3). Together, the tables reveal the fragmented PDM landscape, show how delivery methods are associated with project performance areas, and identify the recurring delivery *characteristics* that underpin those associations.

1) Method identification unveils a PDM landscape that is broad but dominated by a small “core” and a long tail of variants and hybrids

Across the curated corpus (45 documents), the analysis consolidated 48 canonical PDMs, comprising 5 established “core” methods, 12 finance- and lifecycle-based methods, approximately 8 early-involvement approaches, and a substantial set of 23 labelled variants and

hybrid configurations that adapt or combine core delivery logics (Table 1). The mention counts show a highly uneven distribution: DBB, IPD, and DB dominate the literature (each exceeding ~1,100 mentions), followed by CMAR, CM/GC, IDD and PPP/P3 with approximately 140-300 mentions each, while most other methods appear only occasionally (often <25 mentions, and many only once). This pattern indicates that, although comparative discourse often centres on a small set of canonical methods, delivery practice and scholarship also contain substantial diversity expressed through subtypes, staged forms, bundled lifecycle variants (e.g., DBFO/BOT), and hybrid configurations.

For that reason, Table 1 should be read as a consolidation map rather than a simple popularity ranking. Its analytical value lies in making visible the extent to which the field is structured around a few familiar labels while simultaneously containing many variants that adapt, combine, or partially modify those core delivery logics. This pattern is especially visible among early-involvement and lifecycle-oriented methods, where comparable arrangements may be labelled as Early Contractor Involvement, Progressive Design–Build, staged Design–Build, relational delivery, or hybrid collaborative forms, even when they share important underlying characteristics.

The findings also suggest that hybridisation is a normal feature of contemporary project delivery. While Table 1 itself reports frequency of occurrence, a closer reading of the source literature shows that core methods are predominantly discussed in theoretical and comparative studies, whereas variants and hybrid models are more often identified and analysed in case-based research. This suggests that, in practice, project delivery is frequently configured through adaptation and combination of features rather than through the direct application of “pure” method types. For example, projects may retain a conventional contractual structure while incorporating early contractor involvement, partial risk sharing, open-book cost principles, or lifecycle responsibilities. For theory, this means that comparing only method labels may make delivery approaches seem more different than they really are, while hiding the similarities in how they actually work. For practice, it indicates that delivery design often involves tailoring and combining *characteristics* to fit project-specific conditions rather than selecting from a fixed set of canonical methods. This reinforces the need for a characteristic-based analytical perspective.

In this sense, Table 1 provides the analytical basis for the next stages of the study. Once the fragmented and hybridised PDM landscape has been consolidated, the next question is whether these named delivery methods show distinct patterns in relation to project performance. Table 2 addresses this first at the method level by mapping core PDMs to project performance areas, before the analysis moves in Table 3 to the characteristic level to explain the mechanisms underlying those associations.

Table 1 Identified PDMs

No.	PDM (canonical name)	Mentions	No.	PDM (canonical name)	Mentions
1	Design–Bid–Build (DBB)	1281	25	EPC Turnkey	10
2	Integrated Project Delivery (IPD)	1162	26	Force Account	8
3	Design–Build (DB)	1116	27	IPD/TVD / Lean Integrated Project Delivery (label hybrid)*	7
4	Construction Management at Risk (CMAR / CMR / CM@R)	304	28	Agency Construction Management (CMA / Agent CM)	6
5	CM/GC (Construction Manager / General Contractor)	223	29	O&M / OMM (operations/maintenance service forms)	6
6	Integrated Digital Delivery (IDD) (digital delivery approach)	158	30	Turnkey (DB synonym / variant label)	4
7	Public–Private Partnership (PPP / P3)	142	31	Design–Build–Operate (DBO)*	4

