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Inclusive Organizational Infrastructure and Supply Chain Operational Value through Coordination and Integrative Capability

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Abstract

Debate over whether diversity, equity and inclusion (DEI) belongs in the operational core of the firm has intensified rather than settled because of an unresolved analytical problem: the operations and supply chain management (OSCM) literature documents that inclusion is associated with organizational outcomes without specifying the operational machinery producing that association. We reframe inclusion as *inclusive organizational infrastructure* - the configuration of workforce diversity, structural equity and inclusive culture that determines whose knowledge legitimately enters operational decision processes - and model its conversion into operational value as a translation architecture. Drawing on dynamic capabilities theory, supported by inclusion climate, social capital and relational view arguments, we theorize that inclusive infrastructure activates three distinct coordination mechanisms (internal, inter-organizational and boundary-spanning), that these crystallize into integrative operational capability, which is converted into operational value realization. Survey data from 264 food export enterprises in Vietnam and China were analyzed using covariance-based structural equation modeling, bootstrapped mediation decomposition, measurement-invariance testing, multi-group analysis and necessary condition analysis. Coordination and integrative capability jointly transmit 47.2% of the total effect of inclusive infrastructure on operational value, with inter-organizational and boundary-spanning routes carrying most of the indirect effect. Network coordination complexity negatively moderates the capability-to-value relationship, and multi-group evidence indicates that the conversion of inter-organizational and boundary-spanning coordination into capability is significant only under low complexity while the direct infrastructure-to-value relationship persists, a pattern we term *compressed capability translation*. Necessary condition analysis shows that integrative capability is a degree-dependent prerequisite, not merely a predictor.

1 Introduction

1.1 The unresolved DEI problem in OSCM

Few contemporary management questions have generated as much simultaneous consensus and disagreement as the role of diversity, equity and inclusion (DEI) in the operational core of the firm. At the level of stated commitment, convergence appears almost complete: DEI language now saturates supplier codes of conduct, sustainability disclosures and procurement scorecards. At the level of demonstrated operational consequence, however, the field remains conspicuously unsettled. Son et al. [1] capture this tension directly in asking whether the DEI debate in sustainable operations and supply chain management has in fact been settled, and conclude that it has not - not because evidence is absent, but because the evidence that exists has been accumulated at a level of abstraction that cannot adjudicate the disagreement. Prashar [2] reaches a structurally similar conclusion from a conceptual direction, observing that DEI has entered the OSCM conversation as a normative commitment and a reporting category rather than as an operationally specified construct with identifiable mechanisms and boundary conditions. This mirrors a wider concern that diversity scholarship has arrived at a critical juncture where conceptual precision, rather than the accumulation of further associational evidence, is the binding constraint [3], and it compounds a long-standing tendency to conflate diversity with inclusion despite their distinct theoretical referents [4, 5]. That distinction carries an ordering commitment this study adopts: inclusion is treated as the point of departure rather than as a downstream consequence of demographic composition, which is why the construct developed below is built on inclusive infrastructure rather than on diversity levels. The consequence within OSCM is that social dimensions of sustainability have been treated as reporting obligations more often than as objects of operational theorizing [6, 7], even as the field has been urged to make sustainability constitutive of operations rather than ancillary to it [8, 9].

Nor is the difficulty confined to OSCM. Read from the sustainability literature itself, the same construct appears underdeveloped rather than merely under-prioritized: syntheses of sustainable supply chain research report that social goals remain underrepresented in the published corpus relative to environmental ones [10], that the conceptual structure of human-centered practices in supply chain settings is organized around environmental outcomes and resource-based reasoning [11], and that corporate resourcing of the equity-oriented development goals lags behind goals carrying clearer reputational returns [12]. Where inclusion has been given explicit supply chain content, it has been specified in relation to marginalized actors and to resilience outcomes, as in frameworks addressing the resource constraints, weak bargaining position and exposure to systemic inequality faced by smallholder producers [13], rather than in relation to the conversion process operating inside the focal organization. The deficit is therefore not one of stated commitment but of measurement and mechanism.

The difficulty is inherited. Organizational research on diversity has long produced a divided empirical record, with demographic heterogeneity linked to superior information processing in some settings and to relational friction, categorization dynamics and

coordination cost in others [14, 15]. Ely and Thomas [16] showed that the same demographic composition produces materially different outcomes depending on the interpretive perspective through which difference is organized, and Roberson et al. [17] subsequently argued that this pattern of inconsistency is not a measurement failure to be corrected by larger samples but a theoretical signal: diversity is an input whose value depends on the organizational processes that act upon it. The record has not since consolidated. Current evidence continues to report divergent effects for different facets of the same construct - experience diversity positively associated with firm performance, age diversity negatively, and nationality diversity not at all, within a single model [18]. That argument has been absorbed only partially into OSCM. The field has adopted the claim that inclusion matters while leaving unspecified the operational apparatus that determines whether it matters.

This creates a specific and consequential vulnerability. When the business case for inclusion is asserted as a direct empirical association between DEI adoption and firm performance, it becomes contestable on precisely the grounds on which it is most fragile - effect sizes that vary across contexts, results that fail to replicate, and the persistent possibility that both DEI adoption and performance are driven by slack resources. A mechanism-based account is not merely more theoretically satisfying, and it is more defensible, because it specifies the conditions under which the relationship should and should not be observed. The absence of such an account is the problem this study addresses.

1.2 From DEI practices to inclusive organizational infrastructure

Progress requires reconceptualizing what DEI is within an operational system. Much OSCM research treats DEI as a bundle of discrete practices - supplier diversity targets, representation quotas, training programs, reporting commitments - and models the count or intensity of those practices as an antecedent of performance. This practice-bundle framing carries an implicit and largely untested assumption: that adopting a practice changes the organization's operating logic. It frequently does not. Practices can be adopted ceremonially, decoupled from the routines that actually govern how operational decisions are made - the classic pattern of structural conformity without operational consequence [19] - and it is precisely this decoupling that generates the inconsistent findings the field has struggled to interpret. A parallel pattern is legible in how inclusion is written about. In sustainability and supply chain research it appears predominantly as a qualifier attached to recommended arrangements - inclusive institutional arrangements and inclusive organizations [20, 21] - rather than as a construct that is conceptually defined, measured and modeled. Treating inclusion as infrastructure commits us to the latter.

We therefore propose *inclusive organizational infrastructure* (IOI) as the appropriate construct. Infrastructure denotes the enduring, structurally embedded configuration that determines whose knowledge is present in the organization, whether that knowledge is granted equitable access to advancement and reward, and whether it can be voiced and integrated in the settings where operational decisions are actually taken. This configuration has three conceptual foundations. Workforce diversity establishes the heterogeneity of knowledge, experience and network position available to the organization. Structural equity establishes whether that heterogeneity is distributed across hierarchical positions and rewarded consistently, or concentrated in peripheral roles with no decision rights. Inclusive culture - the climate dimension developed by Nishii [22] - establishes whether difference can be expressed without relational penalty and integrated rather than suppressed.

The infrastructure framing carries three analytical advantages. First, it is operationally rather than symbolically defined: it concerns the architecture of participation in work, not the declaration of values. Second, it is a stock rather than a flow, which matches the theoretical claim that inclusion works through accumulated structural properties rather than through episodic interventions. Third, and most importantly for this study, infrastructure is an enabling condition rather than a performance-producing mechanism. Infrastructure makes certain organizational processes possible, but it does not execute them. This immediately raises the question that the DEI-OSCM literature has left open - what does inclusive infrastructure have to be converted into before it becomes operational value?

1.3 The missing operational translation mechanism

Dynamic capabilities theory supplies the conceptual vocabulary for that conversion. Teece et al. [23] and Teece [24] locate competitive advantage not in resource endowments as such but in the organizational processes through which resources are sensed, seized, integrated and reconfigured. Roberson et al. [17] apply this logic explicitly to diversity, arguing that heterogeneous human capital is a resource whose value is realized or destroyed by the capability architecture that surrounds it. The implication for OSCM is direct but has not been empirically formalized: inclusive infrastructure should not be modeled as a proximate determinant of operational performance but as an upstream input into a translation process.

We specify that process as having two sequential stages. The first is coordination. Heterogeneous knowledge is operationally inert until it is brought into contact across the organizational divisions that separate it, and the mechanisms that accomplish this differ meaningfully in their locus. Internal coordination synchronizes activity across functional units within the firm. Inter-organizational coordination aligns activity with supply chain partners, and is theorized by the relational view as a source of advantage residing in the dyad or network rather than the firm [25]. Boundary-spanning coordination operates across the functional and stakeholder interfaces that are normally separated by structural barriers. These are not interchangeable expressions of a single latent orientation, and we treat them as distinct mechanisms rather than as indicators of a higher-order coordination factor.

The second stage is capability formation. Coordination is an activity, and it becomes strategically consequential only when it stabilizes into *integrative operational capability* (IOCap) - a repeatable organizational competence in combining resources, aligning processes and reconfiguring operational configurations in response to changing requirements. This is the recombinative competence that supply chain integration research has linked to sustained advantage [26, 27]. Only at this point is operational value realization (OVR) plausibly generated. The proposed chain - infrastructure enables coordination, coordination crystallizes into capability, capability is converted into value - constitutes what we call a translation architecture, and it is the primary object of empirical investigation here.

1.4 Network complexity as a boundary condition

A translation architecture is not context-free. Its stages can be interrupted, and the most theoretically interesting question is not whether interruption reduces effect magnitudes but *which stage* it disrupts. Supply chain complexity research has established that the number, heterogeneity and interdependence of network actors impose distinctive information-processing burdens on the focal organization [28, 29], and that structural complexity in the upstream network is associated with the frequency of operational disruption [30]. We capture this construct as *network coordination complexity* (NCC): the managerial effort, interdependence and multi-stakeholder alignment difficulty entailed in coordinating across the organization's network of internal units and external partners.

The conventional expectation is that complexity attenuates relationships more or less uniformly. We advance a more specific proposition. Coordination activity itself is relatively robust to complexity because it is driven by the infrastructure that authorizes it. What complexity should disrupt is the *conversion* of coordination into higher-order capability, because capability formation requires that coordination episodes be stable, repeated and mutually reinforcing enough to sediment into routine. Under high complexity, coordination remains present but becomes episodic, contingent and partner-specific - active, yet unable to crystallize. If this reasoning is correct, complexity should not eliminate the coordination stage while nonetheless breaking the coordination-to-capability stage, and the direct infrastructure-to-value relationship should persist. We label the resulting configuration *compressed capability translation*.

1.5 Research questions and contributions

Three questions follow. First, through which organizational mechanisms is inclusive organizational infrastructure translated into operational value, and how much of the total relationship is transmitted through those mechanisms rather than realized directly? Second, does network coordination complexity operate as a general attenuator of the model, or does it selectively disrupt a specific stage of the translation architecture? Third, are coordination and integrative capability merely associated with operational value, or do they function as prerequisites whose absence constrains the level of value that can be attained?

The third question requires an analytical logic that variance-based estimation cannot supply. Structural equation modeling estimates average incremental association: how much of Y moves when X moves. Necessary condition analysis addresses a categorically different question - whether a minimum level of X constrains the maximum attainable level of Y [31–33]. A construct can be a strong predictor without being necessary, and can be necessary while explaining little incremental variance. Because the translation-architecture argument is fundamentally a claim about prerequisites, we treat structural equation modeling (SEM) and necessary condition analysis (NCA) as complementary rather than substitutive logics and report both.

This design responds to a call issued from within the sustainability operations literature itself. Castillo et al. [34], examining a transition in which sustainability, resilience and human centricity are treated as joint design criteria for operations rather than as competing objectives, report that the evidence base for that transition remains predominantly qualitative and conclude that

subsequent work should employ larger, industry-specific datasets and structural equation modeling capable of testing causal relationships. The present study supplies evidence of that kind for the inclusion dimension of the agenda.

The study makes four contributions. Theoretically, it repositions inclusion within OSCM from a social or human resource practice to an operational infrastructure whose value is conditional on a specifiable conversion process, thereby moving the debate identified by Son et al. [1] and Prashar [2] from *whether* inclusion creates value to *how*, *through which mechanisms*, and *under what network conditions*. Second, it decomposes the translation mechanism into distinct coordination routes and shows that the externally oriented routes carry substantially more of the transmitted effect than internal alignment, which has direct implications for how DEI is operationalized in supply chain settings. Third, it identifies complexity-induced disruption as stage-specific rather than global, introducing compressed capability translation as a characterization of how inclusive infrastructure continues to generate value when its capability-building pathway is impaired. Fourth, it demonstrates methodologically that integrative capability functions simultaneously as a predictor and as a degree-dependent prerequisite, and that this prerequisite structure is itself contingent on network complexity - a finding that neither analytical approach could have produced alone.

2 Theoretical background and hypothesis development

2.1 Dynamic capabilities as the theoretical foundation

The dynamic capabilities perspective was formulated to address a limitation in resource-based reasoning that is directly analogous to the difficulty now facing DEI research in OSCM. Resource-based accounts explain advantage by reference to the properties of resources - their rarity, value, inimitability and non-substitutability - but say comparatively little about the organizational processes through which resources are actually deployed, recombined and renewed. Teece et al. [23] reoriented the question toward those processes, defining dynamic capabilities as the firm's ability to integrate, build and reconfigure internal and external competences to address changing environments. Teece [24] subsequently disaggregated this ability into the microfoundations of sensing, seizing and transforming, locating advantage in identifiable organizational routines rather than in an undifferentiated capacity for adaptation. Subsequent work has clarified that such capabilities are neither mystical nor automatic: they consist of identifiable and partly imitable processes [35], are constructed through deliberate learning and the accumulation of experience [36], and depend on the cognitive capacities of the managers who exercise them [37].

Two features of this framework are decisive for the present argument. First, it establishes a categorical distinction between resource possession and resource orchestration. A firm may hold heterogeneous human capital that satisfies every criterion for a strategically valuable resource [38] and derive no advantage from it, because the integrative routines that would convert heterogeneity into decision-relevant knowledge are absent. The knowledge-based tradition makes the same point from a different direction: value arises from the combinative capacity to integrate specialized knowledge held by different individuals, not from the possession of that knowledge as such [39, 40]. Second, it treats integration and reconfiguration as capabilities in their own right - organizational competences that must be constructed, maintained and can be lost - rather than as automatic consequences of managerial intent. This is why the framework accommodates the empirical inconsistency that has characterized diversity research: the same resource endowment can generate divergent outcomes depending on the state of the orchestrating capability.

