

EPC PRE-EXECUTION PLANNING COMMUNICATION: A COMPARATIVE ANALYSIS OF FOUR APPROACHES

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ABSTRACT

Communication during the pre-execution planning phase—encompassing scope definition, schedule development, and procurement strategy before field execution—is critical to the performance of engineering, procurement, and construction (EPC) projects, a delivery model in which a single contracting entity assumes integrated responsibility for engineering, procurement, and construction. Conventional EPC pre-execution planning communication is document-centric and contract-driven, providing traceability but limiting timely cross-functional alignment and learning. Three alternative approaches—Lean Construction, Project Production Management (PPM), and Advanced Work Packaging (AWP)—propose distinct mechanisms to improve planning-phase communication. This paper presents a structured comparative analysis of these four approaches using criteria derived from EPC planning challenges, project communication literature, and socio-technical systems theory. The analysis shows that Lean Construction strengthens collaborative commitment, trust, and feedback loops; PPM introduces system-level flow logic and quantitative variability control; and AWP embeds communication within structured work packages aligned to construction needs. While each approach addresses specific limitations, none is sufficient in isolation. The findings are synthesized into an integrated communication architecture positioning Lean, PPM, and AWP as complementary across social, systemic, and procedural dimensions. This study contributes an analytical baseline, a comparison framework, and an integration model to support future research and implementation in EPC projects.

KEYWORDS

Collaboration, commitment, trust, EPC projects, pre-execution planning.

INTRODUCTION

Engineering, procurement, and construction (EPC) projects are a project delivery model in which a single contracting entity assumes integrated responsibility for engineering design, procurement, and physical construction. This model is prevalent in sectors such as oil and gas, power generation, petrochemicals, and heavy industrial infrastructure, and is typically characterized by large scale, high technical complexity, and long supply chains. Within this context, effective communication is widely recognized as a critical determinant of project

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performance, influencing cost, schedule, quality, and risk outcomes (PMI, 2021; Love et al., 2016). Despite advances in digital tools and formal communication management systems, EPC projects continue to experience persistent coordination failures, rework, and misalignment traceable to deficiencies in early planning communication (Morrow, 2011; Flyvbjerg, 2014).

The pre-execution planning phase plays a particularly influential role (Kabirifar & Mojtahedi, 2019), encompassing scope definition, schedule development, procurement strategy, constructability review, and work breakdown structuring. During this phase, activities across engineering, procurement, and construction are both sequential and concurrent, yet decisions are taken under high uncertainty while locking in a significant proportion of project cost and risk (Miller & Lessard, 2000). This paper focuses on inter-organizational communication across these functional interfaces, as cross-functional coordination represents a distinctive and persistent source of planning failures in EPC projects (Shen et al., 2017; O'Connor et al., 2017).

Conventional communication practices in EPC pre-execution planning are predominantly document-centric and contract-driven, relying on formal deliverables, hierarchical reporting, and approval structures. While this provides traceability and contractual control, it results in fragmented information flows, delayed feedback, and limited cross-functional learning (Love et al., 2018; O'Connor et al., 2017). In response, three alternative approaches have emerged: Lean Construction, emphasizing collaborative planning and commitment-based coordination (Ballard & Howell, 2003; Koskela, 2000); PPM, focusing on flow, variability, and capacity through system-level planning logic (Hopp & Spearman, 2011; Rooke et al., 2012); and AWP, structuring planning communication through standardized work packages with explicit readiness criteria (CII, 2015; O'Brien et al., 2013).

Although increasingly applied in practice, these approaches are often presented independently and without clear comparison to conventional EPC communication. This paper addresses that gap through a structured, criteria-based comparison and integrative framework positioning them as complementary rather than competing, focusing on inter-organizational pre-execution planning communication across engineering, procurement, and construction. This advances Lean Construction discourse by situating collaborative practices within a broader socio-technical framing connecting them to production system logic and structured execution planning (Howell et al., 2011; Rooke et al., 2012).