No.	PDM (canonical name)	Mentions	No.	PDM (canonical name)	Mentions
8	Early Contractor Involvement (ECI) (approach/contract mechanism)	102	32	EPCM / EP-CM*	3
9	Project Alliancing/Project Alliance (PA)	74	33	CM “At Fee” (Agency/Advisor) #	2
10	Design–Build–Finance–Operate (DBFO)*	61	34	Novation Design–Build (label for DB variant) #	2
11	Build–Operate–Transfer (BOT)*	60	35	Package deal (label for DB variant) #	2
12	Lean Project Delivery (LPD / LPDS) (delivery-system label/approach)	51	36	Design–Build–Finance–Operate–Maintain (DBFOM)*, #	2
13	Construction Management (CM) (general)	46	37	Design-refine construct (staged DB label) #	1
14	Relational contracts (category)	44	38	Develop-and-Construct (label for DB variant) #	1
15	Design–Build–Operate–Maintain (DBOM)*	35	39	Direct DB (label for DB variant) #	1
16	Multiple-Prime Contracting (Multi-prime)	33	40	Fee-paid developer (DB team structure variant) #	1
17	Project Partnering (PP)	25	41	Full design-construct (staged DB label)#	1
18	Progressive Design–Build (PDB)	22	42	Multiple Design–Build #	1
19	Private Finance Initiative (PFI)	18	43	“Multiple DBB” (packaged DBB) #	1
20	Strategic alliance / strategic alliancing (SA)	15	44	Design–Build–Finance (DBF) #	1
21	Single Purpose Entity (SPE) (governance/legal vehicle)	13	45	Design–Build–Finance–Maintain (DBFM)#	1
22	Bridging (DB variation)	13	46	Design–Build–Finance–Operate–Transfer (DBFOT)#	1
23	Build–Own–Operate–Transfer (BOOT)*	13	47	Design–Build–Maintain (DBM)*, #	1
24	Job Order Contracting / IDIQ (procurement mechanism)	13	48	Two-stage / staged Design–Build#	0

Notes: * - Hybrids; # - Emerging/rare method

2) Method-level performance mapping highlights conventional performance areas and offers limited guidance for emerging performance areas

Building on the consolidated PDM landscape in Table 1, Table 2 provides the first level of performance interpretation by mapping core PDMs to eight project performance areas. The table presents a qualitative evidence-strength matrix indicating whether associations between PDMs and performance areas are strongly, moderately, or only limitedly supported in the literature corpus. The matrix reflects the presence of evidence rather than the direction of effects.

At the method level, the literature is dominated by conventional performance concerns, with the strongest evidence relating to cost, time, quality, risk, and collaboration. This confirms that the PDM literature still primarily evaluates delivery approaches in terms of traditional project performance criteria. Sustainability and innovation appear more selectively, mainly in digitally enabled or lifecycle-oriented methods such as IDD and PPP/P3. Circularity, by contrast, is largely absent at the level of named delivery methods. In the present corpus, only IPD shows explicit strong evidence in relation to circularity, while the other core methods are not directly discussed in terms of circularity.

This pattern also reflects the dominant evaluation logic of the PDM literature. Conventional KPIs are closely aligned with procurement efficiency, project control, and bounded delivery outcomes, making them easier to observe, compare, and report across studies. By contrast, sustainability, innovation, and circularity often depend on broader stakeholder value, longer temporal horizons, and cross-phase effects that extend beyond the immediate project boundary. The dominance of conventional KPIs in Table 2 therefore points not only to an evidence gap, but also to a prevailing project-bounded logic in how delivery performance has historically been

evaluated. This suggests that the prevailing project-bounded evaluation logic may no longer be sufficient to address emerging requirements that emphasise lifecycle performance and long-term value creation in construction

At the same time, the differences in sustainability, innovation and circularity pattern indicates that circularity cannot be inferred from general discussions of sustainability or innovation at the method-label level. In other words, a delivery method being associated with sustainability or digitalisation does not automatically mean that it is also explicitly discussed as supporting circular outcomes. These three emerging performance areas should therefore be investigated separately. Table 2 shows that none of them is yet firmly established as an evaluation dimension in the mainstream PDM literature, with circularity being by far the least developed.