Roberson et al. [17] make this application explicit. Their central argument is that research linking diversity directly to firm performance has been theoretically underspecified because it omits the capability layer that mediates between the two, and that a dynamic capabilities perspective reframes the research question from whether diversity pays to how organizations construct the capabilities required to make it pay. We adopt this framing as the theoretical spine of the manuscript and extend it in an operational direction. Where Roberson et al. [17] argue at the level of the firm's general capability architecture, we specify the operational mechanisms - coordination across three distinct loci, and integrative operational capability as the higher-order competence they produce - through which the conversion occurs in supply chain settings.

We deliberately position inclusion climate, social capital and relational view arguments as supporting mechanisms operating within this spine rather than as competing theoretical accounts. Nishii [22] explains why inclusive climates generate the relational conditions under which heterogeneous perspectives can be voiced and integrated instead of suppressed. Tsai and Ghoshal [41] explain how social interaction, trust and resource exchange within intra-firm networks convert relational structure into value. Dyer and Singh [25] explain why relation-specific assets, knowledge-sharing routines and effective governance can make the dyad or network - rather than the firm - the locus of advantage. Each of these clarifies *how* a particular stage of the capability architecture operates.

None of them displaces the dynamic capabilities logic that organizes the model as a whole, and we avoid theoretical fragmentation by consistently subordinating them to it.

A reasonable objection is that dynamic capabilities reasoning has been criticized for definitional elasticity, and that invoking it risks explaining outcomes by naming an unobserved capacity. We take this objection seriously and address it structurally rather than rhetorically. The model specifies the capability at a defined level of analysis, operationalizes it through observable organizational competences, positions identifiable antecedents upstream of it, and specifies a boundary condition under which its formation should fail. A framework used this way is falsifiable: if coordination did not predict capability, if capability did not predict value, or if complexity did not disturb the conversion stage, the account would be disconfirmed. The looseness for which dynamic capabilities reasoning has been criticized arises when the capability is inferred from the outcome it is meant to explain, and the design adopted here avoids that circularity by measuring capability independently of value realization.

2.2 Inclusive organizational infrastructure as a capability-enabling condition

The dynamic capabilities framing requires that inclusion be positioned at the correct point in the causal architecture. If integrative capability is what converts heterogeneous resources into value, then inclusion cannot itself be that capability, and it is more accurately understood as the condition that determines the quality and accessibility of the knowledge base on which the capability operates. Inclusive organizational infrastructure is therefore theorized here as a capability-enabling condition - necessary for the knowledge diversity that integrative routines act upon to be available in decision-relevant form, but not itself a mechanism of integration.

Its three conceptual foundations enable the capability architecture in distinguishable ways. Workforce diversity determines the *variety* of the knowledge base. Heterogeneity in demographic background, age cohort, educational and professional formation, and social and cultural experience expands the range of interpretive frames available when operational problems are encountered, and expands the external network positions the organization can reach through its members. This is the informational logic that has long underpinned optimistic accounts of diversity [15], and it is a real but conditional asset: variety without access is noise.

Structural equity determines the *distribution* of that variety across positions of operational consequence. When employment policies are applied consistently, promotion is governed by merit and performance, developmental opportunity and reward are allocated equitably, and mechanisms exist for addressing unfair treatment, heterogeneous knowledge becomes distributed across hierarchical levels and functional domains rather than concentrated in peripheral roles. Equity thus governs whether diverse knowledge occupies positions from which it can enter operational decision processes at all. The same logic has been observed at the level of the supply network, where the structural position of suppliers conditions whether socially responsible practices are actually adopted rather than nominally required [42, 43]. An organization can be demographically diverse and structurally inequitable, in which case the variety is present but operationally inaccessible - a configuration that plausibly accounts for a substantial share of null findings in the diversity-performance literature.

Inclusive culture determines the *usability* of variety once it is present and positioned. Nishii [22] demonstrates that climates for inclusion reduce the relational barriers that otherwise convert demographic difference into conflict, enabling cross-cutting ties and integrative rather than subtractive information processing. Where employees are respected regardless of background, divergent viewpoints are encouraged, psychological safety supports the expression of dissenting information, and inclusive behavior is recognized and reinforced, the knowledge held by heterogeneous members can enter collective processing rather than being self-censored. Culture therefore governs the transmission of knowledge that diversity supplies and equity positions.

The three foundations are complementary and jointly constitutive: variety without positional access, or positional access without relational safety, leaves the infrastructure functionally incomplete. Treating them as facets of a single infrastructure construct rather than as independent predictors reflects this complementarity and is consistent with the empirical structure observed in the measurement analysis reported below.

2.3 Inclusive infrastructure and organizational coordination

The first stage of translation is the activation of coordination. Coordination is the organizational work of aligning interdependent activity under conditions where that activity cannot be fully specified in advance [44–46], and it is fundamentally an informational and

relational accomplishment: it requires that the parties whose activities are interdependent can exchange relevant information, interpret one another's constraints, and adjust. Inclusive infrastructure supports each of these requirements. It widens the range of interpretive frames available at coordination interfaces, distributes knowledge-holders across the positions where interdependence is managed, and reduces the relational friction that impedes candid information exchange across difference. Relational coordination research demonstrates that shared goals, shared knowledge and mutual respect among interdependent actors improve performance beyond what formal structure achieves [47], and Tsai and Ghoshal [41] provide the supporting mechanism at the intra-firm level: social interaction and trust facilitate resource exchange and combination, and inclusive climates are precisely the conditions under which cross-cutting social interaction develops rather than fragmenting along demographic or functional lines.

Internal coordination concerns the synchronization of operational activity across functional units within the organization - timely information exchange between internal teams, rapid cross-unit resolution of operational issues, and effective allocation of internal resources against shared objectives. Because inclusive infrastructure acts directly on the relational conditions governing intra-organizational exchange, its influence on internal coordination should be relatively direct and unmediated by external contingencies.

Inter-organizational coordination concerns the alignment of activity with supply chain partners: coordinating operational activities with key partners, sharing operational information in a timely and effective manner across firm boundaries, and aligning decisions toward common operational objectives. Supply chain research has likewise found it necessary to separate internal integration from supplier- and customer-facing integration rather than treating integration as unitary [48]; the distinction drawn here follows the same logic while locating the third mechanism at functional and stakeholder interfaces rather than at the customer boundary. Dyer and Singh [25] argue that such relational coordination depends on knowledge-sharing routines and complementary governance rather than on formal contract alone. Inclusive infrastructure supports these routines because the boundary roles through which inter-firm coordination is enacted require interpretive flexibility, and because organizations whose internal norms already accommodate heterogeneity are better positioned to accommodate the interpretive differences that partners bring.

Boundary-spanning coordination concerns the ability to work across functional and stakeholder interfaces that are normally separated by departmental or operational barriers - the interfaces at which information routinely fails to flow. This mechanism is the most demanding of the three because it requires actors to operate outside the interpretive conventions of their own domain, which is the organizational competence that inclusive cultures most directly cultivate. Accordingly:

H1a. Inclusive organizational infrastructure is positively associated with internal coordination.

H1b. Inclusive organizational infrastructure is positively associated with inter-organizational coordination.

H1c. Inclusive organizational infrastructure is positively associated with boundary-spanning coordination.

2.4 Coordination as capability formation

Coordination is activity. Capability is competence. The second stage of the translation architecture concerns whether coordination episodes accumulate into an organizational competence that persists between episodes. Dynamic capabilities reasoning is explicit that capabilities are constructed through repeated, patterned organizational activity rather than acquired as discrete assets, and that their construction requires the underlying activity to be stable enough to be learned from. Coordination supplies the raw material of that learning: each episode of aligning interdependent activity generates knowledge about interfaces, constraints and adjustment procedures, and where such episodes recur under sufficiently consistent conditions, they sediment into the integrative routines that constitute capability.

The three coordination mechanisms are not, however, equivalent contributors. Internal coordination operates within a domain where interfaces are relatively stable, authority relations are clear, and much of the necessary alignment is already encoded in formal structure. Its marginal contribution to *integrative* capability may therefore be modest - not because internal alignment is unimportant, but because a substantial portion of it is achieved administratively rather than through the recombinative work that builds integrative competence. Inter-organizational coordination, by contrast, requires the organization to reconcile heterogeneous systems, incentives and information conventions across firm boundaries, work that is inherently integrative and generates knowledge that cannot be obtained internally. Vanpoucke et al. [26] demonstrate that supplier integration develops precisely through such repeated relational investment, and Liu et al. [27] show that integration and complementary competencies operate configurationally rather than additively in producing capability. Supply chain integration research more broadly links external and internal integration to operational

outcomes while emphasizing that their effects are contingent and configurational rather than uniform [49–51]. Boundary-spanning coordination similarly demands recombination across interpretive domains and should contribute substantially to integrative competence. Recent evidence is consistent with treating the externally facing routes as distinct rather than interchangeable: Javed et al. [52] report supply chain collaboration to be positively associated with sustainable supply chain performance in a survey of firms operating under disrupted conditions, and Almelhem et al. [53] show that upstream, supplier-facing strategies and downstream, customer-facing strategies are tracked by different indicator sets and therefore describe different coordination work.

We therefore expect all three mechanisms to contribute positively to integrative operational capability, while anticipating that the externally and cross-boundary oriented mechanisms will contribute more strongly than internal alignment.

H2a. Internal coordination is positively associated with integrative operational capability.

H2b. Inter-organizational coordination is positively associated with integrative operational capability.

H2c. Boundary-spanning coordination is positively associated with integrative operational capability.

The expectation of differential magnitude stated above concerns the relative size of coefficients within a single model rather than a formal test of coefficient equality, and we treat it as an interpretive proposition rather than a separately tested hypothesis.

2.5 Integrative operational capability and operational value realization

Integrative operational capability denotes a repeatable organizational competence in combining resources drawn from different operational areas, rapidly aligning operational processes when requirements change, synthesizing knowledge and expertise from heterogeneous sources, reconfiguring operational resources against emerging challenges, and mobilizing operational capabilities toward desired outcomes. This construct maps closely onto the integrating and transforming microfoundations identified by Teece [24], rendered at the operational rather than the strategic level of analysis, and is conceptually adjacent to operational agility, which likewise concerns the speed with which operational configurations can be adjusted [54].

Operational value realization is deliberately specified as a value-conversion outcome rather than as a set of efficiency metrics. It captures whether operational activity consistently delivers value supporting organizational objectives, whether operational resources are effectively converted into meaningful outcomes, whether operational improvements generate measurable benefits across areas of the organization, whether processes contribute to both efficiency and effectiveness, whether created value is sustained over time, and whether benefits from coordinated effort are successfully realized. This specification matters theoretically. A purely efficiency-based outcome would bias the model toward internal optimization and would not register the value created by recombination and adaptation, which are exactly the mechanisms the theoretical argument foregrounds. Value realization also foregrounds sustainment, which aligns the outcome with the sustainability orientation of the collection this manuscript addresses: value that is not sustained over time is not the object of interest.

The theoretical claim is that capability, not coordination, is the proximate determinant of value. Coordination that has not stabilized into capability is consumed in the episode that produced it. Capability persists and can be redeployed. This is the sense in which the model treats capability as the pivotal construct of the translation architecture.

The claim that the analytically interesting question concerns conversion rather than association has recent support. Abdullahi et al. [55] frame the outstanding problem as explaining how specific organizational capabilities translate into outcomes rather than establishing that they are associated with them, and Taera et al. [56] make the sequencing explicit in arguing that resources are not converted directly into performance but must be progressively transformed and stabilized through intermediate capability mechanisms. Kishore et al. [57] model sustainability practices in exactly this form, as a serial mediation grounded in the dynamic capability view. Accordingly:

H3. Integrative operational capability is positively associated with operational value realization.

The sustainment component of this outcome deserves emphasis given the sustainability agenda this collection addresses. Operational value that is generated but not sustained represents a materially different organizational condition from value that persists, and only the latter is consistent with a sustainability framing of operations [8, 9]. Capability is the theoretical reason to expect sustainment: because capability persists between episodes and can be redeployed, value generated through capability is

more likely to recur than value generated through non-recurring effort. This makes the capability stage not merely the pivot of the performance argument but the pivot of the sustainability argument, and it is why the impairment of that stage - rather than a reduction in performance as such - is the outcome of primary theoretical concern.

The architecture does not, however, imply that inclusive infrastructure operates *only* through coordination and capability. Inclusive infrastructure plausibly generates value through routes the model does not explicitly represent: improved retention and reduced replacement cost, enhanced legitimacy with buyers and certification bodies, better problem detection at the point of work, and reduced incidence of the interpersonal failures that generate operational disruption. A direct path is therefore specified, and partial rather than full mediation is the theoretically expected outcome.

H4. Inclusive organizational infrastructure is positively associated with operational value realization.

H5. The relationship between inclusive organizational infrastructure and operational value realization is partially mediated by the coordination mechanisms and integrative operational capability, such that a substantial share of the total effect is transmitted through the translation architecture.

2.6 Network coordination complexity as operational friction

Complexity in supply networks arises from the number of actors, the heterogeneity of their objectives and systems, and the density of interdependence among them [28, 29]. Network coordination complexity is specified here from the perspective of the focal organization: the substantial managerial effort required to coordinate across the network of internal units and external partners, and the extent to which high interdependence among supply chain actors amplifies the difficulty of operational coordination. Related work shows that environmental and network uncertainty conditions the returns to integration [58], that dense relational embeddedness can itself become a liability beyond a threshold [59], and that relational competence conditions how organizations absorb network disturbance [60].

The conventional treatment of such constructs is as a general attenuator: higher complexity, weaker relationships. We propose a more precise mechanism. Complexity does not primarily prevent coordination from occurring - organizations facing complex networks typically coordinate *more*, not less, because complexity generates the interdependence that makes coordination necessary. What complexity disrupts is the *stabilization* of coordination into capability. Capability formation requires that coordination episodes be sufficiently repeated, sufficiently similar, and sufficiently free of interference for the organization to learn transferable routines from them. Under high complexity, each episode is more likely to be partner-specific, contingent and non-recurring. The organization expends coordination effort without accumulating generalizable integrative competence. Coordination remains present but ceases to be capability-building.

A parallel implication concerns the conversion of capability into value. Where capability does exist, complexity should reduce the efficiency with which it is converted into realized value, because the operational environment absorbs a larger share of capability in maintaining alignment rather than in generating improvement. This yields a testable interaction at the capability-to-value stage:

It is worth being explicit about what this construct does and does not capture. Network coordination complexity as measured here is the focal organization's experience of coordination burden and interdependence, not an objective count of network nodes or ties. This perceptual specification is appropriate for the theoretical argument, since the mechanism operates through the organization's capacity to learn from coordination episodes rather than through network topology as such. It nonetheless means that the construct registers complexity as encountered rather than complexity as structured, and organizations with equivalent network structures may differ in measured complexity according to their information-processing capacity. We regard this as consistent with the construct's theoretical role while noting it as a measurement boundary.

H6. Network coordination complexity negatively moderates the relationship between integrative operational capability and operational value realization, such that the relationship is weaker at higher levels of complexity.

