Comprehensive Journal of Science
Volume (10), Issue (38), (Dec, 2025)
ISSN: 3014-6266

مجلة العلوم الشاملة
المجلد (10) ملحق العدد 38 ديسمبر 2025
ردمد: 3014-6266

Drivers of Just-in-Time Adoption in Libyan Construction Firms: The Role of Transformational Leadership and Organizational Learning

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تاريخ الاستلام:2025/11/12 –تاريخ المراجعة: 2025/12/2– تاريخ القبول: 2025/12/27– تاريخ للنشر: 2/5/ 2026

Abstract:
Just-in-Time (JIT) seeks to reduce inventory buffers and improve the reliability of material flow by aligning deliveries with actual site needs. In construction, however, JIT implementation is often constrained by schedule variability, fragmented procurement processes, and disruptions across supplier and logistics networks. Against this backdrop, this study examines JIT adoption in Libya's construction industry by assessing the effects of transformational leadership and organizational learning, and by testing whether supply chain integration mediates these relationships.
A quantitative, cross-sectional survey was administered to managers and engineers in Libyan contracting companies. Data were collected from construction firms in Misrata, Libya, using a structured questionnaire. After screening, 80 valid responses were retained. The research model was evaluated using partial least squares structural equation modelling with bootstrapping to assess the significance of direct and indirect effects and the model's explanatory power.
The results suggest that transformational leadership has a positive and statistically significant direct association with JIT adoption. Organizational learning also shows a significant positive direct relationship with JIT adoption, indicating that firms that systematically capture lessons and refine routines may be better positioned to stabilize time-sensitive planning and logistics. In contrast, supply chain integration does not exhibit a statistically significant direct effect on JIT adoption and does not mediate the effects of leadership or learning on JIT. Overall, the model explains a moderate proportion of variance in JIT adoption. These findings imply that, in Libya's construction context, internal capability development through leadership and learning may be more decisive for JIT adoption than broad integration initiatives alone.
Keywords: Transformational leadership style, organizational learning, Just-in-Time, Libyan construction industry

Introduction

The construction industry plays a crucial role in developing vital infrastructure, yet the execution of projects often fails to meet expectations, characterized by delays, increased costs, and inefficient resource utilization. These challenges go beyond mere operational issues, indicating underlying coordination issues where activities lack cohesion, decisions aren't translated effectively into actionable tasks, and uncertainties are managed reactively rather than through systematic control. Lean construction addresses these issues by treating projects as production systems, focusing on creating value, eliminating waste, and ensuring consistent workflow through careful planning and coordinated execution. In this framework, effective

materials management and logistics are not secondary tasks but essential elements to prevent disruptions that can lead to downtime, rework, and increased variability on-site, undermining the reliability that lean principles aim to establish.
Within the lean approach, Just-in-Time (JIT) aims to synchronize procurement, logistics, and on-site production to ensure timely delivery of inputs in required quantities, avoiding excessive stockpiling. Research indicates that implementing JIT in construction is feasible, but its success relies heavily on well-coordinated planning, accurate information, and reliable supply chain partners. JIT is viewed not just as a logistics technique but as a socio-technical capability requiring disciplined planning to forecast demand accurately and collaborative relationships to ensure prompt responses to changing conditions.
In Libya's construction sector, where timely project delivery is crucial for infrastructure development and economic recovery, challenges such as governmental obstacles, poor contract management, delayed payments, inadequate planning, ineffective site management, and slow decision-making can hinder schedule adherence and material availability (Salam & Gaith, 2020). Faced with such constraints, companies may resort to increasing buffers and accepting longer lead times, actions that can disrupt flow and generate waste in a lean context.
Supply chain integration (SCI) emerges as a viable strategy to overcome these barriers and enhance the effectiveness of JIT. SCI focuses on aligning functions and integrating processes and information internally and externally, particularly important in projects involving diverse stakeholders and complex information flows. Weak information sharing can lead to inefficiencies and coordination challenges, making SCI instrumental in improving visibility, aligning plans with suppliers, and facilitating joint problem-solving during disruptions. However, the success of SCI in such contexts hinges on consistent integration practices rather than sporadic coordination efforts.
At the organizational level, transformational leadership (TL) and organizational learning (OL) are internal capabilities that can facilitate SCI and bolster JIT adoption. Studies connect transformational leadership to project success by influencing team dynamics and fostering adaptive behaviors. Organizational learning supports knowledge retention and dissemination of best practices within construction firms, including formalized knowledge transfer processes across projects. This study in Libya's construction industry investigates how SCI mediates the impact of transformational leadership and organizational learning on JIT implementation outcomes, offering context-specific insights from a developing environment focused on reconstruction. By establishing links between leadership, learning, and integration practices, the study aims to provide actionable strategies for sustaining reliable material flow.

Literature Review

Organizational Resources in Construction Firms

Dynamic capability theory frames higher-order organizational capacity as the ability to “integrate, build, and reconfigure” competencies in response to changing environments (Teece, Pisano & Shuen, 1997). In construction, this lens is especially useful because project outcomes often depend less on static asset ownership than on how effectively firms recombine resources under uncertainty. As a result, organizational resources extend beyond physical plant or financial inputs and are frequently expressed through leadership behaviors, learning routines, and coordination practices that help stabilize workflow despite recurrent variability. This emphasis on intangible resources aligns with the operational reality that construction execution relies on interdependent parties and time-sensitive handovers, where minor disruptions can propagate quickly when coordination mechanisms are weak.