BACKGROUND AND THEORETICAL FOUNDATIONS

COMMUNICATION IN EPC PRE-EXECUTION PLANNING

Communication in projects is commonly defined as the process through which information, meaning, and intent are created, transmitted, and interpreted among project stakeholders to achieve project objectives (PMI, 2021). In EPC projects, communication extends beyond simple information exchange and becomes a critical inter-organizational coordination mechanism across engineering, procurement, and construction functions that are tightly coupled in time but often organizationally separated.

EPC delivery structures concentrate contractual responsibility within a single entity, yet execution typically involves multiple internal departments, subcontractors, vendors, and external stakeholders. This configuration creates numerous organizational interfaces and increases communication complexity, particularly during early project phases when scope, design maturity, and execution strategies are still evolving (Shen et al., 2017; O'Connor et al., 2017). Prior studies have shown that ineffective communication across these interfaces is a major contributor to scope changes, rework, claims, and schedule delays (Love et al., 2016; Flyvbjerg, 2014). The pre-execution planning phase is especially sensitive because engineering decisions influence procurement lead times and construction sequences, while procurement constraints and constructability considerations must simultaneously inform engineering

development. Communication failures at this stage propagate into field execution, where corrective actions become increasingly costly (Miller & Lessard, 2000; Merrow, 2011).

DOCUMENT-CENTRIC COMMUNICATION IN EPC PRE-EXECUTION PLANNING

Conventional document-centric communication in EPC pre-execution planning is shaped by contractual requirements, quality management systems, and risk management considerations (Kabirifar & Mojtahedi, 2019). Communication is formal, hierarchical, and document-based, relying on drawings, specifications, schedules, transmittals, RFIs, and meeting minutes designed to ensure traceability and contractual compliance across organizational boundaries (PMI, 2021). While such systems provide necessary governance, information flows tend to be linear and sequential, feedback loops slow and reactive, and communication focused on transmission rather than shared understanding or collaborative problem-solving (Love et al., 2018). These characteristics reinforce functional silos and discourage early cross-functional integration (O'Connor et al., 2017; Shen et al., 2017).

LEAN CONSTRUCTION AND COLLABORATIVE PLANNING COMMUNICATION

Lean Construction emerged from production theory applied to construction, emphasizing the Transformation-Flow-Value (TFV) framework and the management of workflow and variability (Koskela, 2000). Communication is viewed as a social process enabling coordination, commitment, and learning—closely aligned with relational coordination theory, which emphasizes that high-frequency, timely, problem-solving communication embedded in relationships of shared goals and mutual respect is central to interdependent work performance (Gittell, 2002). In the pre-execution planning phase, practices such as pull planning and phase planning, as part of the Last Planner System (LPS), create structured forums for stakeholders to jointly define sequences, identify constraints, and make reliable commitments (Ballard & Howell, 2003). Research has shown that such practices improve planning reliability and cross-functional alignment (Howell et al., 2011; Ballard et al., 2009). Lean communication also promotes trust and psychological safety—conditions identified as prerequisites for effective cross-functional collaboration (Edmondson, 1999)—though Lean approaches tend to provide limited formal guidance on integrating with production system design and EPC contractual controls.

PPM AND SYSTEM-LEVEL PLANNING COMMUNICATION

PPM applies operations science principles to project-based production, conceptualizing project execution as a network of interdependent activities whose performance depends on flow management rather than local task optimization (Hopp & Spearman, 2011; PPI, 2017). While PPM draws on manufacturing systems theory, its application to EPC contexts requires adapting these principles to conditions of high variability, unique deliverables, and evolving scope. Planning-phase communication is structured around defining system capacity, sequencing logic, buffers, and release conditions—communicating production rules and performance metrics rather than fixed schedules (Rooke et al., 2012). This reframes communication from a managerial coordination problem to a system design problem, providing a quantitative foundation for aligning engineering, procurement, and construction decisions. However, PPM operates primarily at an abstract system level and offers limited guidance on the behavioral and relational dimensions of planning communication.