The stage-specificity claim - that complexity disrupts the coordination-to-capability conversion while leaving coordination activation and the direct infrastructure-to-value relationship comparatively intact - is not a hypothesis testable within a single-group model. It is a claim about structural heterogeneity across complexity regimes, and it is examined through multi-group analysis following a formal assessment of measurement invariance. We state it as an expectation guiding that analysis rather than as a hypothesis, and we are correspondingly careful in the interpretation of group-specific coefficients.

2.7 Conceptual model and hypotheses

Figure 1 presents the conceptual model. Inclusive organizational infrastructure, constituted by workforce diversity, structural equity and inclusive culture, activates three parallel coordination mechanisms. These mechanisms converge on integrative operational capability. Capability is converted into operational value realization, and a direct infrastructure-to-value path is specified alongside the mediated architecture. Network coordination complexity moderates the capability-to-value relationship. Digital operational readiness and institutional enabling conditions are included as controls on operational value realization, reflecting respectively the technological infrastructure supporting coordination and information sharing and the external policy, associational and stakeholder environment within which operational improvement occurs. Their inclusion guards against the attribution to inclusive infrastructure of value that originates in technological capacity or supportive institutional context.

3 Methodology

3.1 Research context and sampling

The empirical setting is the food export sector, which offers unusually favorable conditions for testing a translation-architecture argument. Food export operations are simultaneously internally interdependent, externally networked and institutionally regulated: production, quality assurance, logistics and commercial functions must be synchronized internally. Activity must be aligned with growers, processors, logistics providers, certification bodies and buyers externally, and operational decisions are bounded by food safety and quality regimes that impose non-negotiable requirements. Coordination in this setting is therefore not a discretionary managerial preference but an operational necessity, and its outcomes are consequential and observable. Certification should not, however, be read as evidence of substantive practice change in its own right: systematic review evidence from agricultural export chains finds that voluntary sustainability standards deliver incremental rather than transformative gains and can leave social conditions substantially unaltered [61]. What certification establishes for present purposes is narrower and sufficient - that operational requirements are externally specified and audited, so that coordination failures carry consequences the organization cannot absorb privately. The sector also sits squarely within the domain in which sustainable supply chain management has been theorized, where environmental, social and economic requirements are jointly imposed on operational decisions [62–64]. The sector also exhibits substantial heterogeneity in network configuration - from firms serving a small number of buyers through short chains to firms managing dispersed supply bases and multiple destination markets - which generates the variation in network coordination complexity that the theoretical argument requires.

The analytic sample comprises 264 food export enterprises in Vietnam (n = 223) and China (n = 41), two of the leading food-exporting economies in Asia, where compliance with stringent food safety and quality standards is a prerequisite for market access rather than a source of differentiation. Data were collected between February and April 2025 through a combination of purposive and snowball sampling. Questionnaires were distributed via Google Forms, e-mail and paper to one key informant per firm, screened to be a manager with direct responsibility for operational coordination and at least two years of professional experience in that role. Of 378 questionnaires distributed, 114 were excluded as invalid because of spam, incomplete data or unengaged response patterns, yielding 264 usable responses and an effective response rate of 69.8%. Non-response bias was not formally assessed, and this is recorded as a limitation in Section 7.

Respondents held positions with direct visibility of operational coordination: supply chain managers (31.4%), quality control managers (30.3%), chief executives (8.3%), trading managers (1.9%) and other operational roles (28.0%). The concentration of respondents in supply chain and quality management is appropriate given that the constructs concern coordination architecture and operational capability rather than financial outcomes. The full sample profile is reported in Table 1.

Two features of the setting warrant explicit acknowledgment as boundary conditions on the findings. First, food export enterprises operate under mandatory food safety regimes in which coordination failures produce documented and externally audited consequences, which raises the salience of coordination relative to sectors where alignment failures are absorbed internally. The translation architecture may therefore be more visible here than elsewhere. Second, the sector is characterized by seasonality, perishability and biological variability, which impose adjustment demands that make integrative and reconfiguring competences continuously relevant rather than episodically so. Both features favor detection of the theorized mechanisms and should be weighed when generalizing.

3.2 Construct operationalization

All constructs were measured reflectively using multi-item scales adapted from established sources and scored on five-point Likert-type scales. Inclusive organizational infrastructure was operationalized through 23 items spanning its three conceptual foundations: workforce diversity (5 items), structural equity (7 items) and inclusive culture (11 items), drawing on the diversity management, organizational justice and inclusion climate traditions. Internal coordination (4 items) captured synchronization of activity across internal units, timeliness of internal information exchange, cross-unit issue resolution and internal resource coordination. Inter-organizational coordination (3 items) captured coordination of operational activities with key supply chain partners, timeliness of inter-firm information sharing and alignment of decisions toward common operational objectives. Boundary-spanning coordination (3 items) captured coordination across functional and operational boundaries, information flow across normally separated organizational interfaces, and cross-boundary problem resolution among functions and stakeholder groups.

Integrative operational capability (5 items) captured integration of resources across operational areas, rapid alignment of processes under changing requirements, combination of knowledge and expertise from different sources, reconfiguration of operational resources, and mobilization of operational capabilities toward outcomes. Operational value realization (6 items) captured consistent delivery of value supporting organizational objectives, conversion of operational resources into meaningful outcomes, measurable cross-functional benefits, joint contribution to efficiency and effectiveness, sustainment of created value over time, and realization of benefits from coordinated effort. Network coordination complexity was measured with items capturing the managerial effort required to coordinate across the network and the complexity generated by interdependence among supply chain actors. A third item concerning multi-stakeholder alignment difficulty was deleted during scale purification, leaving two retained indicators. Digital operational readiness (4 items) and institutional enabling conditions (3 items) were included as controls. Complete item wording and source attributions are provided in Appendix 1.

3.3 Exploratory and confirmatory factor analysis

Scale structure was examined first through exploratory factor analysis (EFA) and subsequently confirmed through confirmatory factor analysis (CFA). Each construct extracted a coherent factor with eigenvalues exceeding unity and variance extracted well above conventional thresholds: inclusive organizational infrastructure (eigenvalue = 14.616; variance extracted = 63.548%), internal coordination (2.818; 70.443%), inter-organizational coordination (2.022; 67.407%), boundary-spanning coordination (2.274; 75.785%), integrative operational capability (3.463; 69.254%), operational value realization (4.365; 72.752%), network coordination complexity (1.627; 81.334%), digital operational readiness (2.703; 67.586%) and institutional enabling conditions (2.201; 73.374%).

The confirmatory measurement model retained the three coordination mechanisms as distinct latent constructs. This specification is theoretically motivated - internal, inter-organizational and boundary-spanning coordination differ in their locus and in the organizational work they require - and we did not test or impose a second-order coordination factor. Reporting them as separate mechanisms preserves the ability to decompose the translation mechanism into distinct routes, which is central to the study's contribution and would be lost under aggregation. Item-level standardized regression weights and squared multiple correlations are reported in Appendix 1.

3.4 Reliability and validity

Internal consistency was assessed through Cronbach's alpha and composite reliability. Alpha coefficients ranged from .757 (inter-organizational coordination) to .974 (inclusive organizational infrastructure), with composite reliability evaluated against the same .70 criterion. The very high reliability of the inclusive infrastructure scale reflects its length and the conceptual complementarity of its three foundations. We note in the limitations that high internal consistency in a long scale can indicate item redundancy as well as construct coherence.

Following Hair et al. [65], convergent validity was evaluated through average variance extracted against the .50 criterion. Discriminant validity [66] was assessed using the Fornell-Larcker criterion [67], with the square root of each construct's average variance extracted compared against its correlations with all other constructs, and by verifying that maximum shared variance remained below average variance extracted for every construct [68]. Discriminant validity was further examined using the heterotrait-monotrait ratio of correlations, evaluated against the conservative .85 threshold [69]. Results are reported in Tables 2 and 3.

3.5 Common method diagnostics

Because all constructs were obtained from single informants through a common instrument, method variance is a legitimate concern [70, 71] and was examined through two diagnostics. The primary assessment introduced a common latent factor (CLF) connected to all 53 indicators of the measurement model and compared its fit with that of the baseline confirmatory model [70]. The baseline model fit the data adequately (χ^2 = 2,149.545, df = 1,289, χ^2/df = 1.668, CFI = .918, TLI = .912, RMSEA = .050). Adding the CLF improved chi-square significantly (χ^2 = 2,008.422, df = 1,237; $\Delta\chi^2$ = 141.123, Δdf = 52, $p < .001$), as is expected when a method factor is free to absorb any shared variance, but the change in approximate fit was negligible (ΔCFI = .008, ΔTLI = .006, ΔRMSEA = .001), below the .01 benchmark.

This result requires restrained interpretation, and we state its limitation explicitly rather than in a footnote. The negligible change in approximate fit indicates that method variance is present but not dominant; it does not establish its absence, because the comparison is sensitive to sample size and does not identify the source of the shared variance. Supplementary evidence was obtained through Harman's single-factor test, in which an unrotated solution produced nine factors with eigenvalues above unity accounting for 69.985% of variance, with the first factor accounting for 44.071% (full eigenvalue solution in Appendix 2). Harman's test is a weak diagnostic with limited sensitivity and cannot establish the absence of common method bias; it is reported as a supplementary indicator only, and no claim of demonstrated absence of method bias is made. Results appear in Table 4.

3.6 Structural equation modeling

The structural model was estimated using covariance-based structural equation modeling with maximum likelihood estimation. Covariance-based estimation was selected because the study tests a theoretically specified confirmatory architecture with reflective measurement and requires global model fit assessment and formal multi-group invariance testing - capabilities central to the research design. This departs from the variance-based estimation frequently applied in comparable sustainability and supply chain studies [57, 72], though covariance-based specifications assessed against the conventional fit indices are also applied in this literature [73]; the departure is consequential rather than stylistic: the stage-specific argument advanced here cannot be evaluated unless measurement equivalence across complexity regimes is formally established before group coefficients are compared. Model fit was evaluated using the normed chi-square (CMIN/DF), incremental fit index (IFI), comparative fit index (CFI), Tucker-Lewis index (TLI), root mean square error of approximation (RMSEA) and the associated test of close fit (PCLOSE), following established conventions [65, 74–77]. Explained variance was recorded for each endogenous construct.

Sample size adequacy warrants comment given the complexity of the estimated model. With 264 cases and a measurement model containing a large number of indicators, the ratio of cases to estimated parameters is below what would be preferred for a model of this size, particularly in the multi-group specification where the sample is further divided. We report this as a constraint on precision rather than as a barrier to estimation: the model converged to admissible solutions with no offending estimates, and approximate fit indices were satisfactory in both the pooled and multi-group specifications. Nonetheless, standard errors in the subgroup analyses are correspondingly larger, and non-significance in a subgroup should not be read as evidence of a null relationship.

The design is cross-sectional, and inference is correspondingly constrained. We report associations and consistency with the theorized architecture rather than causal effects, and use language such as "is associated with", "supports" and "provides evidence for" throughout. The directionality of the model is theoretically rather than empirically established. Alternative orderings - for example, capability enabling coordination rather than the reverse - cannot be excluded by these data.

3.7 Mediation and moderation

The translation mechanism was assessed through bootstrapped estimation of indirect effects using 5,000 subsamples with 95% bias-corrected confidence intervals (BC CI), following established practice for multiple-mediator models [78]. Rather than reporting only the aggregate indirect effect, the joint indirect effect was decomposed into its three constituent serial routes - through internal, inter-organizational and boundary-spanning coordination respectively - permitting comparison of the relative contribution of each route to the total transmitted effect. Because AMOS reports bootstrap intervals for total indirect effects but not for individual routes in a multiple-mediator model, route-specific estimates are products of the standardized path coefficients; their support rests on the bootstrap interval of the joint indirect effect together with the significance of each constituent path, and the comparison among routes is descriptive. The variance accounted for (VAF) was computed as the ratio of total indirect to total effect and interpreted against the conventional partial-mediation band.

Moderation was assessed by estimating the interaction between network coordination complexity and integrative operational capability on operational value realization. The interaction was probed through simple slopes computed at low (− 1 SD), mean and high (+ 1 SD) levels of the moderator [79], which are plotted in Fig. 2. We interpret the moderation as a change in the strength of an existing positive relationship rather than as a reversal, and we do not extrapolate the interaction beyond the observed range of the moderator.

3.8 Multi-group analysis

To examine whether the translation architecture operates differently across complexity regimes, the sample was partitioned into low and high network coordination complexity groups and a multi-group analysis was conducted. The sample was partitioned at the midpoint of the five-point network coordination complexity scale: enterprises with a mean score of 3.0 or below formed the low complexity group (n = 158, 59.8%) and those above 3.0 the high complexity group (n = 106, 40.2%). Dichotomizing a continuous moderator discards variance and the location of the cut-point affects group composition, and readers should weigh the multi-group findings accordingly. Because cross-group comparison of structural coefficients is meaningful only if the constructs are measured equivalently, a sequential invariance assessment preceded the comparison. Measurement weights were first constrained to equality and compared against the unconstrained model. Structural weights were then constrained and compared against the measurement-weights model. Invariance decisions were based on the chi-square difference test. Changes in incremental fit indices are reported alongside it, given the known sensitivity of the chi-square difference test to sample size [80, 81], and are used to indicate the practical magnitude of any non-invariance rather than to override the chi-square decision.

A conservative interpretive rule was adopted and is applied consistently in the results. The structural invariance test establishes whether the set of structural relationships differs across groups, but it does not establish that any *particular* coefficient differs. We therefore describe group-specific findings as “significant under low complexity but not under high complexity” and never as “significantly stronger in one group”, because no formal pairwise between-group difference test was conducted for individual coefficients. Differences in explained variance across groups are similarly reported descriptively.

3.9 Necessary condition analysis and bottleneck analysis

Necessary condition analysis was conducted following Dul [31] and the good-practice guidance of Dul et al. [33], with statistical significance assessed through the permutation-based test of Dul et al. [32] using 1,000 resamples; a random seed was not fixed, so exact permutation p-values may vary marginally on replication. NCA addresses a question that regression-based methods are not designed to answer. Where structural estimation identifies average incremental association across the full data space, NCA identifies whether an empty region exists in the upper-left of the scatter - that is, whether cases with low values of the condition are systematically absent from high values of the outcome - which would indicate that a minimum level of the condition constrains the maximum attainable level of the outcome.

