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MAKING PEOPLE PERFORMANCE VISIBLE: CONNECTING SOCIO-EMOTIONAL COMPETENCIES AND LEAN INDICATORS

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ABSTRACT

Lean Construction emphasizes the central role of people in achieving reliable workflows and continuous improvement; however, the evaluation of people's performance is poorly operationalized in practice. While socio-emotional competencies such as communication, collaboration, and problem-solving are widely recognized as critical, they are rarely connected to the performance indicators routinely used in Lean project control. This study addresses this gap by proposing a capability–metric linkage framework that connects socio-emotional competencies of Architecture, Engineering, and Construction professionals with commonly used Lean project indicators. Using a constructive research approach, the study combines a structured literature review, comparative analysis of human capability models, and expert-based validation. A set of prioritized socio-emotional competencies is identified and systematically linked to Lean indicators, including PPC, RNCs, Requests for Information, and rework. The results demonstrate that existing Lean metrics can provide diagnostic signals of people's performance under specific conditions when appropriate traceability conditions are met. The proposed framework contributes theoretically by strengthening the socio-technical interpretation of Lean Construction and practically by supporting evidence-informed diagnosis of people's performance without introducing new measurement systems.

KEYWORDS

Lean Construction, Design Science, collaboration, commitment, promise, reliable promising.

INTRODUCTION

Over the last few decades, Architecture, Engineering, and Construction (AEC) projects have undergone accelerated digital transformation driven by global competitiveness, increasing project complexity, and higher performance expectations. The adoption of technologies such as Building Information Modeling (BIM), collaborative digital platforms, and automation tools has profoundly reshaped design and delivery processes, altering traditional coordination mechanisms and work practices (Osorio-Gómez et al., 2025). However, this transformation goes beyond technological adoption. It fundamentally challenges organizational management structures, decision-making, leadership, and change processes, as well as coordination in

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project-based environments marked by interdependence and uncertainty (Osorio-Gómez et al., 2025; Senescu et al., 2013; Lafhaj et al., 2024). In parallel, AEC projects have become increasingly complex organizationally. Greater specialization and differentiated tasks and teams, together with fragmented disciplinary silos, strict laws and regulatory requirements, and planning conditions shaped by interdependent schedules and overlapping phases, have intensified coordination demands and increased the consequences of breakdowns and errors (Senescu et al., 2013; Lafhaj et al., 2024), such as rework, schedule delays, cost overruns, and late information requests (RFIs) (Morales et al., 2022). Traditionally, project management was framed primarily around time, cost, and scope. Currently, this view is often insufficient on its own to explain or improve overall project performance, and increasing emphasis is placed on value delivery and the use of outcomes-focused measures, rather than assessing performance solely through process adherence or the production of plans and artifacts (Project Management Institute, 2021; Serrador & Turner, 2015). As a result, growing attention has been directed toward human and organizational dimensions such as communication, collaboration, leadership, and learning, which are consistently identified as critical determinants of project outcomes (Galaz-Delgado et al., 2021; Schöttle et al., 2014).

Lean Construction (LC) has long emphasized the centrality of people in achieving reliable workflow, continuous improvement, and value generation (Babalola et al., 2019). Practices such as commitment management, planning reliability, and learning from breakdowns rely inherently on individual and collective behaviour. Despite this conceptual emphasis, the evaluation of people's performance in Lean projects remains poorly operationalized. Lean projects routinely monitor indicators such as Percent Plan Complete (PPC), Reasons for Non-Completion (RNC), rework, or Requests for Information (RFIs). Still, these metrics are typically interpreted at the project or team level. Their potential to reflect individual professional performance is rarely explored, leaving a gap between Lean's people-centered philosophy and its measurement practices (Daniel et al., 2015; Sacks et al., 2017). From a human resources and organizational behaviour perspective, this gap reflects a broader disconnect between abstract competency assessments and tangible project outcomes. Capacity is commonly defined as an individual's ability to perform tasks, encompassing cognitive, social, and attitudinal dimensions such as adaptability, critical thinking, and alignment with organizational values (Bowles, 2023; Robbins & Judge, 2012). Performance, by contrast, refers to observable, measurable results relative to predefined objectives and is typically measured using performance metrics or key performance indicators (KPIs) (Robbins & Coulter, 2010). In AEC practice, these dimensions are often managed separately: competencies are assessed using surveys or qualitative tools, while performance is monitored through project-level indicators such as schedule variance, cost variance, or aggregated PPC values, which obscure individual contributions (Osorio-Gómez et al., 2025).