Within this framing, organizational learning is consistently positioned as more than a passive organizational attribute. Evidence suggests that learning can function as a capability mechanism shaping innovation outcomes, implying that learning is something organizations can deploy strategically as a resource (Chen & Zheng, 2022). Construction-focused work similarly conceptualizes organizational learning as a resilience-related capability that supports adaptation in project organizations facing disruption (AlMaian & Bu Qammaz, 2023). Building on this logic, the present study conceptualizes Organizational Resources as reflective capabilities expressed through Transformational Leadership and Organizational Learning. Operationally, these resources are expected to shape JIT Adoption both directly and indirectly, insofar as they enable the internal and external integration required to align supply processes with site execution.

Transformational Leadership in Construction Projects

Transformational leadership is typically theorized as a pattern of leader behaviors that motivates collective effort, supports adaptation, and orients teams toward shared goals. In project-based environments, this behavioral emphasis is consequential because uncertainty and interdependence amplify the need for rapid coordination, sense-making, and problem solving. Under these conditions, leadership is unlikely to operate through formal authority alone. Its influence is more plausibly expressed through the extent to which it builds commitment to common plans and sustains constructive responses when conditions shift.

Empirical evidence from construction settings aligns with this interpretation by linking transformational leadership to project success and by locating its influence in team-level processes. One stream highlights reflexivity and project team resilience as mediating mechanisms through which transformational leadership translates into project success (Han, Ma, Yang & Zhao, 2025). Related work also emphasizes mediation pathways via team agility and flexibility in explaining how transformational leadership relates to project success (Han, Ma & Liu, 2024). Taken together, these studies converge on a consistent theme: leadership effects appear to depend on whether teams develop the adaptive and coordination-oriented processes needed to translate intent into execution. This point is operationally relevant to JIT because JIT requires disciplined planning, credible commitments to reliable handovers, and timely corrective action when disruptions occur. Where these behavioral and relational conditions are underdeveloped, JIT risks remaining a nominal intent rather than a sustained operating practice.

Evidence from safety-specific transformational leadership further reinforces the relevance of relational and communicative conditions. Findings indicate that transformational behaviors can improve worker safety behavior through knowledge sharing and psychological safety (Ali, Iyiola, Alzubi & Aljuhmani, 2025). Although safety and production coordination are distinct domains, the underlying implication remains applicable: leadership that supports open communication and trust may help establish the human and relational conditions required for cross-party coordination, which is broadly consistent with the behavioral demands of JIT.

Organizational Learning as a Dynamic Capability

Organizational learning is often treated as a routine capability for acquiring, distributing, interpreting, and retaining knowledge in ways that improve future action. In construction, however, learning is not automatically retained or transferred. Organizational boundaries are frequently porous and temporary, subcontracting structures are common, and site conditions can change quickly. These features raise the likelihood that lessons remain localized within specific teams or projects, which can limit reuse and reduce the chance that improved practices become institutionalized.

Dynamic capability theory emphasizes adaptation through the reconfiguration of competencies under change (Teece *et al.*, 1997). Empirical research supports this capability interpretation by showing that organizational learning can influence innovation via dynamic capability mechanisms, reinforcing the view of learning as an actionable capability rather than solely a cultural attribute (Chen & Zheng, 2022). Construction evidence also links organizational learning with organizational resilience, which is consistent with the argument that learning routines can support sustained performance under disruption (AlMaian & Bu Qammaz, 2023).

For JIT Adoption, this capability lens implies several practical channels through which learning may matter without assuming automatic transfer across projects. Learning can support continuous improvement of planning and logistics routines, enable faster diagnosis of recurring delivery and installation failures, and facilitate dissemination of workable coordination practices across project settings. In this context, lessons-learned practices are particularly relevant because they formalize knowledge transfer and reduce reliance on informal memory in transient project environments (Eken, Bilgin, Dikmen & Birgonul, 2020). As a reflective construct, organizational learning can therefore be measured through perceptual indicators of learning behaviors and routines that manifest an underlying capability, while recognizing that such indicators may capture capability strength imperfectly when learning is unevenly embedded across projects.

Just-in-Time (JIT) Implementation in the Construction Industry

Just-in-Time (JIT) is commonly framed as an approach that reduces buffers and depends on dependable replenishment. Recent work, however, cautions against treating JIT as a single, universally transferable recipe. Instead, its design typically needs to reflect local constraints and exposure to disruption. Within construction logistics, JIT is characterized as scheduling deliveries “precisely when they are needed,” with the practical intent of limiting on-site inventory, reducing congestion risk, and improving operational efficiency (Wu, Lu, Wang, Wang & Dong, 2025). This timing logic becomes especially consequential in modular and off-site contexts, where large components intensify space constraints and make both early deliveries (through added storage and handling) and late deliveries (through interrupted installation sequences) operationally costly.

A related debate in the wider supply-chain literature concerns what JIT is assumed to mean under disruption. Recent scholarship argues that critiques often rest on misconceptions, and that JIT can be adapted to turbulent environments when firms apply it selectively by choosing appropriate “JIT segments,” rather than treating JIT as an all-or-nothing design (Choi, Netland, SandersSodhi & Wagner, 2023). For construction, this positioning implies that JIT implementation should not be reduced to a delivery-timing tactic alone. It is more coherently understood as an operational system whose effectiveness depends on reliable planning routines, integrated information, and coordinated execution across suppliers, logistics providers, and site teams.