Both the ceiling envelopment with free disposal hull (CE-FDH) and ceiling regression with free disposal hull (CR-FDH) estimators were applied, since the two make different assumptions about ceiling shape and agreement between them is the appropriate basis for a robust necessity claim. Effect sizes were interpreted using Dul’s benchmarks, under which $d < .10$ is small, $.10 \leq d < .30$ medium, $.30 \leq d < .50$ large and $d \geq .50$ very large. Statistical significance was not treated as evidence of substantive magnitude. Bottleneck analysis was then conducted for the capability-to-value relationship, expressing the minimum level of integrative operational capability required at successive target levels of operational value realization. Both axes of the bottleneck table are expressed as percentages of the observed range of the respective variables and are not Likert scale points. Ceiling diagnostics - ceiling zone, fit, ceiling accuracy, noise, exceptions, support, spread and sharpness - were examined to evaluate the credibility of the estimated ceilings.

We treat SEM and NCA as complementary analytical logics addressing different questions about the same architecture, and we state explicitly that necessary conditions identified through NCA are not sufficient conditions: the presence of a necessary condition at the required level does not guarantee the outcome, and NCA results are never interpreted as demonstrating sufficiency.

4 Results

4.1 Sample profile

Of the 264 responding enterprises, 223 (84.5%) operate in Vietnam and 41 (15.5%) in China. The sample spans the size distribution of the sector without concentrating in any single stratum. Micro-enterprises employing ten or fewer people constitute 13.3% of the sample, small enterprises of 11–50 employees 36.4%, medium enterprises of 51–250 employees 35.2%, and larger enterprises above 250 employees 15.2%. This spread matters analytically because the translation architecture presumes an organization large enough to exhibit internal differentiation. The concentration in the small-to-medium range indicates that the mechanisms under investigation are being observed in firms where coordination is a live managerial problem rather than an administratively settled one.

Ownership is dominated by private forms - limited liability companies (40.5%), private enterprises (34.5%) and joint stock companies (18.6%) - with state-owned enterprises (1.9%), cooperatives (2.7%) and other forms (1.9%) contributing marginally. Export activity is led by fishery products (47.7%), followed by fresh fruit and vegetables (21.2%), dairy (9.1%), poultry and beverages (8.0% each), rice and grains (2.7%) and other categories (3.4%). Export volume is similarly dispersed, with 51.1% of firms exporting under 500 tonnes annually and 11.0% exceeding 3,000 tonnes. Certification coverage is substantial and layered: 83.3% hold HACCP certification, 47.0% ISO 9001, 18.9% ISO 22000, 15.5% GlobalGAP, 12.5% BRC, 7.2% SFQ and 6.8% IFS, with firms frequently holding multiple certifications simultaneously. This certification density confirms that the sampled firms operate under externally audited quality regimes in which coordination failures carry documented consequences, reinforcing the appropriateness of the setting. Table 1 reports the full profile.

Table 1
Demographic and operational profile of the sampled food export enterprises (N = 264)

Characteristic	Category	n	%
Country of operation	Vietnam	223	84.5
	China	41	15.5
Number of employees	1–10 employees	35	13.3
	11–50 employees	96	36.4
	51–250 employees	93	35.2
	> 250 employees	40	15.2
Ownership structure	Limited liability company	107	40.5
	Joint stock company	49	18.6
	Private enterprise	91	34.5
	State-owned enterprise	5	1.9
	Cooperatives	7	2.7
	Others	5	1.9
Current position at the firm	Trading manager	5	1.9
	Quality control manager	80	30.3
	CEO	22	8.3
	Supply chain manager	83	31.4
	Other	74	28.0
Kind of exporting food	Fishery	126	47.7
	Poultry	21	8.0
	Dairy	24	9.1
	Fresh fruit and vegetables	56	21.2
	Drinks and beverages	21	8.0
	Rice and grains	7	2.7
	Other	9	3.4
Average exporting tonnes/year	< 500 tonnes	135	51.1
	500-1,000 tonnes	61	23.1
	1,000–2,000 tonnes	28	10.6
	2,000–3,000 tonnes	11	4.2
	> 3,000 tonnes	29	11.0
Quality and safety certifications*	HACCP	220	83.3
	ISO 9001	124	47.0
	ISO 22000	50	18.9
	GlobalGAP	41	15.5
	BRC	33	12.5

Characteristic	Category	n	%
	SFQ	19	7.2
	IFS	18	6.8

*Note: Firms may hold multiple certifications; frequencies and percentages reflect the proportion of the total sample (N = 264) holding the respective certification.

4.2 Measurement model

The confirmatory measurement model fit the data adequately (χ^2 = 2,149.545, df = 1,289, χ^2/df = 1.668, CFI = .918, TLI = .912, RMSEA = .050) and satisfies conventional psychometric requirements across all nine constructs. Composite reliability ranges from .760 for inter-organizational coordination to .974 for inclusive organizational infrastructure, and average variance extracted ranges from .514 to .674, exceeding the .50 convergent validity criterion throughout. Discriminant validity is supported under the Fornell-Larcker criterion, with the square root of each construct's average variance extracted exceeding its correlations with every other construct, and maximum shared variance remaining below average variance extracted for all constructs. The tightest margin occurs between inter-organizational coordination and operational value realization, where the correlation of .704 approaches the .717 square root of the coordination construct's average variance extracted. The second tightest separates integrative operational capability from operational value realization, where .760 approaches .785. The criterion is met in both cases, but the proximity is worth noting explicitly given that inter-organizational coordination also records the lowest average variance extracted and composite reliability in the model, and given the theoretical centrality of the capability-value pair. We return to both in the limitations.

The heterotrait-monotrait ratio analysis provides convergent evidence, with all values falling between .320 and .756 and therefore well below the conservative .85 threshold. The highest ratio, again between integrative operational capability and operational value realization at .756, remains comfortably within acceptable limits. Taken together, the two criteria indicate that the constructs are empirically distinguishable and that the three coordination mechanisms in particular - with inter-construct heterotrait-monotrait ratios of .453 (IC-BSC), .472 (IC-IOC) and .474 (IOC-BSC) - do not collapse into a single coordination dimension, supporting the decision to model them separately. Results appear in Tables 2 and 3.

Table 2
Convergent and discriminant validity (Fornell-Larcker criterion)

IOI	CR	AVE	MSV	MaxR(H)	IOI	IOCap	DOR	IC	BSC	OVR	IEC	IOC	NCC
	0.974	**0.619**	**0.544**	**0.975**	**0.787**								
IOCap	0.889	0.616	0.578	0.889	0.525	**0.785**							
DOR	0.840	0.568	0.374	0.846	0.612	0.355	**0.754**						
IC	0.862	0.612	0.436	0.880	0.660	0.490	0.608	**0.782**					
BSC	0.840	0.640	0.534	0.873	0.589	0.536	0.391	0.504	**0.800**				
OVR	0.925	0.674	0.578	0.928	0.737	0.760	0.564	0.629	0.731	**0.821**			
IEC	0.816	0.598	0.384	0.824	0.578	0.464	0.553	0.620	0.465	0.617	**0.773**		
IOC	0.760	0.514	0.496	0.765	0.616	0.602	0.453	0.471	0.484	0.704	0.411	**0.717**	
NCC	0.771	0.627	0.282	0.772	0.531	0.347	0.437	0.488	0.368	0.435	0.417	0.319	**0.792**

Notes: CR = composite reliability; AVE = average variance extracted; MSV = maximum shared variance; MaxR(H) = maximum reliability. Bold diagonal values are the square roots of AVE. All inter-construct correlations are significant at $p < .001$. IOI = inclusive organizational infrastructure; IOCap = integrative operational capability; DOR = digital operational readiness; IC = internal coordination; BSC = boundary-spanning coordination; OVR = operational value realization; IEC = institutional enabling conditions; IOC = inter-organizational coordination; NCC = network coordination complexity.

Table 3
Heterotrait-monotrait ratio (HTMT) analysis

IOI	IOI	IOCap	DOR	IC	BSC	OVR	IEC	IOC	NCC
IOCap	0.519								
DOR	0.620	0.358							
IC	0.672	0.499	0.617						
BSC	0.559	0.536	0.335	0.453					
OVR	0.738	0.756	0.565	0.639	0.698				
IEC	0.569	0.460	0.540	0.607	0.410	0.602			
IOC	0.614	0.613	0.459	0.472	0.474	0.709	0.405		
NCC	0.530	0.347	0.429	0.483	0.330	0.431	0.405	0.320	
Notes: All HTMT values fall below the conservative .85 threshold, ranging from .320 to .756.									

The common latent factor comparison reported in Table 4 shows that adding a method factor to the measurement model changed approximate fit negligibly (ΔCFI = .008, ΔTLI = .006, ΔRMSEA = .001), although the chi-square difference is significant ($\Delta\chi^2 = 141.123$, $\Delta df = 52$, $p < .001$). The defensible reading is that method variance is present but not dominant. The supplementary Harman's single-factor analysis yielded a first factor accounting for 44.071% of variance within a nine-factor solution explaining 69.985% in total; the full eigenvalue solution is reported in Appendix 2. Consistent with the well-documented insensitivity of this diagnostic, we report it as supplementary evidence and make no claim that common method bias has been ruled out.

Table 4
Assessment of common method bias (common latent factor comparison)

Model	χ^2	df	χ^2/df	CFI	TLI	RMSEA
Baseline measurement model	2,149.545	1,289	1.668	.918	.912	.050
Common latent factor model	2,008.422	1,237	1.624	.926	.918	.049
Difference	$\Delta\chi^2 = 141.123$	$\Delta df = 52$	0.044	ΔCFI = .008	ΔTLI = .006	ΔRMSEA = .001
Notes: The common latent factor was connected to all 53 indicators. $\Delta\chi^2$ is significant ($p < .001$) but the changes in approximate fit indices fall below the .01 benchmark, indicating that method variance is present but not dominant; the comparison does not establish its absence. Harman's single-factor test (Appendix 2): first factor = 44.071% of variance; nine factors with eigenvalues > 1 explaining 69.985% cumulatively.						

4.3 Structural model

The structural model achieves satisfactory approximate fit (CMIN/DF = 1.604; IFI = .923; CFI = .922; TLI = .917; RMSEA = .048; PCLOSE = .818). The normed chi-square falls well within the conventional band, the RMSEA point estimate sits below the .05 close-fit criterion, and the non-significant PCLOSE test indicates that the hypothesis of close fit cannot be rejected. The incremental indices sit marginally above .90 rather than above .95, which is consistent with a model of this complexity estimated on a sample of 264, and we treat the fit as adequate rather than excellent.

The results provide strong evidence that inclusive organizational infrastructure operates first upon the organization's coordination architecture. Infrastructure is positively associated with internal coordination ($\beta = .662$, $p < .001$), inter-organizational coordination ($\beta = .611$, $p < .001$) and boundary-spanning coordination ($\beta = .588$, $p < .001$), supporting H1a, H1b and H1c. The comparable magnitude of the three coefficients indicates that inclusive infrastructure activates coordination across all three loci rather than exerting its influence predominantly within the firm, and the explained variance in the three coordination constructs ($R^2 = .439$, .373 and .345 respectively) confirms that infrastructure accounts for a substantial share of variation in how the organization coordinates.

The second stage reveals a more differentiated pattern. All three coordination mechanisms are positively associated with integrative operational capability, supporting H2a, H2b and H2c, but their magnitudes diverge markedly. Inter-organizational coordination carries the strongest association (β = .395, p < .001), followed closely by boundary-spanning coordination (β = .373, p < .001), while internal coordination contributes an association that is statistically supported but substantially smaller (β = .153, p = .023). Together the three mechanisms account for 51.8% of the variance in integrative operational capability. Capability in turn is strongly associated with operational value realization (β = .578, p < .001), supporting H3, and inclusive infrastructure retains a direct association with operational value realization (β = .364, p < .001), supporting H4. The model accounts for 81.2% of the variance in operational value realization.

Both controls attain significance in the full-sample model. Digital operational readiness (β = .121, p = .023) and institutional enabling conditions (β = .088, p = .033) are positively associated with operational value realization, with magnitudes considerably smaller than those of the focal constructs. Their inclusion means that the estimated associations for inclusive infrastructure and integrative capability are net of technological capacity and supportive external environment. Full results appear in Table 5.

Table 5
Structural model and hypothesis testing results

Hypothesis / path	β	p	Decision
Direct paths			
H1a: Inclusive Organizational Infrastructure → Internal Coordination	.662	< .001	Supported
H1b: Inclusive Organizational Infrastructure → Inter-organizational Coordination	.611	< .001	Supported
H1c: Inclusive Organizational Infrastructure → Boundary-spanning Coordination	.588	< .001	Supported
H2a: Internal Coordination → Integrative Operational Capability	.153	.023	Supported
H2b: Inter-organizational Coordination → Integrative Operational Capability	.395	< .001	Supported
H2c: Boundary-spanning Coordination → Integrative Operational Capability	.373	< .001	Supported
H3: Integrative Operational Capability → Operational Value Realization	.578	< .001	Supported
H4: Inclusive Organizational Infrastructure → Operational Value Realization	.364	< .001	Supported
Indirect path			
H5: IOI → [IC, IOC, BSC] → IOCap → OVR	.325	-	Supported (Table 6)
Moderating effect			
H6: Network Coordination Complexity × IOCap → OVR	−.113	.002	Supported
Control effects			
Digital Operational Readiness → OVR	.121	.023	Supported
Institutional Enabling Conditions → OVR	.088	.033	Supported
Explained variance (R^2)			
Internal Coordination	.439		
Inter-organizational Coordination	.373		
Boundary-spanning Coordination	.345		
Integrative Operational Capability	.518		
Operational Value Realization	.812		

Notes: β = standardized path coefficient. Model fit: CMIN/DF = 1.604; IFI = .923; CFI = .922; TLI = .917; RMSEA = .048; PCLOSE = .818. The joint indirect effect for H5 is estimated through bootstrapping with 5,000 subsamples and 95% bias-corrected confidence intervals (β = .325, 95% BC CI [.241, .417], p < .001) and is decomposed in Table 6.

Two observations about the pattern of coefficients merit statement before turning to the mediated architecture. First, the near-uniformity of the three infrastructure-to-coordination coefficients contrasts sharply with the dispersion of the three coordination-to-capability coefficients, indicating that the model's differentiation arises at the second stage rather than the first. Second, the explained variance in operational value realization is high at .812, and while this reflects the joint contribution of capability, infrastructure and two controls, values of this magnitude in cross-sectional self-report designs warrant interpretive caution: conceptual proximity between the capability and value constructs, together with shared method variance, may contribute to the observed magnitude. We do not treat the explained variance as an independent indicator of model quality.

4.4 Translation mechanism and mediation

The decomposition of the total relationship between inclusive infrastructure and operational value realization, reported in Table 6, provides the study's central empirical evidence. The standardized total effect is .689 (95% BC CI [.574, .786]). Of this, .364 (52.8%;

95% BC CI [.242, .482]) is realized directly, while .325 (47.2%; 95% BC CI [.241, .417], p < .001) is transmitted through the coordination and capability architecture. The variance accounted for therefore falls squarely within the conventional partial-mediation band, supporting H5. The substantive statement is not that mediation was detected but that almost half of the relationship between inclusive infrastructure and realized operational value passes through an identifiable organizational conversion process.