Furthermore, Table 2 also reveals the limitations of method-level comparison. Labelled PDMs function as broad containers: they indicate associations with performance outcomes but do not explain which specific features produce those effects. This is a significant limitation for projects that must address multiple objectives simultaneously. If practitioners or researchers want to understand how delivery can be configured to support not only conventional KPIs but also emerging aims such as sustainability, innovation and circularity, then method labels alone provide only limited guidance. This motivates the shift to the characteristic level in Table 3.

Table 2 PDM–Performance Mapping

No.	PDM (canonical name)	Cost	Time	Quality	Risk	Collab	Sust	Innov	Circ
1	Design–Bid–Build (DBB)	●	●	●	●	●	●	⊙	⊙
2	Integrated Project Delivery (IPD)	●	●	●	●	●	○	●	●
3	Design–Build (DB)	●	●	●	●	●	●	⊙	⊙
4	Construction Management at Risk (CMAR / CMR / CM@R)	●	●	●	●	●	○	⊙	⊙
5	CM/GC (Construction Manager / General Contractor)	●	●	●	●	●	○	⊙	⊙
6	Integrated Digital Delivery (IDD) (digital delivery approach)	●	●	●	●	●	●	●	⊙
7	Public–Private Partnership (PPP / P3)	●	●	●	●	●	●	●	⊙

Legend: ● - Strong; ● - Moderate; ○ - Limited; ⊙ - Indicated as not found in the literature corpus

3) Characteristics-level mapping explains project performance and highlights research gaps for emerging performance areas

Table 3 is the core analytical contribution of the study because it moves beyond the question of which delivery method is associated with which performance area and addresses the more explanatory question of which delivery *characteristics* appear to produce those associations. The table consolidates *characteristics* across 12 categories – *governance, process, timing, cost, risk allocation, collaboration, finance, pricing, procurement, contract structure, lifecycle scope, and technology enablement*– and maps them both to project performance areas and to the core PDMs in which they recur.

Table 3 Characteristic-level mapping of delivery characteristics across project performance areas and core PDMs