Supply Chain Integration in Construction Supply Networks

SCI is generally used to denote coordination of processes and information flows across internal functions and external partners. Recent work describes integration as requiring "active collaboration between suppliers, cross-functional departments, and customers" connected through process and information flows (Anwar, Rahayu, Wibowo, Sultan, Aspiranti, Furqon & Rani, 2025). In construction, sustaining this level of collaboration is often more demanding because contracting arrangements are fragmented and project data are heterogeneous, which complicates aligned decision-making across organizational boundaries. Consistent with this challenge, construction supply chain research highlights that multi-stakeholder complexity and information heterogeneity can create information-exchange problems that diminish project management efficiency (Mei, Qin, Li & Deng, 2023).

Within this stream, digitally enabled integration is increasingly discussed as a mechanism for improving visibility rather than merely accelerating transactions. Data-sharing research argues that sustainability and efficiency are conditional on supply chain visibility, and that data integration can make supply chains more transparent (Khan & Abonyi, 2022). In line with this view, the present study treats SCI as a reflective latent capability manifested in coordinated planning, information sharing, and joint problem solving across the construction supply network.

Relationships Between Organizational Resources and JIT Implementation

JIT adoption is difficult to sustain when execution becomes inconsistent under uncertainty, particularly because reduced buffers can increase the operational consequences of coordination failures. Organizational resources may shape this consistency by supporting coordination discipline and adaptive response. Evidence from construction firms indicates that transformational leadership can positively influence project success and may do so through team mechanisms linked to adaptation, such as reflexivity and resilience (Han *et al.*, 2025). These mechanisms are operationally relevant to JIT because teams must identify constraints early, adjust work sequences as conditions shift, and recover quickly from delivery or installation disruptions to protect planned flow.

Organizational learning is similarly implicated because JIT depends on routines that must be refined and stabilized over time rather than improvised on a project-by-project basis. Learning processes have been shown to influence performance-relevant outcomes via capability mechanisms (Chen & Zheng, 2022), and construction evidence links learning capability to resilience under disruption (AlMaian & Bu Qammaz, 2023). Given that construction logistics explicitly aims to schedule delivery exactly when needed to reduce inventory and congestion (Wu *et al.*, 2025), leadership and learning resources become more consequential as buffers are reduced and the system becomes less tolerant of intermittent coordination breakdowns.

The Role of Supply Chain Integration in JIT-Oriented Environments

SCI can be interpreted as a structural enabler of JIT because time-based delivery requires synchronized information and execution across firms. In construction, JIT implementation depends on accurate and timely coordination of production, transportation, and on-site installation, with deliveries scheduled precisely when needed (Wu *et al.*, 2025). Where integration is weak, the same timing objective may amplify variability rather than dampen it, particularly when plans cannot be reconciled rapidly across organizational interfaces.

Construction supply chain studies emphasize that information-exchange problems are common in multi-stakeholder project settings and identify information collaboration as important for improving project management efficiency (Mei *et al.*, 2023). From a wider supply-chain lens, visibility is positioned as a condition for efficiency, and data integration is argued to enable transparency (Khan & Abonyi, 2022). Together, these views support the expectation that SCI strengthens JIT outcomes by reducing information latency, enabling more reliable ETA-informed planning, and supporting coordinated exception handling when disruptions occur, while recognizing that such benefits are likely to depend on how consistently integration routines are maintained across project phases and partners.

Supply Chain Integration as a Mediator Between Organizational Resources and JIT Implementation

A mediation argument is most convincing when the mechanism is explicit. The logic here is that organizational resources first build integrative capacity, and that this capacity then makes JIT execution more attainable. Dynamic capability theory frames superior adaptation as the ability to integrate and reconfigure competencies under change (Teece *et al.,* 1997). In construction supply networks, this framing is salient because delivery reliability rarely depends on a single firm acting alone; it depends on whether multiple actors can align decisions, share timely information, and adjust plans when conditions shift.

Transformational leadership and organizational learning are plausible antecedents because they can shape behavioral and cognitive conditions that integration requires, including shared priorities, interpersonal trust, stable knowledge routines, and constructive problem solving across organizational boundaries. In this model, SCI functions as the operational "translation layer" that converts internally held resources into inter-firm coordination capacity. Integration is described as active collaboration across suppliers, internal functions, and customers connected through process and information flows (Anwar *et al.,* 2025), and construction research further indicates that persistent information exchange problems can weaken project management efficiency (Mei *et al.,* 2023). Once integration routines are established, the pathway to JIT becomes more feasible because JIT logistics targets delivery exactly when needed to reduce inventory and congestion (Wu et al., 2025). Accordingly, SCI is theorized to mediate the relationship between organizational resources and JIT adoption by translating leadership and learning capabilities into coordinated supply and reliable, on time site execution.

Research Gaps

Three gaps motivate the proposed model and its Libya-focused quantitative test. First, construction supply chain scholarship continues to report limited systematic analysis of the factors that hinder information collaboration in construction supply chains (Mei *et al.*, 2023). Without clearer specification of what constrains collaboration, SCI interventions may prioritize tools or platforms while leaving underlying coordination frictions unresolved.