Disaggregating the joint indirect effect into its constituent serial routes reveals that the transmission is markedly uneven. The inter-organizational route (IOI → IOC → IOCap → OVR) carries .1395, representing 20.2% of the total effect. The boundary-spanning route (IOI → BSC → IOCap → OVR) carries .1267, or 18.4%. The internal coordination route (IOI → IC → IOCap → OVR) carries only .0585, or 8.5% - less than half the magnitude of either externally oriented route. Because inclusive infrastructure activates the three coordination mechanisms at broadly comparable strength, this asymmetry originates almost entirely in the second stage, where internal coordination converts into integrative capability far less efficiently than its inter-organizational and boundary-spanning counterparts. The transmission of inclusive infrastructure into operational value is therefore accomplished predominantly across organizational boundaries rather than within them.

Table 6
Decomposition of the translation mechanism from inclusive infrastructure to operational value

Path / relationship	Standardized effect (β)	Bootstrap 95% BC CI	Bootstrap p	% of total effect
Total effect (IOI → OVR)	0.689	[.574, .786]	< .001	100%
Direct effect (IOI → OVR)	0.364	[.242, .482]	< .001	52.8%
Total joint indirect effect (IOI → [IC, IOC, BSC] → IOCap → OVR)	0.325	[.241, .417]	< .001	47.2%
Decomposition of the joint indirect effect				
Route 1: IOI → IC → IOCap → OVR	0.662 × 0.153 × 0.578 = 0.0585	–	–	8.5%
Route 2: IOI → IOC → IOCap → OVR	0.611 × 0.395 × 0.578 = 0.1395	–	–	20.2%
Route 3: IOI → BSC → IOCap → OVR	0.588 × 0.373 × 0.578 = 0.1267	–	–	18.4%
Mediation conclusion	Partial mediation supported (H5)			

Notes: Total effect = direct effect + total indirect effect. VAF = total indirect / total effect = 47.2%, within the [.20, .80] partial-mediation band. Confidence intervals and p-values for the total, direct and joint indirect effects are derived from 5,000 bootstrap subsamples with 95% bias-corrected intervals. Route-specific effects are products of standardized path coefficients; AMOS does not provide bootstrap intervals for individual routes in a multiple-mediator model, so the route comparison is descriptive (Section 3.7).

One interpretive constraint applies to the comparison of route magnitudes. The three indirect routes were compared descriptively on the basis of their point estimates and their shares of the total effect. No formal test of the equality of indirect effects was conducted. The observed ordering - inter-organizational, then boundary-spanning, then internal - is therefore reported as the pattern in these estimates rather than as a statistically established ranking, and the substantive claim rests on the magnitude of the difference between the internal route and the two external routes rather than on the narrower separation between the latter two.

4.5 Moderating effect of network coordination complexity

The interaction between network coordination complexity and integrative operational capability on operational value realization is negative and statistically significant (β = −.113, p = .002), supporting H6. The simple slopes plotted in Fig. 2 quantify the attenuation: the capability-to-value slope is .691 at one standard deviation below the mean of complexity, .578 at the mean, and .465 at one standard deviation above. The relationship therefore remains positive and substantial across the observed range of the moderator. Complexity compresses the rate at which capability is converted into realized value without reversing or nullifying the conversion. We note that an interaction of this magnitude, while statistically robust, accounts for a modest share of variation, and we do not extrapolate the pattern beyond the range of complexity observed in these data.

4.6 Measurement invariance and multi-group analysis

Before comparing the translation architecture across complexity regimes, measurement equivalence was established. Constraining measurement weights to equality across the low and high network coordination complexity groups produced no significant deterioration in fit relative to the unconstrained model ($\Delta\chi^2 = 49.554$, $\Delta df = 41$, $p = .169$), with negligible changes in incremental indices ($\Delta NFI = .004$, $\Delta IFI = .005$, $\Delta RFI = -.001$, $\Delta TLI = -.002$). Metric invariance therefore holds: the constructs are operationalized comparably in both groups, and cross-group comparison is defensible.

Constraining structural weights, by contrast, produced a significant deterioration relative to the measurement-weights model ($\Delta\chi^2 = 41.288$, $\Delta df = 14$, $p < .001$). The structural relationships are therefore not invariant across complexity regimes. This decision rests on the chi-square difference test. The accompanying changes in incremental fit indices are small ($\Delta NFI = .003$, $\Delta IFI = .004$) and fall below the .01 benchmark commonly applied to such changes [81], so the structural heterogeneity is statistically detectable but modest in practical magnitude, and the group-specific findings below are interpreted with that qualification. This establishes structural heterogeneity at the level of the system of relationships, but it does not identify which individual coefficients differ, and no such claim is made. Successive comparisons for structural covariances and structural residuals were likewise significant, reinforcing the presence of group-level structural heterogeneity. Results appear in Table 7.

Table 7
Measurement and structural invariance across low and high network coordination complexity groups

Nested model comparison	Δdf	Δχ²	p	ΔNFI	ΔIFI	ΔRFI	ΔTLI	Decision
Measurement weights vs. unconstrained	41	49.554	.169	.004	.005	−.001	−.002	Measurement weights invariant
Structural weights vs. measurement weights	14	41.288	< .001	.003	.004	.001	.002	Structural weights noninvariant
Structural covariances vs. structural weights	7	37.865	< .001	.003	.004	.002	.003	Noninvariant
Structural residuals vs. structural covariances	8	22.730	.004	.002	.002	.001	.001	Noninvariant
Measurement residuals vs. structural residuals	65	327.970	< .001	.025	.032	.017	.022	Noninvariant

Notes: Measurement weights constrain factor loadings; structural weights additionally constrain structural regression paths. Invariance decisions follow $\Delta\chi^2$, and changes in incremental fit indices are reported alongside it to indicate the practical magnitude of any non-invariance, because the chi-square difference test is sensitive to sample size. Each row compares a model in which one additional set of parameters is constrained to equality across groups against the immediately preceding, less constrained model. Δdf is the number of parameters so constrained; a non-significant $\Delta\chi^2$ indicates that those constraints do not worsen fit, and therefore that the parameters concerned may be treated as equivalent across the two groups.

The multi-group results reported in Table 8 show that the first stage of the translation architecture remains operative under both complexity regimes. Inclusive infrastructure is significantly associated with all three coordination mechanisms in both groups: internal coordination (low $\beta = .651$, $p < .001$; high $\beta = .571$, $p < .001$), inter-organizational coordination (low $\beta = .659$, $p < .001$; high $\beta = .437$, $p < .001$) and boundary-spanning coordination (low $\beta = .682$, $p < .001$; high $\beta = .224$, $p = .041$). Coordination activation is thus preserved under complexity, although the coefficients are smaller in the high complexity group and the reduction is most pronounced for boundary-spanning coordination.

The second stage presents a categorically different pattern. Under low complexity, the two externally oriented coordination mechanisms are significantly associated with integrative operational capability (IOC $\beta = .380$, $p < .001$; BSC $\beta = .442$, $p < .001$), whereas internal coordination is not (IC $\beta = .129$, $p = .118$). Under high complexity, none of the three reaches conventional significance: internal coordination $\beta = .061$ ($p = .620$), inter-organizational coordination $\beta = .273$ ($p = .070$) and boundary-spanning coordination $\beta = .170$ ($p = .176$). Consistent with the interpretive rule adopted in the methodology, we describe the inter-organizational and boundary-spanning relationships as significant under low complexity and not significant under high complexity, and the internal coordination relationship as not significant in either group; its full-sample association ($\beta = .153$, $p = .023$) was already the weakest of the three and does not survive the loss of power that subgroup estimation entails. We do not assert that the coefficients differ significantly between groups, as no formal pairwise contrast was conducted. The explained variance in integrative operational capability falls from .600 in the low complexity group to .127 in the high complexity group, and the explained variance in boundary-spanning coordination from .465 to .050.

Two relationships persist under high complexity. Integrative capability remains significantly associated with operational value realization in both groups (low β = .555, p < .001; high β = .335, p = .026), indicating that capability, where it exists, retains its value-generating function. Inclusive infrastructure remains directly associated with operational value realization in both groups, with a numerically larger coefficient under high complexity (low β = .355, p < .001; high β = .519, p = .017). The interaction term is negative and significant within the low complexity group (β = −.135, p = .003) and positive but non-significant within the high complexity group (β = .082, p = .340). Given that the grouping variable is itself the moderator, within-group variance in complexity is restricted and this within-group interaction should be interpreted with corresponding caution. Among controls, digital operational readiness is not significant in either group (low β = .131, p = .086; high β = .120, p = .292), while institutional enabling conditions are significant under low complexity (β = .121, p = .019) but not under high complexity (β = .045, p = .634). Explained variance in operational value realization declines from .831 to .420.

Table 8
Multi-group analysis of coordination and capability building under low and high network coordination complexity

H	Structural path	Low NCC β	Low p	High NCC β	High p	Interpretation
H1a	IOI → IC	.651	< .001	.571	< .001	Significant in both groups
H1b	IOI → IOC	.659	< .001	.437	< .001	Significant in both groups
H1c	IOI → BSC	.682	< .001	.224	.041	Significant in both groups
H2a	IC → IOCap	.129	.118	.061	.620	Not significant in either group
H2b	IOC → IOCap	.380	< .001	.273	.070	Significant only under low NCC
H2c	BSC → IOCap	.442	< .001	.170	.176	Significant only under low NCC
H3	IOCap → OVR	.555	< .001	.335	.026	Significant in both groups
H4	IOI → OVR	.355	< .001	.519	.017	Significant in both groups
H6	NCC × IOCap → OVR	−.135	.003	.082	.340	Significant only under low NCC
Ctrl	DOR → OVR	.131	.086	.120	.292	Not significant in either group
Ctrl	IEC → OVR	.121	.019	.045	.634	Significant only under low NCC
Explained variance (R^2) by group						
	Internal Coordination	.424		.325		
	Inter-organizational Coordination	.434		.191		
	Boundary-spanning Coordination	.465		.050		
	Integrative Operational Capability	.600		.127		
	Operational Value Realization	.831		.420		

Notes: Multi-group model fit - unconstrained: χ^2 = 4,370.791, df = 2,700, χ^2/df = 1.619, RMSEA = .049, PCLOSE = .809; measurement weights: χ^2 = 4,420.345, df = 2,741, χ^2/df = 1.613, RMSEA = .048, PCLOSE = .849; structural weights: χ^2 = 4,461.633, df = 2,755, χ^2/df = 1.619, RMSEA = .049, PCLOSE = .807. Differences in coefficient magnitude between groups are descriptive; no formal pairwise between-group difference test was conducted for individual coefficients.

Taken as a set, the multi-group results identify a single stage at which the architecture ceases to function rather than a uniform weakening across the model. Coordination activation is significant under both regimes. Capability-to-value conversion is significant under both regimes. The direct infrastructure-to-value relationship is significant under both regimes. Only the coordination-to-

capability stage is significant in one regime and not in the other - for the inter-organizational and boundary-spanning mechanisms, which carry most of the transmitted effect in the full sample - and it is at that stage that the decline in explained variance is most severe. The reduction in explained variance at the outcome level under high complexity is therefore consistent with an upstream failure to build capability rather than with a failure of capability to generate value. Two further points constrain interpretation: subgroup estimation reduces statistical power, so non-significance under high complexity is partly a power phenomenon, and the midpoint split, while transparent, discards within-group variance in complexity, so group comparability rests on the metric invariance established above.

4.7 Necessary condition and bottleneck analysis

The necessary condition analysis reported in Table 9 identifies a differentiated architecture of prerequisites underlying the associations estimated above. In the full sample, inclusive organizational infrastructure is a statistically significant necessary condition for both integrative operational capability (CE-FDH d = .14, p = .001; CR-FDH d = .15, p = .001) and operational value realization (CE-FDH d = .11, p = .001; CR-FDH d = .11, p = .001). Both effects fall in the medium band under Dul's benchmarks and are consistent across estimators. Integrative operational capability is likewise a significant necessary condition for operational value realization (CE-FDH d = .13, p = .018; CR-FDH d = .09, p = .040), medium under the first estimator and small under the second.

Among the coordination mechanisms, inter-organizational coordination is a statistically supported but small necessary condition for integrative capability (CE-FDH d = .08, p = .007; CR-FDH d = .06, p = .009). Both effect sizes fall below the .10 threshold and the condition should not be described as substantively strong. Internal coordination is estimator-sensitive at the full-sample level, significant under CE-FDH (d = .06, p = .042) but not under CR-FDH (d = .04, p = .082), and is therefore not established as a robust necessary condition. Boundary-spanning coordination is not a necessary condition under either estimator (d = .08, p = .407; d = .04, p = .579), notwithstanding its substantial association with capability in the structural model.

The group-specific analyses reveal that the necessity architecture is itself contingent on complexity. Under low complexity, internal coordination becomes a significant necessary condition under both estimators (d = .07, p = .021; d = .05, p = .038), inter-organizational coordination strengthens to medium magnitude under CE-FDH (d = .11, p = .001; CR-FDH d = .09, p = .002), and the capability-to-value relationship produces the strongest necessity evidence in the study (CE-FDH d = .22, p = .001; CR-FDH d = .14, p = .006). Boundary-spanning coordination remains non-necessary even in this group. Under high complexity, none of the three coordination mechanisms is a significant necessary condition for capability (all p > .65), and the capability-to-value relationship becomes estimator-inconsistent, non-significant under CE-FDH (d = .09, p = .379) but significant under CR-FDH (d = .14, p = .015). The evidence is insufficient to claim robust necessity in this group. In all cases, necessity is reported as necessity and not as sufficiency: no result implies that attaining the identified level of a condition guarantees the outcome.

The relationship between the two analytical logics is worth stating precisely at this point, because their divergences are substantive rather than contradictory. Boundary-spanning coordination carries one of the largest structural associations with integrative capability while failing to register as a necessary condition under either estimator, in the full sample or in either group. This combination is coherent: a mechanism can contribute substantially to an outcome on average while being dispensable, because alternative mechanisms can supply the same minimum. Conversely, the small structural coefficient for internal coordination, which is not significant within the low complexity group, coexists with significant necessity evidence under low complexity, indicating that a mechanism can be a modest average contributor while still functioning as a floor. Neither pattern would be detectable using either method alone.