AWP AND EXECUTION ORIENTED PLANNING COMMUNICATION

AWP was developed within the industrial construction sector to address misalignment between engineering, procurement, and construction. AWP structures planning communication by decomposing project scope into standardized work packages—Engineering Work Packages (EWPs), Construction Work Packages (CWPs), and Installation Work Packages (IWP)—

explicitly aligned with construction execution sequences (CII, 2015). In the pre-execution planning phase, AWP embeds communication requirements within work package definitions, specifying deliverables, interfaces, readiness criteria, and handoff milestones (O'Brien et al., 2013). Empirical studies indicate that AWP can improve schedule predictability, labor productivity, and planning reliability in EPC projects (CII, 2015; O'Connor et al., 2017). Nevertheless, AWP can become overly rigid or document-heavy without attention to collaborative behaviors and system-level flow logic, potentially reproducing limitations of conventional communication systems.

SOCIO-TECHNICAL SYSTEMS THEORY AS AN INTEGRATIVE LENS

Socio-technical systems (STS) theory, originating in the work of Trist (1981) and elaborated by Pasmore (1988), holds that organizations achieve high performance when their social subsystem—human relationships, norms, trust, and collaborative behaviors—is designed in concert with the technical subsystem—tools, processes, workflows, and information structures. Applied to EPC planning communication, STS theory provides a unifying perspective that connects Lean Construction's behavioral emphasis with PPM's technical system logic and AWP's procedural structures. This integrative framing is particularly relevant for the People, Culture and Change track, which recognizes that sustainable improvements in project production systems depend on cultural transformation, trust development, and behavioral change alongside technical redesign (Howell et al., 2011).

SYNTHESIS: IMPLICATIONS FOR COMPARATIVE ANALYSIS

As demonstrated above, the four communication approaches embody fundamentally different assumptions. Document-centric systems prioritize governance and traceability; Lean emphasizes collaboration, trust, and commitment; PPM focuses on production flow and variability; and AWP operationalizes communication through structured work packages. STS theory suggests that none of these approaches, in isolation, achieves the joint optimization of social and technical dimensions necessary for high-performing project production systems—motivating the structured comparison in the following section.

LITERATURE REVIEW AND RESEARCH METHODOLOGY

LITERATURE SELECTION AND REVIEW PROCEDURE

This study is grounded in a structured conceptual review of published literature on EPC project communication, Lean Construction, PPM, AWP, and socio-technical systems theory. Sources were identified through purposive searches of Scopus, Web of Science, and Google Scholar, supplemented by backward and forward citation tracing from foundational works (Koskela, 2000; Hopp & Spearman, 2011; CII, 2015) and industry guidelines from CII, PMI, and PPI. Sources were selected based on relevance to pre-execution planning communication, theoretical or empirical contribution, and citation influence. The review synthesized findings across four thematic areas — EPC planning challenges, Lean collaborative planning, PPM production logic, and AWP deliverable structuring — with STS theory as a cross-cutting analytical lens.

RESEARCH APPROACH AND UNIT OF ANALYSIS

This study employs a qualitative conceptual comparative analysis (Jabareen, 2009) of four communication approaches in EPC pre-execution planning: (1) document-centric conventional practice; (2) Lean Construction; (3) Project Production Management (PPM); and (4) Advanced Work Packaging (AWP). These were selected because they represent distinct paradigms influencing EPC planning practice and collectively span the social, systemic, and procedural dimensions of communication identified in the STS literature. The unit of analysis is pre-

execution planning communication, defined as the inter-organizational processes used to align scope, sequencing, and decision-making before field execution begins.

DEVELOPMENT OF COMPARISON CRITERIA

The comparison criteria were derived from the structured literature review, drawing on EPC planning, project communication, production theory, and socio-technical systems literature. An eleventh criterion—socio-technical alignment—was added to capture the degree to which each approach integrates behavioral and technical dimensions of communication. Table 1 summarises all eleven criteria with descriptions and representative sources.