Second, construction leadership research notes limited work on team-level adaptation mechanisms that explain how transformational leadership affects project outcomes (Han *et al.,* 2025). This gap indicates the need to connect leadership resources to operational mechanisms, such as SCI, that are closer to flow reliability and day-to-day coordination, rather than treating leadership effects as implicitly self-executing.

Third, JIT logistics research in construction identifies practical gaps in which JIT ambitions "often fall short" without dedicated predictive coordination tools, including ETA-oriented models in modular logistics (Wu *et al.*, 2025). This matters for model development because it suggests that the intent to implement JIT is insufficient unless the operational prerequisites for credible timing commitments are in place, and these prerequisites plausibly include integrative routines that improve visibility and synchronization across parties.

Taken together, prior work supports leadership, learning, visibility, and integration as relevant. However, it remains uncommon to test a single reflective mediation model in which transformational leadership and organisational learning influence just-in-time (JIT) adoption through supply chain integration (SCI) within one unified quantitative framework. The present study addresses this gap in the context of Libya's construction industry.

Conceptual Framework and Hypotheses

Building on prior empirical evidence and the theoretical gaps identified above, this study develops a conceptual framework that positions Supply Chain Integration (SCI) as the mediating mechanism linking organizational resources to Just-in-Time (JIT) adoption. The framework treats transformational leadership and organizational learning as key organizational resources that may shape the conditions under which JIT can be enacted as a stable operating practice, rather than remaining an aspirational logistics principle.

The underlying logic is that JIT adoption in construction typically depends on disciplined coordination under time pressure. Transformational leadership is expected to contribute by clarifying priorities, reinforcing commitment to shared plans, and supporting cross-functional coordination between procurement and site teams. These behavioral conditions may be particularly salient where projects face variability and disruptions, because JIT reduces slack and increases sensitivity to coordination breakdowns. Organizational learning is expected to contribute by enabling firms to capture lessons from delivery and execution failures, refine routines, and institutionalize improved practices across projects. In settings where recurring disruptions are common, such learning routines may help stabilize time-sensitive planning and logistics and, in turn, support more consistent JIT adoption.

SCI is positioned as the operational capability that links these internal resources to inter-firm execution. Because construction supply and site operations span organizational boundaries, time-reliable delivery depends not only on internal intent but also on the extent to which information and processes are aligned with suppliers and logistics partners. Accordingly, SCI is expected to support JIT by reducing coordination frictions, enabling more reliable synchronization between supply processes and site execution, and improving joint problem solving when disruptions occur. At the same time, this logic recognizes an implicit boundary condition: the expected benefits of SCI are more likely to materialize when integration routines are maintained consistently across project phases and key partners, rather than applied intermittently.

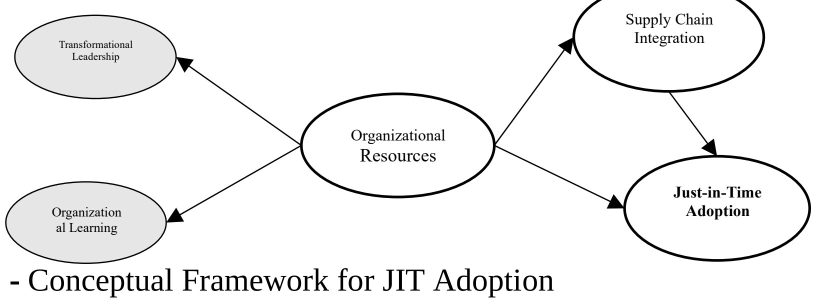


Figure 1 - Conceptual Framework for JIT Adoption

Based on this framework, the proposed relationships are summarized in Figure 1 and formalized in the following hypotheses:

H1. Transformational Leadership has a significant positive relationship with the adoption of Just-in-Time among the Libya's Contracting Companies.

H2. Organizational Learning has a significant positive relationship with the adoption of Just-in-Time among the Libya's Contracting Companies.

H3. Supply Chain Integration has a significant positive relationship with the adoption of Just-in-Time among the Libya's Contracting Companies.

H4. The relationship between Organizational Learning and Just-in-Time Adoption among the Libya's Contracting Companies is significantly mediated by Supply Chain Integration.

H5. The relationship between Transformational Leadership and Just-in-Time Adoption among the Libya's Contracting Companies is significantly mediated by Supply Chain Integration.

Methodology

We estimated the research model and tested cause effect relations among latent variables using partial least squares structural equation modeling (PLS-SEM) in SmartPLS 4. PLS-SEM is suitable when prediction is a key objective, models are complex, and data may deviate from multivariate normality; software citation and usage follow SmartPLS guidance.

Following best practice, we assessed the measurement model before the structural model, and we specified all constructs as reflective (indicators are manifestations of their latent variables). For reflective constructs, we examined outer loadings, internal consistency reliability (e.g., composite reliability and ρA), convergent validity (AVE), and discriminant validity using the HTMT criterion and its inference procedure. We also reported consistent PLS (PLSc) estimates as a robustness check.

To align with PLS-SEM's prediction focus, we estimated path coefficients and their significance via nonparametric bootstrapping in line with current reporting guidance, and we assessed predictive relevance using the Stone Geisser Q^2 procedure. The study was conducted in Misrata, Libya, and targeted construction firms operating within the city

Questionnaire's scale

Attitudinal items were measured on a five-point Likert-type scale (1 = strongly disagree to 5 = strongly agree), consistent with the long tradition initiated by Likert (1932). Psychometric evidence indicates that scales with roughly 4–7 categories achieve high reliability and validity, while adding more categories provides little benefit and can increase respondent burden; hence the five-point choice balances discrimination with clarity and effort (Sullivan & Artino, 2013; Preston & Colman, 2000; Lozano, García-Cueto & Muñiz, 2008; Aybek & Toraman, 2022).