Recent research has attempted to bridge this disconnect. Studies have demonstrated the value of maturity models for aligning workforce development with digital tools like BIM (Adekunle et al., 2022; Chen et al., 2023; Castañeda et al. 2024), as well as the significant positive effect of knowledge management and management commitment on talent management strategy in the offshore construction context (Setyawan & Nelson, 2020). Other approaches have used predictive analytics and machine learning to forecast employee performance based on technical and behavioural variables (Kumar Saroha et al., 2025). Despite these advances, most existing frameworks remain weakly integrated with Lean production systems or rely on indicators that are not embedded in everyday Lean project control (Lagos et al., 2025). At the same time, competency-based models have gained prominence as structured approaches to conceptualizing and assessing professional capabilities. Frameworks such as the Industry 4.0 Competency Model (Prifti et al., 2017) and the Human Capability Standards (Bowles, 2023) emphasize socio-emotional competencies, learning capacity, and adaptability as key enablers

of performance in digitally intensive environments. These models explicitly distinguish between latent capability and observable behaviour, offering a conceptual basis for linking "soft skills" to measurable outcomes. However, these models have not been widely operationalized through Lean project indicators, which limits their applicability in LC contexts.

This limitation is particularly relevant within the People, Culture, and Change domain of LC research. Competency-based approaches have been discussed as conceptually aligned with Lean principles (Kpamma et al., 2014), and KPI-linked implementations have been demonstrated in Lean settings (Garay-Rondero et al., 2019). At the same time, the human resources literature supports translating socio-emotional constructs into measurable indicators (Gabcanova, 2012), whereas construction-focused studies commonly assess people-related factors using survey-based instruments (Kaewnaknaew et al., 2022). However, the explicit reinterpretation of Lean project metrics (e.g., PPC, RFIs, rework-related measures) as proxies for socio-emotional competencies remains an opportunity for research. Against this background, this study addresses the following research question: How can the socio-emotional competencies of AEC professionals be systematically linked to Lean project indicators to make people's performance visible and measurable? To answer this question, the paper builds on a structured review and comparison of human capability models and performance metrics. It proposes a sector-specific framework that links prioritized competencies with Lean project indicators. By reinterpreting existing Lean metrics as indicators of human performance, the study aims to bridge the gap between abstract competency frameworks and the practical realities of Lean project control. Importantly, these indicators are not interpreted as direct measures of competencies, but as observable signals that may reflect underlying socio-emotional capabilities under specific traceability and contextual conditions.

RESEARCH METHOD

RESEARCH DESIGN

The research was structured into three sequential stages: (1) identification and classification of human capability models and performance metrics; (2) comparative analysis and selection of a reference capability model; and (3) expert-based validation and construction of the capability–metric linkage matrix. This staged design allows for the progressive refinement of both conceptual and empirical elements, progressing from exploration to synthesis and validation. Such an approach is consistent with constructive research in LC, where artefacts are iteratively developed and assessed against practical relevance and theoretical grounding (Figure 1).

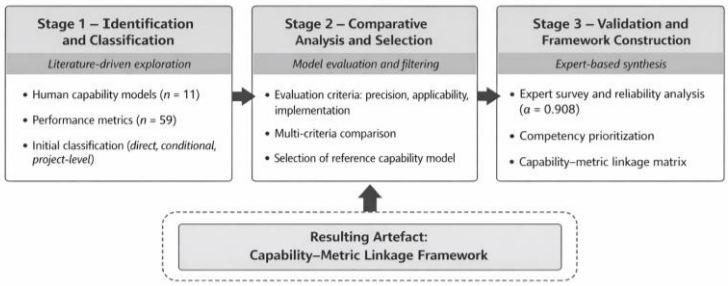

Figure 1: Research design and stage of the study

IDENTIFICATION OF CAPABILITY MODELS AND PERFORMANCE METRICS

Identification of Human Capability Models

A systematic literature review was conducted using the Scopus database, which is widely recognized for its extensive coverage of peer-reviewed research and is a central multidisciplinary database across engineering, management, and organizational studies

(Mongeon & Paul-Hus, 2016). The search focused on publications from 2015 to 2025 to ensure relevance to contemporary digital and organizational contexts.