Table 1: Criteria for comparing pre-execution planning communication approaches

Criterion	Description	Reference
Purpose of communication	Primary intent of communication during planning (information transfer, commitment-making, or production coordination).	PMI (2021); Ballard & Howell (2003); Koskela (2000); Yin et al. (2023)
Communication logic	Underlying conceptual model guiding communication (transactional, collaborative, system-based, or procedural).	Koskela (2000); Hopp & Spearman (2011); PMI (2021); Fan et al. (2023)
Direction and flow	Predominant communication flow (hierarchical vs. cross-functional; push vs. pull).	Ballard & Howell (2003); Kenley & Seppanen (2010); Shen et al. (2017); Fan et al. (2023); Li et al. (2021)
Level of formalization	Degree of reliance on formal documents, procedures, and standardized processes.	PMI (2021); Merrow (2011); O'Connor et al. (2017); Mahajan & Baride (2023)
Stakeholder integration	Extent of cross-functional integration among engineering, procurement, and construction during pre-execution planning.	Shen et al. (2017); Love et al. (2016); O'Connor et al. (2017); Yin et al. (2023); Fan et al. (2023); Li et al. (2021)
Handling of uncertainty	Mechanisms used to address incomplete information and variability.	Miller & Lessard (2000), Flyvbjerg (2014), Hopp & Spearman (2011)
Feedback and relational communication mechanisms	Presence of structured feedback and learning loops supporting continuous planning adjustment.	Ballard (2000); Howell et al. (2011); Koskela (2000); Gittell (2002)
Planning-to-execution linkage	How planning outputs are translated into executable construction work.	CII (2015); O'Brien et al. (2013); O'Connor et al. (2017); Mahajan & Baride (2023)

Table 1: Criteria for comparing pre-execution planning communication approaches (continued)

Criterion	Description	Reference
Work readiness definition	Clarity and explicitness of the criteria determining when work is ready.	CII (2015); Ballard & Howell (2003); O'Brien et al. (2013)
EPC compatibility	Alignment with EPC contractual structures, governance, and control requirements.	Merrow (2011); PMI (2021); Liu et al. (2025); Mahajan & Baride (2023)
Socio-technical alignment	Degree to which communication integrates social/behavioral and technical/procedural dimensions of planning.	Trist (1981); Pasmore (1988); Schweitzer et al. (2025)

ANALYTICAL PROCEDURE AND VALIDATION

Each communication approach was analyzed against the eleven criteria using evidence from the reviewed literature, following three steps: (1) extraction of approach-specific communication characteristics from primary and secondary sources; (2) systematic comparison across criteria to identify strengths, limitations, and gaps; and (3) synthesis of cross-approach complementarities using STS theory as an integrating framework. Emerging comparisons were cross-checked against multiple independent sources, and conflicting characterizations were reconciled where possible.

RESULTS AND DISCUSSION

COMPARATIVE RESULTS ACROSS PRE-EXECUTION PLANNING COMMUNICATION CRITERIA

Table 2 summarises how the four approaches perform across the eleven comparison criteria. The table reveals distinct communication logics and complementary strengths rather than direct substitution among approaches.

Table 2: Comparison of pre-execution planning phase communication approaches

Criterion	Document-Centric (Conventional)	Lean Construction	PPM	AWP
Purpose of communication	Primarily to transmit information.	Focuses on commitments and reliable promises.	Focuses on controlling production flow and reducing variability.	Aligns engineering deliverables with construction tasks.
Communication logic	Transactional or hierarchical (top-down).	Collaborative and iterative (team-driven); socially embedded.	System-based (production-system planning and flow management).	Procedural (package-based, work-package logic with readiness gates).
Direction and flow	Push-driven, siloed (discipline to discipline).	Pull-driven, cross-functional (collaborative planning sessions).	Push-driven by plan but monitored by flow metrics.	Pull by package readiness, handoffs defined by work packages.
Level of formalization	Contracts, RFIs, transmittals, and formal sign-offs.	Visual boards, collaborative forums, informal meetings.	Requires defined processes for flow control and metrics.	Structured work packages, readiness checklists, and handoff gates.
Stakeholder integration	Limited early involvement of contractors and vendors; integration occurs late through formal channels.	Integrated planning sessions with all the last planners and key stakeholders.	Teams coordinate on WIP, but are often analytical.	Cross-team integration at work-package level.
Handling of uncertainty	Changes handled reactively via formal change orders; little proactive buffering.	Iterative planning and constraint removal adapt to changes.	Explicit buffers and WIP limits manage variability proactively.	Gates and handoffs reduce some uncertainty at package boundaries.
Feedback mechanisms	Few structured feedback loops; issues surface reactively.	Regular percent-plan-complete meetings and daily huddles for team learning.	Reliance on metrics, periodic reviews, but limited social interaction.	Focus is on execution readiness, not continuous behavioral feedback.