To mitigate social desirability and common-method bias, the instrument assured anonymity, used neutral wording, and separated predictor and outcome measures to create psychological/temporal separation. These procedural remedies are widely recommended in the common-method variance literature and recent reviews (Podsakoff, MacKenzie, Lee & Podsakoff, 2003; Podsakoff, Podsakoff, Williams, Huang & Yang, 2024; Krumpal, 2013; Tourangeau & Yan, 2007; DeCastellarnau, 2018).

Table 1: Summary of Variables and Measurement of Indicators

Items	Variable &	Scale	NO. of questions
Transformational	Transformational	5-	5
Leadership	Leadership	5-	5
Just-in-Time	Just-in-Time	5-	4
Supply Chain Integration	Supply Chain	5-	4

Table 2: Source of Variables and Indicators

S/N	Variables	Sources	Remarks
1.	**Transformational Leadership**	(Carless *et al.,* 2000; Podsakoff *et al.,* 1990)	Adapted
2.	**Organizational Learning**	(Jerez-Gómez et al., 2005)	Adapted
3.	**Just-in-Time Adoption**	(Shah & Ward, 2007; Sakakibara *et al.,* 1997)	Adapted
4.	**Supply Chain Integration**	(Flynn *et al.*, 2010; Zhao *et al.*, 2011; Frohlich & Westbrook, 2001)	Adapted

Sample size

A structured self-administered questionnaire was distributed to 101 managers and engineers in Libyan construction firms, of which 80 complete and usable responses were returned, yielding an effective response rate of 79.2%. The targeted sample size was determined a priori using G*Power 3.1 for a linear multiple regression model with up to three predictors, assuming a medium effect size ($f^2 = 0.15$), a significance level of 0.05, and a desired statistical power of 0.80, which indicated a minimum requirement of approximately 77 observations (Faul, Erdfelder, Lang & Buchner, 2007; Faul, Erdfelder, Buchner & Lang, 2009). Although the realized sample falls below this ideal target, it remains within the range commonly accepted in applied PLS-SEM research, particularly for models of moderate complexity and when the main effects of interest are expected to be moderate to large (Hair, Hult, Ringle, Sarstedt, Danks & Ray, 2021; Kock & Hadaya, 2018). The potential implications of the reduced sample size for detecting small effects and for the generalizability of the findings are acknowledged in the limitations of the study

Findings

Profile of the Firm and the Respondents

The respondents' demographic data were examined using descriptive frequency statistics in IBM SPSS (version 22). Table 3 presents the key demographic and organizational characteristics, including position, work experience, gender, ownership type, and workforce size in Libya's contracting companies.

Table 3: Demographic Profile of the Sampled Companies and their Respondents

Respondents	Frequency	Percentage %
Position in the company		
Executive Director	7	8.8
General Manager	3	3.8
Head of Department	11	13.8
Project Manager	14	17.5
Engineer	30	37.5
Architect	15	18.8
Gender		
Male	71	88.8
Female	9	11.2
Firm ownership		
Government	5	6.2
Private	75	93.8
Workforce		
<100	75	93.8
101 – 250	4	5.0
251 – 500	1	1.2
>500	0	0.0

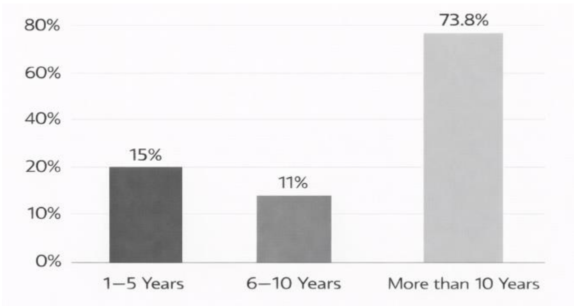


Figure 2 - Distribution of respondents by years of professional experience

Collinearity Statistics (VIF)

In the structural model, all inner VIF values are 1.491 – 2.375, indicating no critical multicollinearity among predictors. Hair *et al.*, (2021) note that VIF values > 5 suggest probable collinearity problems, and issues may also arise in the 3 – 5 range. Since our VIFs are clearly below 3, the path coefficient estimates are unlikely to be biased by collinearity and can be interpreted with confidence.

Table 4: Multicollinearity Test for Exogenous Latent Constructs

Items	VIF
Supply Chain Integration	1.491
Transformational Leadership	2.149
Organizational Learning	2.375

Assessment of Measurement Model

The evaluation of the measurement model (outer model) includes assessing indicator (item) reliability, content validity, internal consistency reliability, convergent validity, and discriminant validity (Hair & Alamer 2022; Fornell & Larcker, 1981).