The search string combined terms related to modelling and human capability to target the recognition of cognitive, socio-emotional, and professional competencies. Inclusion criteria required that models: (a) addressed human capability at the individual or organizational level; (b) focused on cognitive, behavioural, or socio-emotional dimensions rather than physical performance; and (c) applied, at least conceptually, to project-based or complex work environments. As a result, eleven capability models were identified and documented. To support systematic comparison, each model was profiled using standardized attributes, including conceptual focus, methodological approach, level of analysis, and sector.

Table 1: Summary of identified human capability models.

Model	Core focus	Level of analysis	Sector
People Capability Maturity Model (P-CMM)	Workforce maturity and process improvement	Organizational	Software/knowledge work
Human Capability Standards (HCS)	Socio-emotional and cognitive capability	Individual	Cross-sector
Industry 4.0 Competency Model	Digital, cognitive, and socio-emotional competencies	Individual / Organizational	Industry 4.0
BIM Capability Maturity Model	BIM-related organizational capability	Organizational	AEC
Digital Capability Framework	Digital skills and transformation readiness	Organizational	Cross-sector
Intellectual Capital Maturity Model	Knowledge management and learning	Organizational	Cross-sector
Competency Model	Behavioural and underlying traits	Individual	Cross-sector
Human Capital Framework	Skills, knowledge, and experience	Individual	Cross-sector
Organizational Capability Model	Dynamic capabilities	Organizational	Cross-sector
Performance Capability Model	Competency–performance linkage	Individual	Cross-sector
Talent Capability Framework	Talent development and performance	Organizational	Construction

Identification of Performance Metrics

Together, a second literature review targeted performance metrics commonly used in AEC and LC area. The search emphasized indicators that reflect professional performance, either directly or through traceability. An initial set of 59 metrics was identified. These metrics were subsequently classified into three groups: (1) metrics that directly measure individual professional performance; (2) metrics that may reflect individual performance if traceability conditions are met; and (3) metrics oriented exclusively toward project-level outcomes (Table

2). This classification was refined through expert review to ensure relevance and practical interpretability. To mitigate systemic bias, the framework considers metrics as performance signals only when the specific cause of the variance can be traced to individual or team-controlled actions, rather than to external constraints such as material delays or client changes.

Table 2: Classification of performance metrics

Metric	Measurement focus	Level of analysis	Traceability condition
PPC	Planning reliability	Team / Individual	Task ownership identified
RNC	Commitment failure	Team / Individual	Cause linked to the responsible role
Requests for Information (RFIs)	Information flow and clarity	Project / Individual	Author and responder identified
Rework rate	Quality and error management	Project / Individual	Rework source identified
Design change frequency	Stability and coordination	Project / Team	Change initiator identified
Response time to RFIs	Responsiveness	Individual	Time-stamped requests
Clash resolution time	Coordination capability	Team	Responsibility assigned
Productivity variance	Output efficiency	Project	Aggregated
Cost variance	Financial performance	Project	Aggregated
Schedule variance	Time performance	Project	Aggregated

COMPARATIVE ANALYSIS AND MODEL SELECTION

To select a reference capability model suitable for Lean AEC contexts, the identified models were evaluated using a multi-criteria assessment framework. Three evaluation dimensions were defined. First, “precision”, referring to conceptual clarity, internal consistency, and discriminative capacity. Second, “applicability” refers to the transferability of findings across sectors, roles, and organizational contexts. Third, “implementation”, referring to data requirements, resource intensity, and deployment effort. Data for this evaluation were obtained through a combination of author surveys (when available) and structured document analysis. All criteria were assessed using a five-point Likert scale, allowing quantitative comparison. The results were consolidated into a comparative matrix, from which the industry 4.0 Competency Model emerged as the most suitable reference framework due to its balance of conceptual robustness, digital orientation, and operational feasibility (Table 3).

EXPERT VALIDATION

Following model selection, the competencies of the reference framework were adapted to the AEC context, maintaining their original structure while incorporating sector-specific language related to BIM, interdisciplinary coordination, and project delivery. A structured expert survey was then administered to professionals with experience in the AEC sector. Respondents rated the importance of 26 competencies using a five-point Likert scale (Table 4). The sample

included professionals with varying levels of expertise, enabling exploratory comparison between novice and experienced profiles. The instrument's internal consistency was assessed using Cronbach's alpha, yielding α = 0.908, indicating high reliability (Ursachi et al., 2015).