Table 2: Comparison of pre-execution planning phase communication approaches (continued)

Criterion	Document-Centric (Conventional)	Lean Construction	PPM	AWP
Planning-to-execution linkage	Planning often disconnected from actual construction execution.	Pull planning improves alignment but lacks explicit package definitions.	Aligns flow logic, but not specific deliverable readiness.	Engineering outputs directly tied to construction packages with clear handoffs.
Work readiness definition	Readiness often implicit or contractual.	Constraints logged; work ready when reliable promises are kept.	Focus on flow metrics rather than specific deliverable readiness.	Explicit ‘free of constraints’ criteria for releasing each work package.
EPC compatibility	Fits traditional EPC contracts and governance processes.	Requires cultural change but can be layered on existing plans.	Conceptual shift needed, but uses standard project data.	Designed for EPC delivery, enhances compliance and contractual traceability.
Socio-technical alignment	Technical/procedural emphasis; social dimension neglected.	Integrates social practices, trust-building, and collaborative commitment.	System-level logic, but limited in behavioral/relational dimension.	Procedural clarity, but less developed in cultural and relational aspects.

INTERPRETATION OF RESULTS AND KEY FINDINGS

The results indicate that conventional EPC planning communication provides strong governance, documentation control, and contractual traceability, aligning with traditional EPC risk management (PMI, 2021; Merrow, 2011). However, its vertical, document-driven, push-based logic limits early cross-functional integration and weakens feedback during planning, contributing to late discovery of interface issues, redesign, rework, and schedule disruption (Shen et al., 2017; Love et al., 2018). Critically, conventional systems score low on socio-technical alignment, addressing the technical-governance dimension while neglecting social and relational conditions necessary for cross-functional trust.

Lean Construction addresses these shortcomings through collaborative planning, shared understanding, and commitment-based coordination (Ballard & Howell, 2003; Koskela, 2000). The relational coordination dimension—frequent, timely, problem-solving communication supported by shared goals and mutual respect (Gittell, 2002)—is a distinctive strength not systematically cultivated by PPM or AWP. However, Lean's reliance on social interaction and informal planning artifacts limits scalability and integration with formal EPC control systems when applied in isolation (O'Connor et al., 2017).

PPM reframes planning communication around production system behavior, linking communication to WIP limits and buffer management for more proactive uncertainty management (Hopp & Spearman, 2011; PPI, 2017). Its relatively low socio-technical alignment

score reflects a strong technical-analytical orientation without corresponding attention to behavioral and cultural coordination conditions. AWP strengthens execution linkage by embedding communication within standardized work packages and explicit readiness criteria (CII, 2015; O'Brien et al., 2013), but its high formalization can reduce flexibility unless supported by collaborative planning behaviors.

COMPLEMENTARITY, SOCIO-TECHNICAL INTEGRATION, AND IMPLICATIONS FOR EPC PRACTICE

No single communication approach sufficiently addresses the full range of pre-execution planning challenges in EPC projects. Viewed through the STS lens, the four approaches occupy distinct but complementary positions: conventional EPC communication provides the governance baseline; Lean addresses the social and behavioral dimension by fostering trust and reliable commitments (Ballard & Howell, 2003; Koskela, 2000); PPM addresses the systemic dimension through quantitative flow and variability management (Hopp & Spearman, 2011); and AWP addresses the procedural dimension by translating plans into execution-ready work packages (CII, 2015).