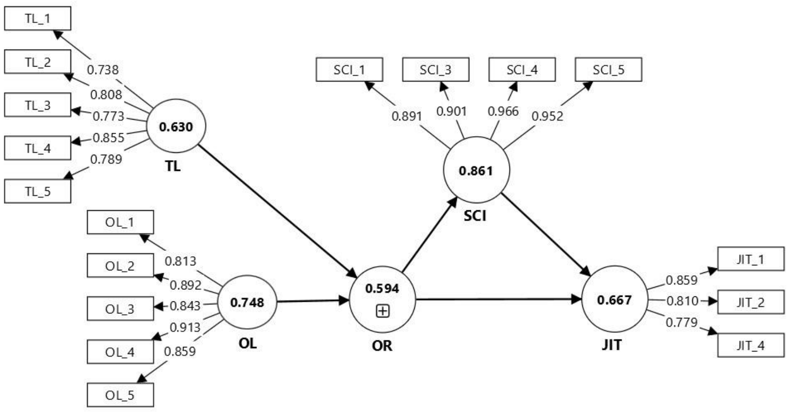


Figure 3 - Evaluation of Measurement Model Through PLS Algorithm

Convergent Validity

Convergent validity of the reflective constructs was assessed by examining the standardized factor loadings of the indicators, as well as Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE) in line with established PLS-SEM guidelines (e.g., Hair, Risher, Sarstedt & Ringle, 2019; Fornell & Larcker, 1981). Table 5 reports the item loadings together with the internal consistency and convergent validity statistics for Supply Chain Integration, Transformational Leadership, Organizational Learning, and Just-in-Time implementation.

Table 5: Construct Reliability and Validity

Items	Loading	Cronbach's Alpha	rho_A	CR	AVE
TL	0.738 – 0.855	0.850	0.855	0.895	0.630
OL	0.813 – 0.913	0.915	0.917	0.937	0.748
SCI	0.891– 0.966	0.924	0.929	0.949	0.862
JIT	0.779 – 0.859	0.750	0.756	0.857	0.668

Note; (S. C. I.) Supply Chain Integration, (T.L.) Transformational Leadership,
(O. L.) Organizational Learning, (J.I.T.) Just-in-Time.

All constructs demonstrate convergent validity: indicator loadings are ≥ 0.738 and AVE values are ≥0.50, meaning each construct explains at least 50% of its indicators' variance (Hair *et al.*, 2019). Internal consistency is also satisfactory because Cronbach's alpha, rho_A, and CR are ≥0.70 (Hair *et al.,* 2019).

Discriminant Validity

HTMT results indicate acceptable discriminant validity because all construct pairs are below 0.90, with the highest value observed for TL – JIT (HTMT = 0.864). This supports that SCI, TL, OL, and JIT are empirically distinct, consistent with the HTMT decision rule proposed by Henseler, Ringle & Sarstedt (2015). Although TL – JIT is close to the stricter 0.85 cut-off, TL and JIT remain theoretically different: TL reflects leadership behaviors that inspire and develop followers (Bass, 1999), whereas JIT represents an operational lean practice bundle focused on material-flow timing and inventory reduction (Shah & Ward, 2003). Therefore, the elevated TL – JIT association likely reflects a strong enabling relationship rather than conceptual overlap.

Table 6: Discriminant Validity Assessment Using the HTMT Criterion

Items	SCI	TL	OL	JIT
SCI	**1.000**			
TL	0.547	**1.000**		
OL	0.599	0.818	**1.000**	
JIT	0.395	0.864	0.798	**1.000**

Note; (S. C. I.) Supply Chain Integration, (T.L.) Transformational Leadership, (O. L.) Organizational Learning, (J.I.T.) Just-in-Time.

Assessment of Significance of the Structural Model

The assessment of the structural model (the inner model) was conducted after all conditions of the outer model assessment had been satisfied. The path coefficients among the latent constructs in the structural model were then estimated. The significance of these path coefficients was tested using a non-parametric bootstrapping procedure (Hair & Alamer 2022), where 5,000 bootstrap samples are recommended as a rule of thumb for model estimation in PLS-SEM (Hair & Alamer 2022; Nitzl, Roldán & Cepeda, 2016).

Table 7: Results of Bootstrapping for Structural Model Evaluation

Hypothesis	Variables	Beta (ß)	T-Value	P-Value	Findings
H1	TL -> JIT	0.506	3.450	0.001	Supported**
H2	OL -> JIT	0.368	2.623	0.009	Supported**
H3	SCI -> JIT	-0.129	1.438	0.150	Not supported
H4	TL -> SCI -> JIT	-0.023	0.792	0.429	Not supported
H5	OL -> SCI -> JIT	-0.060	1.317	0.188	Not supported

Note: **Significant at 0.05 (p-value), Note; (S. C. I.) Supply Chain Integration, (T.L.) Transformational Leadership, (O. L.) Organizational Learning, (J.I.T.) Just-in-Time.

H1: A significant positive relationship exists between Transformational Leadership and the adoption of Just-in-Time among Libya's construction firms.

H2: A significant positive relationship exists between Organizational Learning and the adoption of Just-in-Time among Libya's construction firms.

H3: No significant relationship exists between Supply Chain Integration and the adoption of Just-in-Time among Libya's construction firms.

H4: No significant mediating effect of Supply Chain Integration is found in the relationship between adoption among Libya's construction firms.

H5: No significant mediating effect of Supply Chain Integration is found in the relationship between adoption among Libya's construction firms.