Category	Key Characteristics	Performance Areas								(Core) Delivery Methods						
		Cost	Time	Quality	Risk	Collab	Sust	Innov	Circ	DBB	IPD	DB	CMAR	CM/GC	IDD	PPP
Governance	1 Single-point accountability	○	○	○	●	○	○	○	○	○	○	●	○	○	○	○
	2 CM as management overlay	●	●	●	●	●	○	○	○	○	○	○	●	○	○	○
	3 Single-purpose entity (SPE)	●	○	●	●	●	○	○	○	○	●	○	○	○	○	○
	4 Consensus / joint governance	○	○	●	○	●	○	○	○	○	●	○	○	○	○	○
	5 Administrative overhead	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○
	6 Owner-led design control	●	○	●	●	○	○	○	○	●	○	○	○	○	○	○
Process	7 Internalised design–construction	●	●	●	●	●	○	○	○	●	○	●	○	○	○	○
	8 Lean delivery system (LPD)	●	●	○	○	●	○	○	○	○	○	○	○	○	○	○
	9 Target value design (TVD)	●	●	●	●	●	○	○	○	○	○	○	○	○	○	○
	10 Bridging (owner-led concept)	●	●	●	●	●	○	○	○	○	○	●	○	○	○	○
Timing	11 Sequential delivery	○	●	○	○	○	○	○	○	●	○	○	○	○	○	○
	12 Fast-track / overlapping	●	●	○	●	○	○	○	○	○	○	●	●	●	○	○
	13 Early contractor involvement	●	●	●	●	●	○	○	○	○	●	●	●	●	○	●
	14 Progressive / two-phase DB	●	●	○	●	○	○	○	○	○	○	●	●	●	○	○
Cost	15 Late cost determination	●	○	○	●	○	○	○	○	○	○	○	○	○	○	○
Risk allocation	16 Owner-retained risk	○	○	○	●	○	○	○	○	●	○	○	●	○	○	○
	17 Risk transfer to contractor	●	●	●	●	○	○	○	○	○	○	●	○	○	○	○
	18 Shared risk pool	●	●	●	●	●	○	○	○	○	●	○	○	○	○	○
	19 Claims avoidance / no-dispute	●	●	○	●	●	○	○	○	○	○	○	○	○	○	○
	20 Design responsibility boundary	●	●	●	●	○	○	○	○	●	○	●	●	●	○	○
Collaboration	21 Contractual collaboration	●	●	●	●	●	●	○	○	●	●	○	●	○	●	●
	22 Relational contracting	●	●	●	●	●	○	○	○	○	●	●	●	○	○	○
	23 Partnering workshops	○	○	○	○	●	○	○	○	○	●	●	○	○	○	○
	24 Integrative delivery	●	●	●	○	●	○	○	○	○	●	○	○	○	○	○
Finance	25 Private finance / concessions	●	●	●	●	○	○	○	○	○	○	●	○	○	○	○
	26 Public–private partnership	○	○	○	○	●	○	○	○	○	○	●	○	○	○	○
	27 PFI / service-purchase model	○	○	●	○	○	○	○	○	○	○	○	●	●	○	○
Pricing	28 Guaranteed maximum price	●	●	○	●	○	○	○	○	○	○	●	●	●	○	○
	29 Open-book costing	●	○	○	●	●	○	○	○	○	●	○	●	○	○	○
	30 Performance-based incentives	●	●	●	●	●	○	○	○	○	●	●	●	○	○	○
Procurement	31 Best-value procurement	○	●	●	●	○	○	○	○	○	○	●	●	●	○	○
	32 Low-bid procurement	●	○	○	○	○	○	○	○	●	○	○	○	○	○	○
	33 Packaged / staged procurement	○	●	○	●	○	○	○	○	●	○	●	●	●	○	○
Contract structure	34 CM at risk (CM→GC)	●	○	○	●	○	○	○	○	●	○	○	●	●	○	○
	35 Agency CM (no trade risk)	○	○	○	●	●	○	○	○	○	○	○	●	○	○	○
	36 Separate design & build	○	○	○	○	○	○	○	○	●	○	●	●	●	○	○
	37 Single integrated DB contract	●	●	●	●	●	○	○	○	○	●	●	○	○	○	○
	38 Multiple-prime contracting	●	●	○	●	●	○	○	○	○	○	○	○	○	○	○
	39 Multi-party agreement	○	○	○	○	●	○	○	○	○	●	○	○	○	○	○
	40 EPC / Turnkey	○	○	○	●	○	○	○	○	○	○	○	○	○	○	○
	41 EPCM / EP-CM	○	○	○	●	○	○	○	○	○	○	○	○	○	○	○
42 Force account	○	○	○	●	○	○	○	○	○	○	○	○	○	○	○	
Lifecycle scope	43 Lifecycle bundling (O&M)	●	●	●	●	●	○	○	○	○	○	●	○	○	●	●
	44 End-of-term transfer	●	●	●	●	●	●	○	○	○	○	○	○	○	○	○
Technology enablement	45 Digital delivery integration (IDD)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

Legend: ● - Strong; ● - Moderate; ○ - Limited; ○ - Indicated as not found in the literature corpus.

Table 3 can be interpreted in two complementary ways. The rows include individual delivery *characteristics*, while the columns show which *characteristics* recur across specific performance areas. The PDM columns reconnect these *characteristics* to labelled delivery methods, illustrating that similar delivery logics recur across different method labels. This is precisely the point at which the analysis becomes more explanatory: performance effects that are often attributed to “DB,” “IPD,” or “PPP” can now be interpreted in terms of recurring *characteristics* rather than as inherent properties of the labels themselves.