STS theory suggests this integration constitutes a joint optimization of the social and technical subsystems of EPC planning communication—not merely an additive combination. Lean-based collaborative planning can be embedded within AWP work package development, ensuring readiness criteria are socially negotiated rather than unilaterally imposed, while PPM flow logic informs the sequencing of planning sessions and ensures buffer management is reflected in handoff gate design. The resulting integrated communication architecture is summarised in Table 3.

Table 3: Integrated communication architecture for EPC pre-execution planning phase

Dimension	Primary Approach	Communication Mechanisms	Addressed Criteria
Social/Behavioral	Lean Construction	Collaborative planning, commitment-based coordination, trust-building, cross-functional learning loops	Stakeholder integration, feedback, relational communication, socio-technical alignment
Systemic/Analytical	PPM	Production flow logic, variability management, WIP control, buffer design	Uncertainty handling, direction and flow, planning-to-execution logic
Procedural/Structural	AWP	Work package decomposition, readiness criteria, handoff gates, and deliverable-construction alignment	Work readiness definition, planning-to-execution linkage, EPC compatibility
Governance/Control	Conventional (baseline)	Contractual traceability, documentation, formal approvals, and audit trail	Level of formalization, EPC compatibility, and communication logic

Adopting this integrated architecture requires cultural transformation: engineering, procurement, and construction teams must develop shared planning identities, build inter-functional trust, and establish norms of collaborative commitment-making. Research on

organizational learning and cross-functional team dynamics suggests such cultural change is most effectively supported through structured, repeated collaborative interactions—precisely the kind that Lean-based planning practices provide (Edmondson, 1999; Schweitzer et al., 2025). PPM's performance metrics and AWP's readiness gates then institutionalize behavioral changes initiated through Lean collaborative planning, creating reinforcing feedback loops between social practice and technical structure. These findings align with calls in the IGLC community to move beyond isolated tools toward integrated production systems addressing both social and technical dimensions of project performance (Howell et al., 2011; Rooke et al., 2012), and with the broader STS proposition that high-performing work systems require deliberate co-design of their social and technical subsystems (Trist, 1981; Pasmore, 1988).

CONCLUSIONS

This study compared conventional document-centric EPC planning communication with Lean Construction, PPM, and AWP across eleven criteria grounded in EPC planning, project communication, and socio-technical systems literature. Conventional EPC communication remains document-centric and reactive, offering limited cross-functional integration and trust development. Lean strengthens the social and behavioral dimension through collaborative alignment and commitment-based coordination. PPM provides a technical-systemic foundation through flow and variability management. AWP delivers a procedural link between planning outputs and field execution through structured work packages and readiness criteria.

The key theoretical contribution is a conceptual integrated communication architecture—grounded in STS theory—that positions Lean, PPM, and AWP as complementary across social, systemic, and procedural dimensions, with conventional practices providing the governance baseline. Implementing this architecture requires deliberate cultural change: building cross-functional trust, shared planning norms, and collaborative commitment cultures. Lean-based planning practices provide the structured collaborative interactions most effective in driving such change, while PPM metrics and AWP readiness gates institutionalize the resulting behavioral shifts (Edmondson, 1999; Schweitzer et al., 2025). This directly aligns with the People, Culture and Change track's focus on cultural transformation and trust development as enablers of improved project production systems.

Future empirical research should test this framework through longitudinal case studies in active EPC projects, examining how Lean collaborative practices affect cultural adoption of AWP readiness criteria, how PPM flow metrics influence cross-functional planning conversations, and under what conditions the integrated architecture most effectively reduces planning variability and improves execution readiness.

BOUNDARIES AND LIMITATIONS OF THE STUDY

This study is bounded by its conceptual and analytical nature, drawing on existing literature and industry guidance rather than empirical evidence. The analysis clarifies theoretical and practical distinctions among planning-phase communication approaches and proposes an integration framework for future empirical investigation, rather than measuring quantitative performance impacts. The scope is limited to inter-organizational communication during the pre-execution planning phase of EPC projects; communication in other phases, delivery methods, or alternative frameworks—including digital communication platforms—is outside the scope of this research.

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