Table 9
Necessary condition analysis results

Relationship	CE-FDH d (p)	CR-FDH d (p)	Conclusion
Full sample			
IC → IOCap	.06 (.042)	.04 (.082)	Weak; estimator-sensitive
IOC → IOCap	.08 (.007)	.06 (.009)	Statistically supported but small necessary condition
BSC → IOCap	.08 (.407)	.04 (.579)	Not necessary
IOI → IOCap	.14 (.001)	.15 (.001)	Necessary condition (medium)
IOCap → OVR	.13 (.018)	.09 (.040)	Necessary condition (medium / small)
IOI → OVR	.11 (.001)	.11 (.001)	Necessary condition (medium)
Low network coordination complexity			
IC → IOCap	.07 (.021)	.05 (.038)	Necessary condition (small)
IOC → IOCap	.11 (.001)	.09 (.002)	Necessary condition (medium / small)
BSC → IOCap	.13 (.384)	.07 (.585)	Not necessary
IOCap → OVR	.22 (.001)	.14 (.006)	Strongest necessity evidence in the study (medium)
High network coordination complexity			
IC → IOCap	.03 (.730)	.01 (.738)	Not necessary
IOC → IOCap	.06 (.676)	.03 (.757)	Not necessary
BSC → IOCap	.10 (.653)	.07 (.567)	Not necessary
IOCap → OVR	.09 (.379)	.14 (.015)	Estimator-sensitive; insufficient evidence for robust necessity

Notes: Effect sizes interpreted using Dul's benchmarks - d < .10 small; .10 ≤ d < .30 medium; .30 ≤ d < .50 large; d ≥ .50 very large. Significance assessed by permutation test [32]. Necessary conditions are not sufficient conditions.

The bottleneck analysis in Table 10 translates the capability-to-value necessity into operational terms. Under CE-FDH, no minimum level of integrative capability is identified for target levels of operational value realization from 0% to 50% of the observed range. From 60% through 90%, a minimum of 25.0% of the observed capability range is required, rising to 55.0% at the maximum target level. The CR-FDH estimator produces a more gradual profile: no bottleneck up to 60%, then a requirement rising from 10.1% at the 70% target to 22.5% at 80%, 35.0% at 90% and 47.4% at 100%. Both axes express percentages of observed ranges rather than Likert scale points, and the values should not be read as absolute scale scores. The consistent implication across estimators is that necessity is degree-dependent: the minimum capability requirement is not fixed but rises with the level of operational value the organization seeks to attain.

Table 10
Bottleneck analysis of integrative operational capability for operational value realization

Target level of OVR (% of observed range)	Minimum IOCap required - CE-FDH (%)	Minimum IOCap required - CR-FDH (%)
0	NN	NN
10	NN	NN
20	NN	NN
30	NN	NN
40	NN	NN
50	NN	NN
60	25.0	NN
70	25.0	10.1
80	25.0	22.5
90	25.0	35.0
100	55.0	47.4

Notes: NN = not necessary (no bottleneck detected at this target level).

Ceiling diagnostics for the capability-to-value relationship, reported in Table 11, support the credibility of the estimated ceilings. Under CE-FDH the ceiling zone is 1.867 with 100% fit, 100% ceiling accuracy, zero noise and no exceptions. Under CR-FDH the ceiling zone is 1.325 with 71.0% fit, 99.6% ceiling accuracy, zero noise, one exception and sharpness of 1.00. Permutation tests are significant under both estimators (p = .018 and p = .040), with p-accuracy of .010 and .012 respectively. Figure 3 displays the permutation distribution for the CE-FDH estimate, in which the observed effect size of .13 lies above the .11 threshold corresponding to the .05 significance level across 1,000 replications. Figure 4 presents the scatter with both ceiling lines and the empty upper-left region that constitutes the empirical basis of the necessity claim. Support values of 9.1% and 8.7% indicate that the ceilings are estimated from a limited number of ceiling cases, and this should temper confidence in the precise location of the ceiling even where accuracy is high.

Table 11
Diagnostic indicators for the NCA ceiling estimates (IOCap → OVR)

Diagnostic indicator	CE-FDH	CR-FDH
Ceiling zone	1.867	1.325
Effect size (d)	0.127	0.090
Slope	-	0.737
Intercept	-	2.865
p-value	.018	.040
p-accuracy	.010	.012
Complexity	3	1
Fit	100.0%	71.0%
Ceiling accuracy	100.0%	99.6%
Noise	0.0%	0.0%
Exceptions	0	1
Support	9.1%	8.7%
Spread	0.35	0.28
Sharpness	-	1.00

Notes: Distribution of permuted effect sizes across 1,000 replications for the CE-FDH estimator. The observed effect size (d = .13) exceeds the threshold value (d = .11) corresponding to p = .05.

5 Discussion

5.1 The operational business case for inclusion

The most consequential implication of these findings is that the business case for inclusion in operations has been argued at the wrong level of specification. When inclusion is defended by asserting a direct empirical association with performance, the defense stands or falls on the magnitude and replicability of a single coefficient - and the diversity literature has shown that this coefficient is unstable across contexts, samples and operationalizations [14, 15]. The instability is not a defect to be corrected by better measurement; it is the empirical signature of a mechanism-dependent relationship being modeled as if it were mechanism-free. What these results indicate is that inclusive infrastructure is related to operational value through an identifiable conversion process, and that roughly half of the relationship passes through it. This reframing changes what the business case has to establish. It no longer requires that inclusion always pays; it requires that the organization possesses the conversion machinery through which inclusion can pay.

This directly addresses the state of the debate documented by Son et al. [1] and the conceptual gap identified by Prashar [2]. Both observe that DEI has been absorbed into OSCM discourse without operational specification. The present findings supply that specification in a form that is both testable and falsifiable: inclusive infrastructure should be associated with operational value where coordination mechanisms convert it into integrative capability, and the association should attenuate at the conversion stage where those mechanisms cannot stabilize. A study finding no relationship between inclusion and operational outcomes would, under this account, be interpreted not as evidence against the business case but as evidence about the state of the conversion architecture in that setting - a claim that can itself be tested rather than asserted.

The theoretical grounding of this reframing is Roberson et al. [17], whose central move was to insist that diversity be positioned as a resource acted upon by capabilities rather than as a proximate determinant of performance. Our contribution is to render that argument operationally concrete within OSCM. Where Roberson and colleagues argue for a capability layer in general terms, these results identify which capabilities, at which loci, transmit how much, and under what network conditions the transmission survives.

5.2 Coordination as the missing translation mechanism

The pattern of the mediation decomposition is theoretically more informative than the mediation result itself, and its interpretation turns on a structural asymmetry within the two-stage architecture. Inclusive infrastructure activates all three coordination mechanisms at broadly comparable strength. The divergence among the three routes therefore does not originate in differential activation. It originates entirely at the second stage, where the three mechanisms convert into integrative capability at markedly different rates. The externally oriented and cross-boundary routes together transmit close to four-fifths of the mediated relationship, while internal coordination transmits less than a tenth of the total.

This asymmetry has a coherent theoretical reading. Internal coordination operates in a domain where much of the necessary alignment is already accomplished administratively: reporting lines, standard procedures and functional authority resolve a substantial portion of internal interdependence without requiring integrative work. Its association with capability is real but modest because it is partly substitutable by structure. Inter-organizational coordination, by contrast, cannot be resolved administratively. It requires the reconciliation of heterogeneous systems, incentive structures and information conventions across firms where no common authority exists, and this reconciliation is inherently recombinative. This is the relational locus of advantage identified by Dyer and Singh [25], and the accumulation process Vanpoucke et al. [26] demonstrate empirically.

The finding also carries a corrective for how DEI is typically operationalized in supply chain settings. Inclusion initiatives are overwhelmingly internally directed - recruitment, promotion, training, internal culture - and their expected operational return is implicitly internal. These results suggest that this expectation is misdirected. The distinctive operational return to inclusive infrastructure in a networked setting is realized at the organization’s boundaries, where the interpretive flexibility that inclusive infrastructure cultivates is most scarce and most valuable. Notably, this does not imply that internal inclusion work is unproductive. Internal coordination remains significantly associated with capability, and the necessity analysis under low complexity identifies it as a prerequisite. The claim is about where the marginal operational value is realized, not about where the infrastructure must be built.

A further implication concerns construct aggregation. Had the three mechanisms been modeled as indicators of a higher-order coordination construct, the asymmetry that constitutes the central finding would have been invisible. The aggregate mediated effect would have been reported and the differential conversion rates would have been averaged away. This is a methodological point with theoretical weight: in translation architectures, the identity of the transmitting mechanism is part of the theoretical claim, and aggregation destroys it. The decomposition is not itself a methodological novelty - comparing constituent indirect paths is standard practice in multiple-mediator estimation [78] - but sustainability research that models mediating mechanisms has generally reported the aggregate mediated effect rather than the relative contribution of competing routes [57, 72, 82]. Integration itself is usually treated the same way: in agricultural export processing the association between supply chain integration and operational performance is reported as a single aggregate coefficient ($\beta = .547$ in Ghanaian cocoa processing [83]), a specification in which the internal and external components are combined into one predictor. What the decomposition earns is the finding that transmission runs predominantly across organizational boundaries rather than within them.

5.3 From coordination to capability

The results support a distinction that operations research frequently elides: coordination and capability are not the same construct at different intensities. Coordination is episodic activity. Integrative capability is a persistent organizational competence. The model’s structure - coordination as antecedent, capability as pivot, value as outcome - encodes the claim that coordination generates value only insofar as it accumulates into competence, and the empirical pattern is consistent with that claim. Capability carries the strongest single association in the model with realized value, and the coordination mechanisms operate on value only through it.

This positions integrative operational capability as the theoretical fulcrum of the architecture, and connects it directly to the transforming microfoundation identified by Teece [24]. The capability construct as operationalized here - combining resources across operational areas, realigning processes under changing requirements, synthesizing heterogeneous knowledge, reconfiguring resources against emerging challenges - is a rendering of orchestration at the operational level of analysis. Liu et al. [27] demonstrate that integration and competency operate configurationally rather than additively in producing such competence, and the present findings are consistent with that view: capability emerges from the joint operation of multiple coordination mechanisms rather than from the intensification of any one.

The stage distinction also clarifies why coordination-focused interventions frequently disappoint. Organizations that invest in coordination without attending to whether coordination episodes can be learned from - whether they recur, whether they involve stable counterparties, whether the knowledge they generate is captured - are investing in activity that dissipates. The capability stage is where coordination becomes an asset rather than an expense, and it is the stage at which the results indicate the architecture is most vulnerable.

A related implication concerns how the field should read null and weak findings in DEI-OSCM research. Under a translation-architecture account, a weak association between inclusion and operational outcomes is not by itself informative, because it is consistent with at least three distinct organizational conditions: infrastructure that has not been built, infrastructure that has been built but is not converting into coordination, or coordination that is occurring but is not crystallizing into capability. These conditions call for entirely different responses, and a design that measures only inclusion and outcomes cannot distinguish among them. This is, we suggest, a substantial part of why the literature has accumulated an inconsistent record without converging: the studies have been measuring the endpoints of a process whose intermediate states carry the explanatory content.

5.4 Network complexity and the breakdown of capability building

The multi-group evidence provides the study's most theoretically distinctive contribution, and its value lies in the specificity of what breaks. Complexity does not disable the translation architecture globally. Inclusive infrastructure continues to activate all three coordination mechanisms under high complexity. Coordination does not disappear. Nor does complexity render capability irrelevant: where integrative capability exists under high complexity, it remains significantly associated with realized value. What is not significant under high complexity is the conversion of coordination into capability - the stage at which activity would become competence. The breakdown is carried by the two externally oriented mechanisms; internal coordination, the weakest converter in the full sample, is not significant in either subgroup, so the multi-group evidence speaks to the inter-organizational and boundary-spanning routes rather than to the internal one.

This has a clear theoretical rationale grounded in how capabilities are formed. Capability construction requires that activity be repeated under sufficiently stable conditions for transferable routines to be abstracted from it. Under high network coordination complexity, coordination episodes become partner-specific, contingent and non-recurring. The organization expends coordination effort continuously but accumulates little that generalizes. Coordination becomes maintenance rather than learning. The collapse in explained variance at the capability stage under high complexity is consistent with this reading: it is not merely that coefficients shrink, but that the coordination mechanisms cease to account for the emergence of capability at all, suggesting that under complexity the determinants of capability lie substantially outside the coordination architecture the model specifies.

Interpretive discipline is required here, and we impose it explicitly. The invariance testing establishes that the structural system differs across complexity regimes, but it does not establish that any particular coefficient differs significantly between groups, and we have not conducted formal pairwise contrasts. The defensible statement is that the inter-organizational and boundary-spanning coordination-to-capability relationships are significant under low complexity and are not significant under high complexity, while the internal relationship is not significant in either group. That statement is sufficient to support the theoretical argument, because the argument concerns the presence or absence of a functioning conversion stage rather than the precise magnitude of its attenuation. We also note that the within-group interaction estimates for H6 are affected by restricted variance in the grouping variable and should not be read as independent evidence about the moderation.

Read alongside the full-sample moderation result, a coherent two-level account emerges. At the capability-to-value stage, complexity operates as a graded friction: the relationship persists but its slope compresses as complexity rises. At the coordination-to-capability stage, complexity operates as a disruption: the relationship does not merely weaken but ceases to be detectable. The friction is not uniform across the architecture, and the distinction between graded attenuation and stage disruption is what the analysis is designed to reveal.

5.5 Compressed capability translation

The configuration observed under high complexity - coordination active, conversion to capability impaired, direct infrastructure-to-value relationship intact and numerically prominent - warrants a name, and we propose *compressed capability translation*. The term denotes a state in which inclusive organizational infrastructure continues to generate operational value while the mediated route

through which that value would ordinarily be amplified and made durable is constricted. Value continues to flow, but through a shortened path.

Several mechanisms could plausibly sustain the direct relationship under complexity. Inclusive infrastructure may reduce turnover among the experienced personnel on whom complex coordination disproportionately depends, preserving operational continuity that would otherwise be lost. It may improve the detection and escalation of problems at the point of work, which is more valuable precisely where network conditions make problems harder to anticipate centrally. It may confer legitimacy with buyers and certification bodies whose requirements are themselves a source of complexity. And the psychological safety component may support the local improvisation that complex environments demand - improvisation that resolves immediate problems without generating transferable routines. Each of these routes produces value without passing through the coordination-to-capability stage. We advance them as plausible interpretations consistent with the observed pattern rather than as tested mechanisms. The data do not adjudicate among them.

The concept carries a warning that is easily missed. Compressed translation is not equivalent functional performance achieved by a different route. The mediated pathway is what converts inclusion into a durable capability asset. The direct pathway delivers contemporaneous value without building the competence that would sustain it. An organization operating under compressed translation may therefore appear to be realizing the benefits of inclusion while accumulating no capability stock - a condition that is invisible in cross-sectional performance data and would become apparent only when conditions change and the absent capability is required. This makes compressed translation a diagnostic construct as much as a descriptive one: it identifies a configuration that looks healthy in outcome terms while being structurally impaired.