Table 3: Comparative evaluation of human capability models.

Model	Precision	Applicability	Implementation	Total score
People Capability Maturity Model	4.0	3.5	2.5	10.0
Human Capability Standards	4.5	4.0	4.0	12.5
Industry 4.0 Competency Model	4.5	4.5	4.0	13.0
BIM Capability Maturity Model	3.5	3.0	3.0	9.5
Digital Capability Framework	4.0	3.5	3.5	11.0
Intellectual Capital Maturity Model	3.5	3.5	3.0	10.0

Table 4: Profile of expert respondents.

Attribute	Distribution (%)
Academic degree	BSc 32 / MSc 46 / PhD 22
Professional role	Eng/Des 38 / PM 34 / Aca/Con 28
Years of experience	0-5: 29 / 6-10: 31/ >10: 40

RESULTS

PRIORITIZED SOCIO-EMOTIONAL COMPETENCIES

The expert survey produced a ranked list of socio-emotional competencies based on perceived importance for professional performance in the AEC sector. Respondents evaluated 26 competencies using a five-point Likert scale. Competencies with a mean score of 4.0 or higher were considered highly relevant and retained for further analysis (Table 5).

Table 5: Prioritized socio-emotional competencies (mean ≥ 4.0)

Rank	Competency	Mean	Std. dev.
1	Communication effectiveness	4.62	0.51
2	Commitment reliability	4.55	0.56
3	Collaboration	4.48	0.59
4	Problem-solving capability	4.42	0.61
5	Adaptability	4.31	0.64
6	Learning orientation	4.08	0.68

For clarity, the prioritized socio-emotional competencies are defined as follows. Communication effectiveness refers to the ability to convey and interpret information clearly,

timely, and accurately to support coordination and decision-making in interdependent environments (Senescu et al., 2013; Robbins & Judge, 2023). Commitment reliability refers to the capability to make and fulfil promises consistently, reflecting accountability and trustworthiness within planning systems such as the LPS (Ballard et al., 2020; Daniel et al., 2015). Collaboration refers to the ability to work effectively across disciplines, aligning goals, resolving conflicts, and integrating diverse perspectives in project-based settings (Schöttle et al., 2014). Problem-solving capability refers to the ability to identify root causes of issues and implement effective corrective actions in dynamic and uncertain environments (Formoso et al., 2020; Asadi et al., 2023). Adaptability refers to the capacity to respond effectively to changing conditions, requirements, and constraints inherent to AEC projects (Prifti et al., 2017). Finally, learning orientation refers to the ability to reflect on past performance, internalize lessons-learned, and improve future actions, supporting continuous improvement focal to LC (Babalola et al., 2019; Garay-Rondero et al., 2019).

The results indicate a clear prioritization of competencies related to communication, commitment, collaboration, problem-solving, and adaptability. Communication effectiveness obtained the highest mean score, reflecting its central role in interdisciplinary coordination, information flow, and decision-making. Commitment, reliability, and collaboration were closely monitored, underscoring the importance of honouring commitments and working effectively across disciplinary boundaries in project environments. Problem-solving capability and adaptability were also ranked among the most critical competencies, emphasizing the need to manage uncertainty, change, and emergent issues inherent to AEC projects. Lower-ranked competencies tended to relate to more individual or reflective attributes, such as self-awareness or long-term strategic thinking. While still valued, these competencies were perceived as less immediately observable or less directly connected to day-to-day project performance. This prioritization suggests that experts place greater emphasis on competencies that manifest through interaction, coordination, and responsiveness within project workflows. Overall, the results demonstrate strong consensus among experts on which socio-emotional competencies are most critical for effective performance in AEC environments. These findings yield a focused set of competencies suitable for operationalization via project-level indicators.