Several broad patterns emerge from Table 3. First broad pattern is that conventional performance areas—*cost*, *time*, *quality*, *risk*, and *collaboration*—are associated with a relatively consistent set of recurring delivery mechanisms across differently named PDMs. *Characteristics* related to early and progressive involvement, integrated design–construction processes, target value design, structured risk arrangements, and collaboration-oriented governance repeatedly appear across these areas. This suggests that many performance effects attributed to specific delivery methods are mediated by a smaller set of underlying delivery mechanisms, indicating that method labels often function as shorthand for combinations of delivery *characteristics* rather than explanatory categories in their own right.

These *characteristics* do not influence all performance areas in the same way; rather, they appear to contribute through distinct, and often combined, causal pathways. While a full causal validation lies beyond the scope of this paper, Table 3 allows several preliminary observations. Early contractor involvement and progressive commitment are most clearly associated with cost and time performance, as they bring constructability and implementation knowledge into design and reduce late-stage changes. Integrative delivery and relational contracting are most strongly linked to collaboration and risk performance, as they reduce fragmentation and adversarial behaviour across organisational boundaries. Lifecycle-oriented and digitally-enabled characteristics, such as lifecycle bundling and digital delivery integration, appear more closely related to sustainability and innovation because they extend responsibility beyond handover and preserve information continuity. In this sense, the performance effects reported in Table 3 are not produced by method labels alone, but by recurring combinations of delivery *characteristics* that activate different mechanisms across specific performance areas.

More importantly for this study, Table 3 highlights clear research gaps for the emerging performance areas of *sustainability*, *innovation*, and *circularity*. Compared with conventional performance areas, these dimensions are less consistently represented in the PDM literature. For *sustainability* and *innovation*, the table shows some moderate to strong associations, particularly for *characteristics* such as integrative delivery, target value design, lifecycle bundling, and digital delivery integration. These *characteristics* point to the importance of coordination, lifecycle awareness, and information continuity for emerging project objectives. However, the evidence remains uneven across delivery methods.

The gap is most pronounced for *circularity*. Only a small number of characteristics, most notably relational contracting (21), integrative delivery (23), and performance-based incentives (29) are explicitly indicated in the examined corpus as related to circularity. This suggests that circularity remains only weakly articulated within the current PDM literature, even where theoretically relevant enabling conditions may already be present. This gap is not only empirical but also structural. Most established PDMs are rooted in a predominantly linear project logic.

At the same time, several delivery *characteristics* appear theoretically relevant for circularity even though the current literature does not yet discuss them explicitly in circularity terms. Early contractor involvement, for example, may support circularity by enabling requirements such as

design for disassembly, reuse, and lifecycle optimisation to be addressed earlier in design and procurement decisions. Lifecycle bundling may support circularity by extending responsibility beyond handover and making long-term asset value, maintenance, and recovery more visible in delivery decisions. Open-book costing and shared risk structures may contribute by improving transparency and aligning incentives around longer-term value rather than short-term cost optimisation. Similarly, multi-party governance and digital delivery integration may support circularity by improving cross-phase coordination, traceability, and information continuity. Their absence from the circularity column therefore likely reflects a lack of explicit discussion in the corpus rather than evidence that these *characteristics* are irrelevant. This is partly because circularity is still an emerging topic in project management research, and the literature has not yet systematically translated its implications into project delivery terms. Figure 3 visualises this distinction.

Figure 3 should be interpreted as a conceptual heuristic rather than as an evaluative model or evidence-ranking framework. It does not present calculated scores or measured effect sizes. Instead, it visualises a synthesis judgement about the relative relevance of selected delivery *characteristics* for circularity, based on two considerations: (i) whether a characteristic is explicitly linked to circularity in the current corpus, and (ii) whether its broader associations with integration, lifecycle responsibility, transparency, coordination, or incentive alignment make it theoretically promising for circular outcomes. Fully coloured circles indicate *characteristics* explicitly evidenced in the literature; dashed circles indicate *characteristics* assessed as theoretically strong but not yet explicitly supported in the current corpus; lighter circles indicate more tentative or indirect relevance. The vertical position and circle size therefore represent conceptual contribution strength, intended only to guide future research and not to rank evidence empirically.