Framed against the sustainability orientation of this collection, the implication is pointed. Operational value that is generated directly but not accumulated as capability is value that is unlikely to be sustained. The outcome construct used here explicitly includes sustainment over time, and compressed translation identifies the mechanism by which sustainment is placed at risk even while current value realization appears intact.

5.6 What NCA reveals beyond SEM

The necessary condition analysis contributes findings that the structural model could not have produced, and the divergences between the two are more informative than the agreements. The clearest instance is boundary-spanning coordination, which carries one of the strongest associations with integrative capability in the structural model yet is not a necessary condition for it under either estimator. These results are not contradictory, and they answer different questions. Boundary-spanning coordination contributes substantially to capability on average, but organizations can evidently reach the required level of capability through alternative coordination configurations without it. It is a productive mechanism, not an indispensable one.

The converse pattern appears for inclusive infrastructure, which emerges as a significant necessary condition for both capability and value at medium effect size and with consistency across estimators. This is the strongest available form of evidence for the study's central theoretical claim. Association evidence establishes that more inclusive infrastructure is related to more operational value. Necessity evidence establishes something more restrictive - that organizations below a minimum level of inclusive infrastructure are systematically absent from the upper range of both capability and value. Inclusion functions as a floor condition, not merely as a lever.

The bottleneck analysis converts the capability necessity into a degree-dependent statement, and this is where NCA's practical contribution is clearest. No minimum capability requirement is detected at low target levels of operational value. The requirement appears only as ambition rises, and increases as it rises further. The managerial translation is not that capability must be maximized but that the capability threshold is a function of the performance level sought. Organizations targeting moderate operational value realization face no detectable capability bottleneck. Organizations targeting the upper range face a substantially higher minimum. This is a materially different form of guidance from a regression coefficient, which specifies an average return per unit rather than a threshold below which an outcome level is unattainable.

The complexity-contingent necessity structure adds a further layer. Under low complexity the architecture behaves as a constraint system in which coordination and capability function as identifiable prerequisites, with the capability-to-value necessity reaching its strongest magnitude in the study. Under high complexity these bottlenecks are not detectable, which is consistent with a shift from a constraint-driven architecture to a more configurational one in which multiple alternative routes to value exist and no single

mechanism is indispensable. This interpretation should be held with appropriate caution: absence of detectable necessity in a subgroup analysis reflects reduced statistical power as well as substantive change, and the estimator inconsistency for the capability-to-value relationship in the high complexity group is a signal to interpret conservatively. Throughout, we maintain that necessity is not sufficiency: no NCA result in this study implies that attaining a threshold guarantees an outcome. One feature of this treatment deserves comment. Applications of necessary condition analysis in sustainability and supply chain research have typically estimated necessity on a single pooled sample [72, 84], which leaves unexamined whether an identified threshold holds uniformly or is itself conditional; estimating ceilings separately by complexity regime is what allows that question to be posed.

A methodological caution belongs alongside these interpretations. NCA identifies empty spaces in the data, and empty spaces can arise for reasons other than the operation of a necessary condition - restricted range in the condition, sampling that under-represents particular combinations, or measurement floors and ceilings can all produce the same visual signature. The diagnostics reported here mitigate but do not eliminate these possibilities: ceiling accuracy is high and exceptions are minimal, yet support values indicate that the ceilings rest on a relatively small number of cases. The appropriate posture is therefore to treat the necessity findings as convergent evidence that strengthens a theoretical argument already supported by structural estimation, rather than as an independent demonstration that would carry the argument alone.

5.7 Integrated theoretical contribution

Taken together, the findings support a repositioning of inclusion within operations and supply chain management. Inclusion is not adequately theorized as a social or human resource practice whose operational relevance must be argued by analogy, nor as a normative commitment justified by external expectation. It is more accurately theorized as organizational infrastructure - a structural property that determines whose knowledge is available, positioned and usable within the operational system, and therefore what the firm's integrative capabilities have to work with.

The value of that infrastructure is not automatic. It is translated through coordination and crystallized into integrative operational capability, and this translation is where the OSCM contribution lies: the field's distinctive analytical asset is precisely its ability to specify coordination and capability mechanisms with operational precision, which is what the DEI debate has lacked. The finding that the externally oriented routes dominate transmission situates this contribution firmly in supply chain rather than general management territory, since it is the networked character of the operational system that makes boundary-crossing coordination the consequential route.

Network coordination complexity is best understood not as a general performance depressant but as a form of operational friction that acts selectively upon the architecture. It disrupts the coordination-to-capability conversion while leaving both coordination activation and the direct infrastructure-to-value relationship comparatively intact, producing compressed capability translation. Read against a wider reorientation in which sustainability, resilience and human centricity are treated as joint design criteria for operations rather than as competing objectives [34], this is a resilience result as much as a performance one: an organization in the compressed state continues to convert infrastructure into value while ceasing to accumulate the capability on which future conversion depends, which is the condition that capability-based accounts of organizational resilience identify as the difficult case to detect [55, 56]. It is also a socio-technical result, and prior evidence converges with it in an instructive way. Shan et al. [85], testing social and technical integration against two sustainability practices across 759 manufacturing firms, find their joint effect significant for sustainable sourcing but not for sustainable production, and recover the same asymmetry in a three-way interaction with supply chain uncertainty: the socio-technical synergy appears in the outward-facing practice and is absent in the inward-facing one. The present study reproduces that asymmetry at a different point in the causal chain, since it is the externally oriented coordination routes rather than internal alignment that carry the transmitted relationship, and it locates the complexity effect at the conversion stage rather than at the stage where practices are enacted. And the necessity evidence establishes that capability is not merely a predictor of value but a degree-dependent prerequisite under sufficiently manageable network conditions - a structural claim that no variance-based analysis could have delivered.

The cumulative effect is to move the DEI-OSCM debate past the question that has stalled it. The productive question is not whether inclusion creates operational value. It is through which organizational mechanisms inclusion is converted into value, how much of the relationship those mechanisms carry, and under what network conditions the conversion process remains intact. Framed this way, disagreement about DEI in operations becomes empirically tractable rather than ideologically fixed, because competing positions generate different and testable predictions about the state of the conversion architecture.

6 Theoretical and managerial implications

For theory, the study makes four connected contributions. The first is conceptual. Reconceptualizing DEI as inclusive organizational infrastructure rather than as a bundle of adopted practices shifts the unit of analysis from managerial intent to structural capacity, and gives the construct a locus in the operational system that practice-count measures do not. Infrastructure is what determines whose knowledge is present, positioned and usable when operational decisions are made, and it is that property - not the adoption of a program - that dynamic capabilities reasoning identifies as consequential. This offers the DEI-OSCM literature a construct that can be measured, modeled and falsified in operational terms, addressing the specification problem that Prashar [2] identifies conceptually and that Son et al. [1] show has kept the empirical debate unresolved.

The second contribution is mechanistic. By decomposing the transmission of inclusive infrastructure into distinct coordination routes rather than aggregating them, the study demonstrates that the operational value of inclusion is realized predominantly across organizational boundaries. This finding extends Roberson et al.'s [17] capability argument in a specifically supply chain direction and connects it to the relational view [25] and to supply chain integration research [26, 27]. It also carries a methodological implication for future DEI-OSCM modeling: the identity of the transmitting mechanism is part of the theoretical claim, and higher-order aggregation of coordination constructs would foreclose the very comparison that generates the insight.

The third contribution concerns boundary conditions. Complexity is routinely modeled as a general attenuator, with the implicit expectation that its effects are distributed across a model. The present findings support a more precise formulation in which complexity acts selectively upon a specific stage of a translation architecture - disrupting the conversion of coordination into capability while leaving coordination activation and direct value creation comparatively intact. Compressed capability translation names this configuration and identifies it as a state that appears healthy in contemporaneous outcome terms while being structurally impaired, since value is being generated without capability being accumulated. This is a proposition that invites longitudinal testing, and its formulation is the study's most distinctive theoretical offering.

The fourth contribution is methodological and epistemic. Integrating necessary condition analysis with structural estimation demonstrates that the two logics answer genuinely different questions about the same architecture, and that their divergences are informative rather than problematic. Boundary-spanning coordination is a substantial contributor to capability without being a prerequisite for it. Inclusive infrastructure is a prerequisite as well as a contributor. The bottleneck analysis further shows that necessity is degree-dependent rather than absolute. For a field increasingly concerned with the conditions under which relationships hold rather than with average effects alone, this complementarity has value beyond the present application.

For practice, the implications are specific rather than exhortatory. The first is that inclusion should be resourced as infrastructure rather than as programming. The distinguishing feature of infrastructure is that it is structural and cumulative: consistent application of employment policy, merit-governed advancement, equitable access to development, functioning mechanisms for addressing unfair treatment, and a climate in which divergent operational judgment can be voiced without penalty. These properties determine whether diverse knowledge reaches the settings where operational decisions are taken. Programs that leave them unchanged should not be expected to produce operational returns, and the frequent finding that they do not is consistent with this account rather than evidence against inclusion.

The second is that managers should look to the organization's boundaries for the operational return on inclusive infrastructure. The routes carrying most of the transmitted relationship run through coordination with supply chain partners and across functional and stakeholder interfaces - precisely the settings where interpretive flexibility, tolerance of divergent framing and the capacity to work outside domain conventions are most demanded and least abundant. Practically, this suggests that boundary roles, partner-facing teams and cross-functional interfaces are where inclusive infrastructure should be most deliberately staffed and supported, and where its operational payoff should be monitored. This is also where the human-centered emphasis in current operations thinking acquires a concrete operational referent. Framed generally, that emphasis reads as a commitment to workforce well-being; framed through the present architecture, it identifies a specific and non-substitutable function, since the interpretive work performed at organizational boundaries is precisely the work that coordination technology does not perform and that inclusive infrastructure most directly enables [34].

The third concerns the distinction between coordinating and building capability. Coordination that does not recur under stable enough conditions to be learned from consumes resources without accumulating competence. Organizations facing complex

networks should therefore attend explicitly to capability capture - mechanisms that abstract transferable routines from coordination episodes, such as structured post-episode review, deliberate stabilization of a subset of partner relationships, and documentation of interface knowledge that would otherwise remain tacit and partner-specific. The finding that the coordination-to-capability stage is where complexity does its damage identifies this as the highest-leverage intervention point, and it is not the point at which most complexity-management effort is currently directed.

The fourth follows from the bottleneck analysis and concerns the calibration of ambition to capability. Because the minimum capability requirement rises with the level of operational value sought, organizations pursuing moderate improvement face no detectable capability threshold, while those pursuing performance in the upper range face a substantially higher one. Setting ambitious operational value targets without a commensurate capability base is therefore not merely inefficient. The necessity evidence indicates that the target level is unlikely to be attainable. Equally, the necessity finding for inclusive infrastructure means that organizations below a minimum level of inclusiveness are systematically absent from the upper range of both capability and value - which reframes inclusion, for the purposes of operational planning, as a floor condition rather than a discretionary enhancement.

A final caution belongs in this section rather than in the limitations. None of these implications should be read as licensing an instrumental defense of inclusion contingent on demonstrated operational return. The findings establish that inclusive infrastructure is associated with operational value through a specifiable mechanism, and that the mechanism can be impaired by network conditions. They do not establish that the value of inclusion is exhausted by its operational return, and an organization that abandoned inclusive infrastructure upon finding its conversion mechanism impaired would, on this evidence, be dismantling both a direct source of value and a necessary condition for capability.

A fifth practical implication concerns measurement and monitoring. Because the impairment identified here occurs at the coordination-to-capability stage rather than at the outcome level, it is invisible to performance dashboards that track operational results alone. Organizations operating in complex networks would be better served by monitoring indicators of capability accumulation - whether coordination knowledge is being captured, whether interface routines are being reused across partners, whether the organization can execute an integrative response without assembling it from scratch - than by monitoring realized value in isolation. On the present evidence, realized value can remain satisfactory while the capability base that would sustain it fails to accumulate, and only the former is typically measured.

7 Limitations and future research

Several limitations bound the interpretation of these findings. The design is cross-sectional, so temporal ordering is theoretically rather than empirically established and causal language is avoided throughout. Alternative orderings, including reciprocal relationships between capability and coordination, cannot be excluded. Data were obtained from single informants using a common instrument. The common latent factor comparison indicates that method variance is present but not dominant, and Harman’s single-factor test is a weak diagnostic. Consequently, common method variance is mitigated rather than excluded, and multi-source or multi-wave designs would materially strengthen inference.

The sample was obtained through purposive and snowball sampling from food export enterprises in Vietnam and China, and non-response bias was not formally assessed, so representativeness cannot be established and generalization beyond the analytic sample should be treated as provisional. The two country subsamples were pooled; the Chinese subsample (n = 41) is too small for a separate invariance test, so country-level heterogeneity cannot be excluded and country was not modeled as a boundary condition. The setting is food export enterprises operating under externally audited quality regimes, and the salience of coordination in this sector may make the translation architecture more visible here than in sectors with lower regulatory and interdependence intensity.

Measurement carries three specific caveats. Network coordination complexity is measured with two retained indicators following item deletion, which is minimally identified within the confirmatory model and limits construct coverage of the complexity domain. The inclusive infrastructure scale exhibits very high internal consistency, which can indicate item redundancy as well as construct coherence and warrants examination of a more parsimonious formulation. The Fornell-Larcker margins between inter-organizational coordination and operational value realization, and between integrative operational capability and operational value realization, while satisfied, are narrow, and the heterotrait-monotrait ratio for that pair is the highest observed. Conceptual proximity between capability and its realized outcome merits attention in future operationalizations.

Analytically, the multi-group comparison establishes structural heterogeneity at the system level but does not identify which individual coefficients differ, since no formal pairwise between-group contrasts were conducted. Structural non-invariance also rests on the chi-square difference test alone, since the corresponding changes in incremental fit indices fall below conventional practical-significance benchmarks. Group-specific results are correspondingly described as significant or non-significant within groups. Bootstrap confidence intervals are available for the total, direct and joint indirect effects but not for the individual serial routes, so the comparison among routes is descriptive. Subgroup estimation also reduces statistical power, so non-significance under high complexity reflects reduced power alongside any substantive change. The within-group interaction estimates are additionally affected by restricted variance in the grouping variable. In the necessity analysis, ceiling support values are modest, indicating that ceilings are estimated from a limited number of ceiling cases, and estimator inconsistency in the high complexity group precludes a robust necessity claim there.