DIFFERENCES BETWEEN NOVICE AND EXPERIENCED PROFESSIONALS

To explore potential differences in competency prioritization based on professional experience, responses were disaggregated into two groups: novice professionals (≤ 5 years of experience) and experienced professionals (> 10 years of experience). Mean scores for each competency were compared descriptively between the two groups (Table 6). The results reveal notable differences in emphasis. Novice professionals tended to place greater importance on competencies related to technical communication clarity, responsiveness, and adherence to rules. These competencies reflect an orientation toward task execution and adherence to established procedures, consistent with early-career roles that emphasize learning and operational reliability. In contrast, experienced professionals placed greater emphasis on collaboration, leadership-related behaviors, adaptability, and problem-solving in uncertain environments. These competencies are more strongly associated with managing interdependencies, resolving conflicts, and navigating changing project conditions. The higher valuation of these competencies among experienced respondents suggests a shift from task-focused performance toward relational and systemic contributions as experience increases. Despite these differences, both groups agreed strongly on the overall importance of communication effectiveness and commitment reliability. This convergence indicates that specific competencies are perceived as foundational across career stages, while others gain prominence as professionals assume greater responsibility and influence within projects. These findings highlight the importance of differentiating competency development strategies by

career stage and support the need for performance evaluation approaches that account for experience-related shifts in professional contributions.

Table 6: Comparison of competency prioritization by experience level

Competency	Novice (≤5 yrs)	Experienced (>10 yrs)	Difference
Communication effectiveness	4.68	4.56	+0.12
Commitment reliability	4.51	4.58	−0.07
Collaboration	4.33	4.57	−0.24
Problem-solving	4.21	4.53	−0.32
Adaptability	4.12	4.46	−0.34

CAPABILITY-METRIC LINKAGE MATRIX

Building on the prioritized competencies, a capability–metric linkage matrix was developed to connect socio-emotional competencies with Lean project indicators. Only competencies with mean scores of 4.0 or higher were included in the matrix to ensure focus on those deemed most critical by experts. It is important to note that these metrics do not directly measure competencies; instead, they provide indirect signals that require contextual interpretation. Each selected competency was linked to one or more Lean metrics based on conceptual alignment, measurement feasibility, and relevance to Lean project control practices. For example, communication effectiveness was associated with the number of RFIs and RFI response time, reflecting both the clarity of information provided and responsiveness to information needs. Commitment reliability was linked to PPC and RNC, capturing the ability to make and fulfil reliable promises within planning systems. Collaboration was associated with metrics such as clash-resolution time and frequency of design changes, which reflect the effectiveness of interdisciplinary coordination. Problem-solving capability was linked to RNC categories and rework rates, indicating the ability to identify root causes and implement corrective actions. Adaptability was associated with response times to design changes, reflecting how professionals manage evolving requirements and uncertainty. The resulting matrix (Table 7) demonstrates that widely used Lean project indicators can serve as proxies for socio-emotional competencies when appropriate traceability conditions are met. Rather than introducing new measurement instruments, the framework leverages existing data generated through Lean control systems, enhancing its practical applicability. The expert validation process confirmed the plausibility and clarity of the proposed linkages. Experts emphasized that while metrics do not directly capture competencies, consistent patterns across indicators can reveal underlying behavioural tendencies. The matrix thus provides a structured means to reinterpret Lean metrics as indicators of people's performance, without altering existing project control practices. The strength of each linkage depends on contextual factors such as project complexity, process maturity, and attribution clarity. Therefore, the framework must be used as a diagnostic tool to support reflection, filtering out systemic constraints and focusing on areas where professional agency is clearly identifiable.

DISCUSSION

This study contributes to LC research by strengthening the linkage between people-related capabilities and Lean project performance indicators, a gap repeatedly identified in IGLC literature but rarely operationalized. Recent IGLC contributions across multiple tracks have

emphasized that LC is inherently a socio-technical system, in which reliable workflows and continuous improvement depend as much on human behaviour as on technical tools (Hamzeh et al., 2012; Alves et al., 2012). Despite this recognition, most studies continue to address people-related aspects qualitatively, leaving a disconnect between Lean principles and the metrics used to manage projects. LC theory is grounded in the dual principles of continuous improvement and respect for people, with planning reliability, learning from variation, and commitment management as central mechanisms. IGLC research has consistently shown that practices such as the LPS rely on trust, accountability, and collaboration to function effectively (Ballard et al., 2020; Daniel et al., 2015). But several authors have noted that LC metrics such as PPC and RNCs are often treated as technical indicators, rather than as reflections of underlying human or organizational capabilities (Hamzeh et al., 2012). The framework is better understood as a diagnostic and interpretive tool; the proposed linkages should not be interpreted as deterministic relationships. LC metrics are influenced by multiple system-level factors, including process design, resource availability, and project complexity. Therefore, they should be understood as diagnostic signals rather than direct measurements of individual capabilities.

Table 7: Capability–metric linkage matrix.