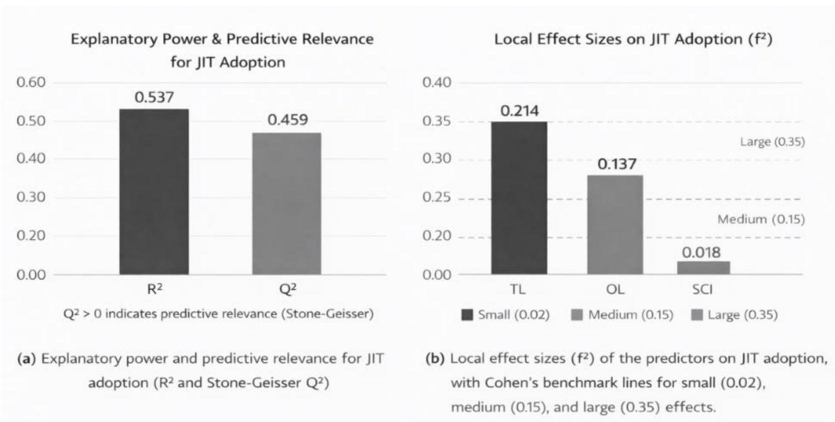
These significance decisions follow standard PLS-SEM bootstrapping inference rules (Hair *et al.,* 2019) and mediation testing via bootstrapped indirect effects (Preacher & Hayes, 2008).

Effective Size and Predictive Relevance

The model explains 53.7% of the variance in Just-in-Time (JIT) ($R^2 = 0.537$), indicating moderate explanatory power in PLS-SEM terms (Hair *et al.*, 2019). Regarding effect size, the predictors show differentiated contributions to JIT: TL has a medium effect ($f^2 = 0.214$), OL has a small-to-medium effect ($f^2 = 0.137$), while SCI has a negligible effect ($f^2 = 0.018$), consistent with the common f^2 benchmarks summarized in Hair *et al.*, (2019) (≈0.02 small, 0.15 medium, 0.35 large). For predictive relevance, JIT shows positive Q^2 ($Q^2 = 0.459$), meaning the model has out-of-sample predictive relevance for the endogenous construct, as recommended in PLS-SEM reporting (Hair *et al.*, 2019).

Table 8: Explained Variance (R^2) for the Endogenous Construct (JIT)

Latent Variable	Variance Explained (R^2)
Just-in-Time	0.537



(a) Explanatory power and predictive relevance for JIT adoption (R^2 and Stone-Geisser Q^2)

(b) Local effect sizes (f^2) of the predictors on JIT adoption, with Cohen's benchmark lines for small (0.02), medium (0.15), and large (0.35) effects.

Figure 4 - Explanatory power, predictive relevance, and local effect sizes of the structural model for JIT adoption.

Test of The Mediating Effect

Mediation was assessed by estimating bootstrapped indirect effects with 5,000 resamples, which is recommended because it does not rely on normality assumptions for indirect effects (Preacher & Hayes, 2008). The indirect effect of transformational leadership on JIT adoption through supply chain integration was not significant ($\beta = -0.023$, $t = 0.79$, $p = .429$). Likewise, the indirect effect of organizational learning on JIT adoption through supply chain integration was not significant ($\beta = -0.060$, $t = 1.32$, $p = .188$). In addition, the direct path from supply chain integration to JIT adoption was not significant ($\beta = -0.129$, $p = .150$). By contrast, the direct effects remained positive and statistically significant: transformational leadership on JIT adoption ($\beta = 0.506$, $p < .001$) and organizational learning on JIT adoption ($\beta = 0.368$, $p = .009$). Consistent with mediation guidance in PLS-SEM (Nitzl *et al.,* 2016) and reporting recommendations (Hair *et al.,* 2019), these results indicate that supply chain integration does not mediate the relationships between transformational leadership or organizational learning and JIT adoption in the current sample.

Discussion

The structural model shows that transformational leadership (TL) and organizational learning (OL) are statistically significant predictors of Just-in-Time (JIT) adoption among Libya's construction firms. TL exhibits a positive and significant direct effect on JIT adoption ($\beta = 0.506$, $t = 3.450$, $p = 0.001$), and OL also shows a positive and significant direct effect ($\beta = 0.368$, $t = 2.623$, $p = 0.009$). In contrast, supply chain integration (SCI) does not demonstrate a statistically significant direct effect on JIT adoption ($\beta = -0.129$, $t = 1.438$, $p = 0.150$), and neither of the indirect paths via SCI is statistically significant. The model explains a moderate proportion of variance in JIT adoption ($R^2 = 0.537$), indicating that it captures meaningful drivers of JIT adoption in this context, while leaving room for additional explanatory factors beyond those included here.

Interpreting these results operationally, the stronger TL effect is plausible given the behavioral demands of JIT in construction. JIT requires disciplined short-interval planning, timely escalation of constraints, and consistent adherence to delivery and installation windows. These demands are difficult to sustain when coordination is distributed across site and procurement functions and when interruptions are common. TL may help to stabilize this environment by clarifying priorities, reinforcing accountability for plan reliability, and encouraging coordination across functional boundaries, especially between procurement and site teams. The size and significance of the TL path are therefore consistent with the idea that leadership can shape whether JIT is enacted as a routine practice rather than remaining an aspirational principle.