These limitations map onto a research agenda. Longitudinal designs are required to test whether compressed capability translation produces the capability deficit the concept predicts, and whether that deficit becomes consequential when operating conditions change. Multi-source designs pairing managerial reports with archival operational and certification-audit data would strengthen the outcome measurement and reduce method dependence. Comparative work across sectors differing in regulatory intensity and network configuration would establish the boundary of the architecture. Configurational methods would test whether the alternative routes to value implied by the high complexity results can be identified as distinct equifinal configurations. Finally, examining whether specific capability-capture practices restore the coordination-to-capability stage under complexity would convert the study's most distinctive finding into an actionable and testable intervention proposition.

8 Conclusion

The debate over diversity, equity and inclusion in operations and supply chain management has been conducted largely as a dispute over whether inclusion produces operational returns. We argue that the dispute has persisted because the question has been posed at a level of abstraction at which it cannot be resolved. Inclusion, reconceptualized as inclusive organizational infrastructure, does not produce operational value directly and automatically. It produces value through a translation architecture: infrastructure activates coordination, coordination crystallizes into integrative operational capability, and capability is converted into realized operational value.

The evidence from 264 food export enterprises supports each stage of that chain and specifies its internal structure. Almost half of the total relationship between inclusive infrastructure and operational value is transmitted through the coordination and capability architecture, and that transmission runs predominantly through inter-organizational and boundary-spanning coordination rather than through internal alignment - a finding that places the operational value of inclusion at the organization's boundaries, where its networked character makes interpretive flexibility most consequential.

Network coordination complexity determines whether the translation mechanism remains intact, and it does so selectively rather than globally. It does not prevent inclusive infrastructure from activating coordination, and it does not eliminate the value-generating function of capability where capability exists. What it disrupts is the capability-building stage of that architecture. Under these conditions inclusive infrastructure continues to generate value directly while its capability-building pathway is constricted, a configuration we term compressed capability translation. The necessity evidence completes the account by showing that inclusive infrastructure and integrative capability are not merely predictors but degree-dependent prerequisites under sufficiently manageable network conditions: organizations below the relevant thresholds are systematically absent from the upper range of operational value, though meeting those thresholds guarantees nothing.

The contribution to the collection's agenda is therefore to relocate the debate. The productive question is not whether inclusion creates operational value, but how, through which organizational mechanisms, and under what network conditions inclusion can be converted into value that is not only realized but sustained. Answering it requires exactly the analytical apparatus that operations and supply chain management possesses - the capacity to specify coordination and capability mechanisms with operational precision - and it is in supplying that apparatus to the DEI conversation that the field can most usefully contribute.

Abbreviations

AVE Average variance extracted

BSC Boundary-spanning coordination

CE-FDH Ceiling envelopment with free disposal hull

CFA Confirmatory factor analysis

CFI Comparative fit index

CLF Common latent factor

CMIN/DF Normed chi-square (minimum discrepancy divided by degrees of freedom)

CR Composite reliability

CR-FDH Ceiling regression with free disposal hull

DEI Diversity, equity and inclusion

DOR Digital operational readiness

EFA Exploratory factor analysis

HTMT Heterotrait-monotrait ratio

IC Internal coordination

IEC Institutional enabling conditions

IFI Incremental fit index

IOC Inter-organizational coordination

IOCap Integrative operational capability

IOI Inclusive organizational infrastructure

MSV Maximum shared variance

NCA Necessary condition analysis

NCC Network coordination complexity

NFI Normed fit index

OSCM Operations and supply chain management

OVR Operational value realization

PCLOSE Test of close fit (p of close fit)

RFI Relative fit index

RMSEA Root mean square error of approximation

SEM Structural equation modeling

TLI Tucker-Lewis index

VAF Variance accounted for

Declarations

Author Contributions

Conceptualization, methodology, and supervision were conducted by H.T.Q. (Huy Truong Quang) and T.N.P. (Thi Ngan Pham), with intellectual input from P.A.H. (Phuong Ai Hoang) and A.L.P. (Anh Lan Pham). Formal analysis, investigation, and writing-original draft preparation were primarily carried out by N.N.B.D. (Nguyen Nhat Bao Dang) and M.N.H.H. (My Nguyen Hoang Ha), with support from K.U.T. (Khanh Uyen Tran) and A.L.P. Data collection, resource acquisition, and investigation were undertaken by N.N.B.D., M.N.H.H., K.U.T., and A.L.P. Writing-review and editing were performed by T.N.P., H.T.Q., P.A.H., K.U.T., and A.L.P. Validation, data curation, and methodological support were provided by T.N.P., H.T.Q., N.N.B.D., and A.L.P. Project administration and overall coordination were led by H.T.Q. and T.N.P. All authors have read and agreed to the published version of the manuscript.

Statements and Declarations

Conflicting interests: We wish to confirm that there are no known conflicts of interest associated with this publication. We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us.

We confirm that we have given due consideration to the protection of intellectual property associated with this work and that there are no impediments to publication, including the timing of publication, with respect to intellectual property. In so doing we confirm that we have followed the regulations of our institutions concerning intellectual property.

Ethical Approval and accordance

The study was approved by the RMIT University BL CHEAN's COB Research Ethics Board (Project number: 28568; Review reference: 2025-28568-28462), and the research was carried out in accordance with the guidelines and regulations of this ethics committee.

Consent to participate

Informed consent was obtained from all respondents before participation in the research survey.

Consent to Publish

Not applicable.

Availability of data

The data that support the findings of this study are available from the corresponding author on reasonable request; they are not publicly available in order to protect participant privacy. The full eigenvalue solution for the Harman single-factor test is provided in Appendix 2.

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Figures

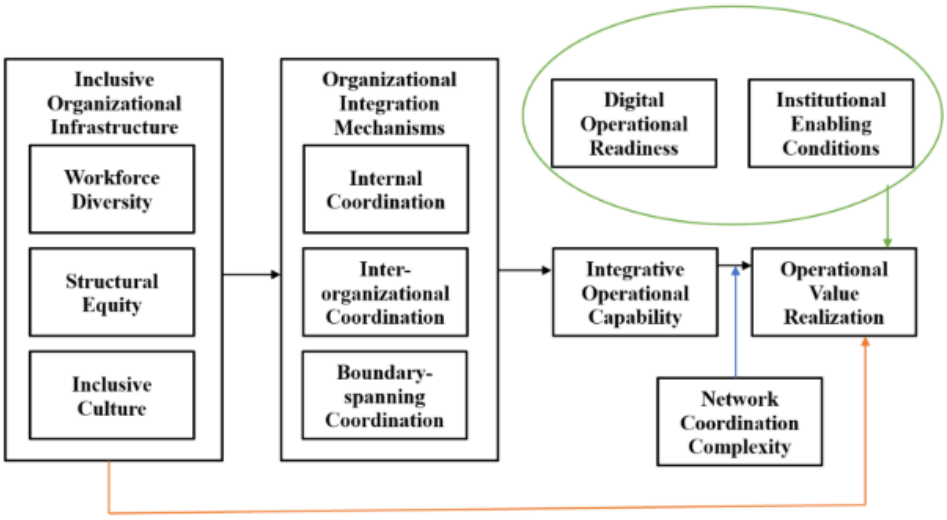


Figure 1

Conceptual research model

Notes: Solid arrows denote direct paths; the lower path denotes the direct IOI → OVR relationship; the moderating effect of network coordination complexity is specified on the IOCap → OVR relationship; digital operational readiness and institutional enabling conditions enter as controls on operational value realization. IC, IOC and BSC are modeled as three distinct coordination mechanisms and are not specified as indicators of a higher-order coordination construct.

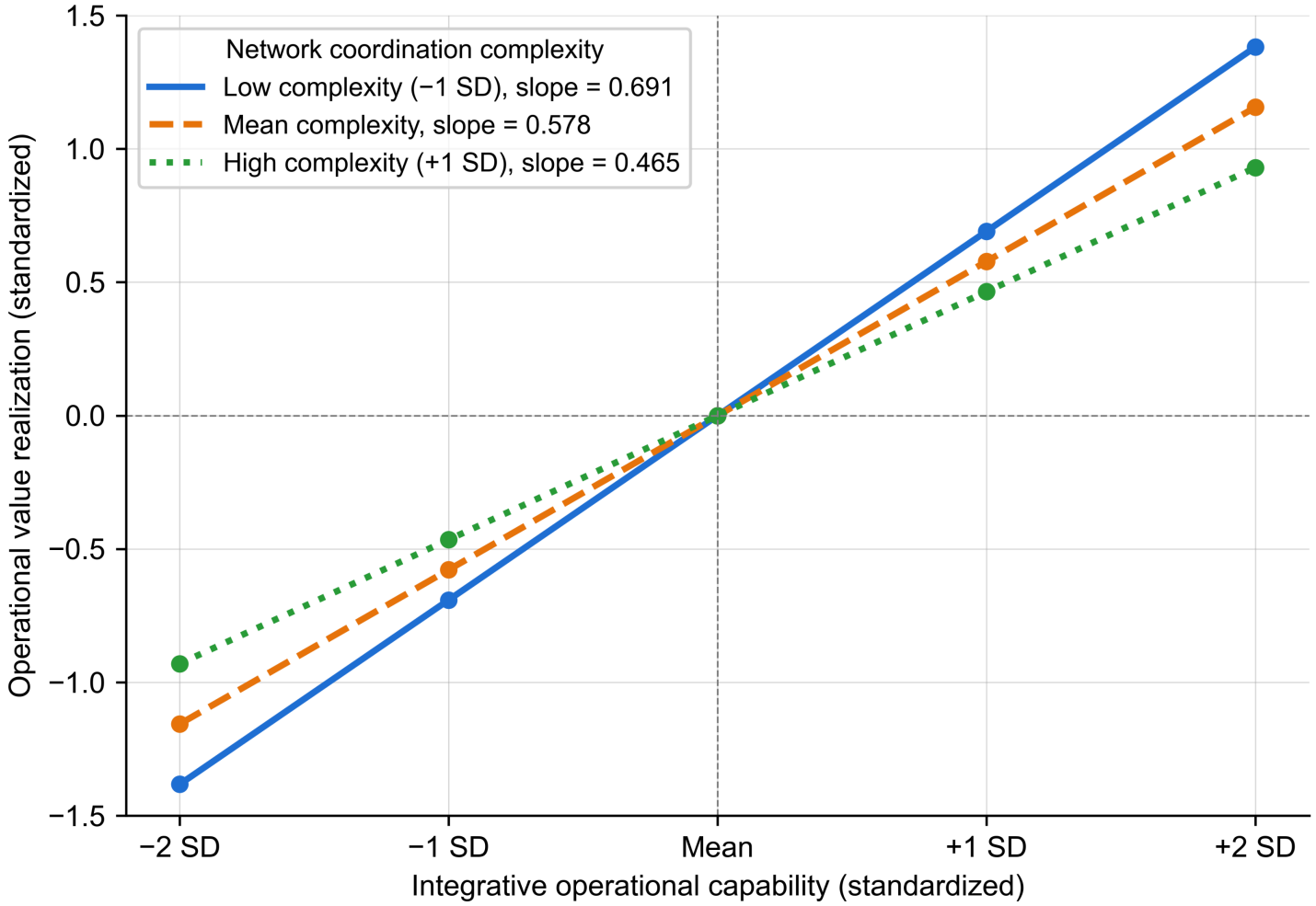


Figure 2

Operational friction: the dampening effect of network coordination complexity on capability translation

Notes: Simple slopes of IOCap → OVR at low (−1 SD), mean, and high (+1 SD) levels of network coordination complexity. Interaction effect: β = −.113, p = .002.

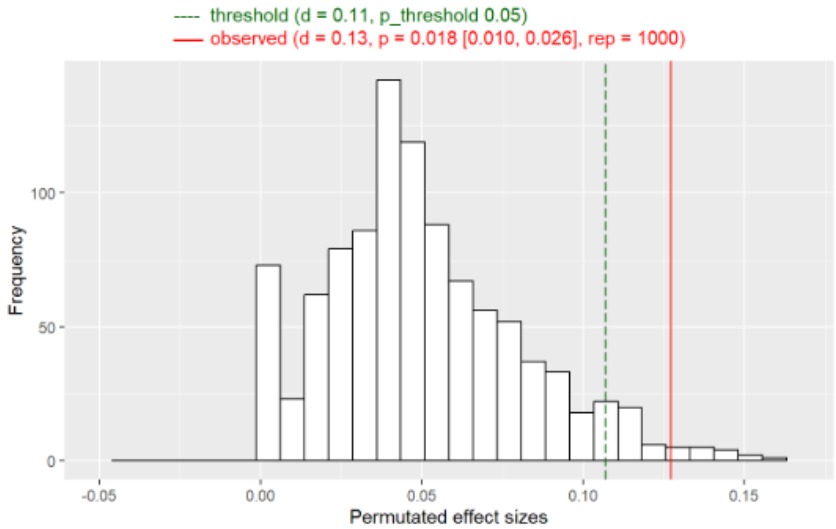


Figure 3

Permutation test for the necessary effect of integrative operational capability on operational value realization

Notes: Distribution of permuted effect sizes across 1,000 replications for the CE-FDH estimator. The observed effect size (d = .13) exceeds the threshold value (d = .11) corresponding to p = .05.

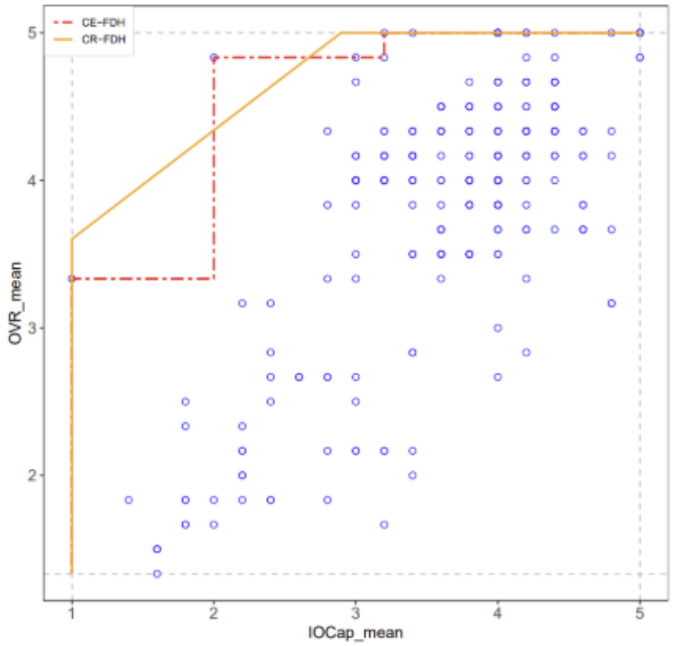


Figure 4

Ceiling lines and bottleneck region for integrative operational capability and operational value realization

Notes: CE-FDH (step function) and CR-FDH (linear) ceiling lines. The empty region in the upper-left quadrant constitutes the empirical basis for the necessity inference; cases combining low integrative operational capability with high operational value realization are systematically absent.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Appendix1.docx
- BiographicalDetails.docx