Socio-emotional competency	Associated Lean metrics	Rationale for linkage	Boundary conditions /limitations
Communication effectiveness	RFIs, RFI response time	Reflects clarity, completeness, and responsiveness	Valid when RFIs are attributable; may be affected by complexity or information systems
Commitment reliability	PPC, RNC	Indicates ability to make and keep reliable promises	Requires clear task ownership; may be affected by external constraints
Collaboration	Clash resolution time, design changes	Reflects interdisciplinary coordination	More valid in human-driven coordination; may reflect process maturity in BIM contexts
Problem-solving	RNC categories, rework	Indicates capacity to address root causes	Requires clear cause attribution; may reflect system-level issues
Adaptability	Design change response time	Reflects response to uncertainty and change	Requires identifiable responsibility; may reflect process efficiency
Learning orientation	Reduction of recurring RNCs	Indicates learning from failures	Requires tracking overtime; may reflect organizational systems

The linkage between communication effectiveness and RFIs is strongly supported by both IGLC and journal literature. Multiple IGLC studies have shown that high RFI volumes are symptomatic of poor information quality, insufficient early coordination, and fragmented communication rather than isolated design errors (Jeréz-Lazcano et al., 2025). This interpretation is consistent with the findings of Morales et al. (2022), who demonstrated that proactive BIM use and early interdisciplinary coordination significantly reduce RFIs by addressing upstream information gaps. From a Lean perspective, RFIs thus represent a form of informational waste and provide a measurable signal of deficiencies in communication-related socio-emotional capabilities. Similarly, the association between commitment reliability and PPC/RNC reinforces foundational Lean concepts that have been discussed extensively in IGLC research. Ballard et al. (2020) and Daniel et al. (2015) emphasize that PPC should be interpreted as an indicator of promise quality and commitment reliability rather than simple task

completion. The capability–metric linkage proposed in this study extends this view by explicitly linking PPC and RNC to individual- and team-level competencies, such as accountability, self-regulation, and trustworthiness. This framing supports the use of PPC not only for control but also as a learning mechanism to develop people's capabilities through systematic reflection on planning failures. The linkage between problem-solving capability, adaptability, and rework-related metrics also aligns with recent IGLC findings. Rework has long been identified as a significant source of waste in construction, and recent studies continue to emphasize its relationship with inadequate learning and poor root-cause analysis (Formoso et al., 2020; Asadi et al., 2023). IGLC research increasingly frames rework as evidence of insufficient problem-solving capability and weak learning loops rather than isolated quality defects. By linking rework and RNC patterns to socio-emotional competencies, this study provides a structured approach to connecting quality outcomes with human learning and adaptability, reinforcing Lean's emphasis on continuous improvement through people development.

CONCLUSIONS

From a theoretical perspective, this work advances LC theory by reinforcing its socio-technical foundation. While previous studies have highlighted the importance of respect for people, collaboration, and learning, these constructs have often remained weakly connected to performance measurement. This study bridges that gap by reframing LC indicators as proxies for socio-emotional competencies, thereby more explicitly integrating human behaviour into Lean performance theory. The proposed framework extends existing interpretations of PPC, RNC, RFIs, and rework beyond technical control measures, positioning them as observable manifestations of commitment reliability, communication effectiveness, collaboration, problem-solving, and adaptability. The study contributes to a more coherent alignment between Lean principles, human capability models, and performance measurement practices. From a practical standpoint, the framework offers practitioners a feasible approach to incorporating people performance into Lean management without introducing additional measurement systems. By leveraging data already generated through Lean project control practices, organizations can use existing indicators not only for monitoring production but also for coaching, learning, and capability development. Some limitations should be acknowledged. The study relied on expert judgment to prioritize competencies and establish capability–metric linkages, which introduces a degree of subjectivity despite the high reliability of the survey instrument. In addition, the framework assumes sufficient traceability between Lean metrics and individual or team responsibilities, which may not be present in all project contexts. The empirical validation was cross-sectional and descriptive, and causal relationships between competencies and performance outcomes were not tested. Finally, although the study is grounded in the AEC sector, contextual factors such as project type, contract arrangements, and organizational maturity may influence the applicability of the proposed framework. Future research should empirically test the framework through longitudinal case studies and quantitative analyses to examine causal relationships between socio-emotional competencies and LC performance outcomes. The framework should be applied as a diagnostic tool to support reflection and inquiry, rather than as a direct measurement system of individual competencies.

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