OL appears to complement this role by supporting the continuous refinement that JIT typically requires once buffers are reduced. When inventory slack is limited, recurring delivery delays or rework quickly translate into stoppages and schedule disruption. Learning routines can reduce this vulnerability by helping firms identify recurrent failure modes, revise ordering and receiving practices, and embed improvements so that subsequent projects do not repeat the same disruption patterns. This interpretation is broadly aligned with evidence that organizational learning practices support construction organizations' resilience under high uncertainty (AlMaian & Bu Qammaz, 2023). In Libya's context, where disruptions and procedural variability may be common, such learning mechanisms may be particularly valuable for stabilizing time-sensitive logistics routines. The persistence of the OL effect alongside a non-significant SCI effect is therefore suggestive of a setting in which internal learning loops may partially compensate for external instability by strengthening how firms anticipate, absorb, and respond to supply interruptions.

The non-significant SCI result also points to an important contextual boundary condition for the often-assumed link between integration and JIT. While SCI is frequently treated as a direct enabler of time-based delivery, the present findings indicate that this relationship may not hold uniformly. Several context-consistent explanations are plausible: integration may be uneven across suppliers and projects, limited to information exchange without corresponding reliability in execution, or constrained by transport instability and low data quality. Under such conditions, "integration" may not translate into the consistent synchronization that JIT requires. In this sense, leadership-driven coordination and firm-level learning may have greater immediate influence on JIT adoption than broader end-to-end integration efforts that are difficult to maintain in practice.

This pattern is consistent with the broader observation that successful JIT application depends on multiple critical factors rather than on any single mechanism. Hussein and Zayed (2021) highlight that numerous factors shape JIT success, which implies that integration alone is unlikely to produce JIT outcomes without complementary planning discipline and execution capability. Accordingly, the present results should be interpreted as indicating that, in Libya's construction firms, JIT adoption may be more strongly associated with internal capability development through leadership and learning than with SCI as modelled here.

At the same time, the moderate explanatory power ($R^2 = 0.537$) also signals limits to what can be inferred from this model alone. Although TL and OL account for a meaningful share of variance in JIT adoption, additional drivers are likely to be relevant in this setting. Moreover, the non-significant SCI effects should be understood in light of contextual constraints and measurement boundaries, including the possibility that integration is implemented inconsistently across projects and partners. Within these limits, the findings nonetheless clarify that internal managerial and learning capabilities remain salient predictors of JIT adoption even when network-level integration does not show a direct or mediating role in the tested model.

1 Research and Managerial Implications

Research implications. This study indicates that internal organizational capabilities are more proximal drivers of JIT adoption than broad supply chain integration in the Libyan construction context: transformational leadership and organizational learning show positive associations with JIT, whereas supply chain integration has no significant direct or mediating effect in the tested model. This pattern provides a boundary condition for lean/JIT arguments that are often transferred from manufacturing to construction without sufficient contextualization (Koskela, 1992). Future research should (i) re-specify supply chain integration as multi-dimensional (internal vs external) or contingent (e.g., supplier criticality, supply uncertainty), and (ii) test moderated or conditional mediation using bootstrapping-based procedures (Nitzl *et al.*, 2016).

Managerial implications. Managers seeking to implement JIT should priorities leadership routines and learning mechanisms that stabilize short-term planning and systematically capture causes of material-related disruptions, then pursue selective, high-value integration with critical suppliers through small-scale pilots before scaling. This sequencing is consistent with evidence that successful JIT in construction-related settings depends on multiple organizational and coordination factors rather (Hussein & Zayed, 2021).

Limitations and Paths for Future Research

Limitations. This study is cross-sectional, so the findings should be interpreted as associations rather than causal or time-varying effects. Data were collected using a single self-administered questionnaire, which may increase self-report bias and common method variance. The sample is geographically concentrated in Misrata, not the whole of Libya, which limits transferability to areas with different procurement systems, transport reliability, and contracting practices. The model also omits potentially influential contextual factors (e.g., contract incentives, material criticality, site receiving capacity, digital readiness, environmental turbulence) and treats supply chain integration as a single reflective mediator, which may oversimplify how integration operates in construction settings.

Paths for future research. Future studies should use longitudinal designs to test temporal ordering and observe how JIT implementation evolves across project phases. They should also reduce single-respondent bias by combining survey data with objective indicators (e.g., delivery performance records, procurement logs, and site productivity measures). Research can test boundary conditions such as supply uncertainty and digital readiness, and compare results across different cities, project types (public vs private), and contract forms. Finally, supply chain integration should be re-examined as a multi-dimensional construct (internal vs external) and, where conceptually justified, modelled formatively rather than reflectively, while testing alternative mechanisms (additional mediators or moderators) using bootstrapping-based procedures

Conclusions

This study provides empirical evidence on organizational drivers of JIT adoption in Libya’s construction firms. Transformational leadership and organizational learning exhibit positive and statistically significant relationships with JIT adoption, whereas supply chain integration does not show a statistically significant direct effect and does not mediate the leadership–JIT or learning–JIT relationships. In this context, the results indicate that JIT adoption is shaped more by internal managerial routines and learning capability than by broad external integration initiatives alone.

From a practical standpoint, firms can strengthen JIT readiness by developing reliable short-interval planning, clarifying material call-off and delivery rules, and embedding systematic learning loops that convert delivery failures into process updates. Integration with external partners remains relevant; however, the evidence suggests it is more likely to be useful when pursued selectively and when paired with execution capability, rather than treated as a standalone solution.

Overall, the study helps specify where managerial attention may be most productively concentrated when attempting to reduce material buffers without undermining workflow continuity. It also provides a foundation for future quantitative work that incorporates additional contextual factors and tests alternative capability pathways to explain remaining variance in JIT adoption in Libya’s construction industry.

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