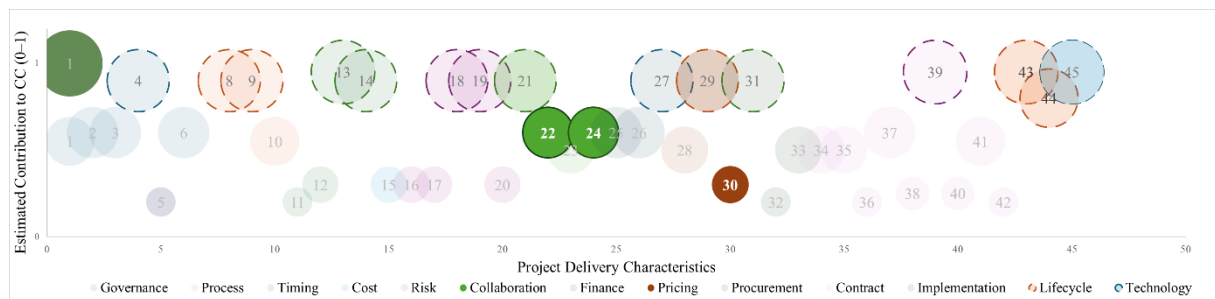


Figure 3 Conceptual heuristic of how project delivery characteristics may contribute to circularity in the context of circular construction (CC)

Overall, Table 3 shows why a characteristic-based lens provides the main analytical contribution of this study. It offers a more transferable basis for explaining project performance than delivery method labels alone and, at the same time, reveals where the current literature remains underdeveloped for emerging performance areas. Together, Table 3, Table 2 and Figure 3 provide a structured starting point for future research on emerging performance areas in project delivery. Figure 3 illustrates the *circularity* case, providing a template for similar analyses on *sustainability* and *innovation*.

Conclusions

This study provides a structured, evidence-based baseline for analysing PDMs through a characteristic-based perspective. By consolidating the fragmented PDM landscape and mapping both delivery methods and their underlying *characteristics* to key project performance

areas, the analysis demonstrates that project outcomes are more meaningfully explained through recurring delivery characteristics, such as early involvement, collaborative governance, incentive alignment, and lifecycle-oriented delivery, than through PDM labels alone.

The findings confirm that the PDM literature remains centered on a small set of core delivery methods and is still primarily oriented towards conventional performance areas, especially *cost, time, quality, risk, and collaboration*. At the same time, practice reflects a broader and more hybridised delivery landscape than method labels typically suggest. This reinforces the need to move beyond label-based comparison and towards analysis of the *characteristics* that recur across differently named delivery arrangements.

For the emerging performance areas of *sustainability, innovation, and circularity*, the evidence remains uneven and incomplete. Sustainability and innovation are linked to several delivery characteristics, particularly integrative delivery, target value design, lifecycle bundling, and digital delivery integration, but these links are not yet consistently developed across the literature. *Circularity* remains the least developed area: only a small number of characteristics, most notably relational contracting, integrative delivery, and performance-based incentives, are explicitly associated with it in the examined corpus.

Overall, the study identifies clear research gaps for emerging performance areas and shows that a characteristic-based lens provides the most suitable basis for addressing them as a structured starting point for future research. Further studies should investigate how combinations of delivery *characteristics* can be configured and validated to support sustainability, innovation, and especially circularity while maintaining performance across the conventional project criteria.

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Keywords

Project Delivery Method, Key Characteristics, Project Performance Area, Emerging Performance Areas, Circularity

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