

When Digitalization Manufactures Distance: Rethinking Supply Chain Governance

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ABSTRACT

Core supply chain design levers such as centralization, formalization, and standardization have historically been enacted through direct buyer-supplier interaction. Digital technologies in this context have largely been assumed to function as neutral supports for these governance structures by reducing geographic and informational distance without altering the underlying logic of coordination or control. However, we argue that digitalization can also generate new forms of separation by reshaping how interorganizational interaction is organized. We introduce the concept of digitally induced distance and distinguish three forms: buyer-access distance, time-compression distance, and capability distance. We theorize how these distances condition the effectiveness of centralization, formalization, and standardization in shaping coordination, scalability, and participation outcomes. By reframing digital technologies as sources of structural distance rather than purely coordination-enhancing tools, this paper contributes to research on organizational design and supply chain governance and explains why formally sound governance arrangements may yield uneven outcomes under digitalization.

Keywords:

Conceptual paper, Digitalization, Buyer-Supplier Distance, Supply Chain Governance

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INTRODUCTION

Supply chains are increasingly governed through digital systems. Decisions related to sourcing, contracting, coordination, and execution are now routinely executed by platforms, portals, workflows, and algorithmic tools that structure how buyers and suppliers interact. Digital technologies have become integral to how interorganizational activities are coordinated, monitored, and controlled, shaping not only information flows but also the everyday enactment of governance across firm boundaries (Angelopoulos et al., 2023; Flynn, Koufteros, & Lu, 2016). As a result, contemporary supply chain governance is no longer exercised primarily through direct interpersonal interaction or bilateral negotiation, but through digital interfaces that organize interaction at scale.

Organizational design theory provides the dominant framework for understanding how such governance systems are structured. Research on supply chain governance draws heavily on canonical design levers, particularly centralization, formalization, and standardization, to explain how firms allocate authority, stabilize expectations, and coordinate activities across legally autonomous actors (Donaldson, 2001; Ketchen Jr & Hult, 2007; Van de Ven, Delbecq, & Koenig Jr, 1976). These design elements are widely theorized as reliable mechanisms for improving coordination, scalability, and performance in complex interorganizational systems (Flynn, Huo, & Zhao, 2010; Ralston, Blackhurst, Cantor, & Crum, 2015). Within this literature, digital technologies are typically treated as infrastructural supports that enhance information processing and execution efficiency while remaining orthogonal to governance design itself (Dong, Fang, & Straub, 2017).

This separation becomes increasingly difficult to sustain as governance is enacted through digitalized interfaces rather than alongside it. Organizational design arguments rest on a set of enabling conditions that are rarely articulated explicitly. Centralization presumes access to authoritative decision makers and the ability to escalate and interpret information across organizational boundaries (Galbraith, 1973). Formalization assumes sufficient temporal latitude for rules and procedures to be interpreted, adapted, and applied in situated contexts (Adler & Borys, 1996; Poppo & Zenger, 2002). Standardization presupposes alignment between governance requirements and the technical, organizational, and analytical capabilities of participating actors (Koufteros, Vonderembse, & Jayaram, 2005; Mintzberg, 1979). These conditions underpin the assumed effectiveness of organizational design levers, yet they are precisely the conditions that digital systems often reconstitute by filtering access, compressing interaction cadence, and embedding participation thresholds into routine execution.

To address this limitation, this paper introduces the concept of digitally induced distance. Digitally induced distance captures how digitalization alters interaction at the buyer-supplier interface by reshaping access, temporal pacing, and participation. We conceptualize distance not as a residual constraint or an exogenous attribute of relationships, but as a condition manufactured through the configuration and use of digital systems. Importantly, digitally induced distance operates as a moderating condition that shapes how established organizational design elements are enacted in practice rather than determining governance outcomes directly. We distinguish three forms of digitally induced distance. Buyer-access distance reflects constrained access to authoritative decision makers (Cäker, 2008; Holmström, Holweg, Lawson, Pil, & Wagner, 2019). Time-compression distance captures the reduction in temporal latitude created by automated workflows and accelerated decision cycles (Bendoly, 2011; Simon, 1947). Capability

distance reflects misalignment between standardized digital requirements and heterogeneous supplier capabilities (De Vita, Tekaya, & Wang, 2011; Moshtari & Seepma, 2025).

This paper makes three contributions. First, it extends organizational design theory by identifying digitally induced distance as a missing moderator that explains why formally similar configurations of centralization, formalization, and standardization may operate differently once interaction is digitalized. Second, it advances research on governance by reframing digital technologies from neutral execution infrastructures to governance-conditioning mechanisms that structure interaction at organizational boundaries (Flynn et al., 2016; Lumineau et al., 2025). Third, it contributes to supply chain management scholarship by shifting analytical attention to the interface level, where governance is enacted through digitalization rather than through formal specification alone. Together, these contributions provide a foundation for more precise theorizing about how digitalization reshapes governance in contemporary supply chains.

ORGANIZATIONAL DESIGN FOUNDATIONS OF SUPPLY CHAIN GOVERNANCE

Supply chains are increasingly understood not as loose collections of dyadic exchanges, but as intentionally designed and governed systems whose performance depends on coordinated action among autonomous actors (Ketchen Jr & Hult, 2007; Miles & Snow, 2007). Rather than emerging spontaneously from market transactions, supply chains are actively structured through choices about roles, interfaces, and control mechanisms that shape how work is divided and integrated across organizational boundaries. This view positions supply chains as a distinctive organizational form that extends classic organizational problems of coordination, control, and adaptation beyond the firm (Miles & Snow, 2007). Organizational design theory is therefore directly applicable, because questions of authority allocation, governance, and consistency arise in multi-firm systems as they do within organizations. Work on *meta-organizations* further

demonstrates that systems composed of autonomous actors can nonetheless be purposefully designed to pursue collective goals through non-market governance arrangements (Gulati, Puranam, & Tushman, 2012). Empirical research in supply chain management similarly treats supply chains as system-level entities whose structure and governance shape coordination and performance (Flynn et al., 2010). Together, this literature establishes supply chains as legitimate objects of organizational design rather than residual outcomes of bilateral contracting.

Organizational design theory identifies centralization, formalization, and standardization as distinct structural levers through which organizations allocate authority, coordinate activities, and exercise control, each addressing a different coordination problem (Donaldson, 2001; Van de Ven et al., 1976). Centralization specifies where decision authority resides, shaping how resource allocation, task prioritization, and exception handling are resolved. Formalization governs behavior through codified rules, procedures, and contractual arrangements that reduce ambiguity by specifying acceptable actions *ex ante*. Standardization aligns activities through uniform processes, interfaces, and performance expectations, enabling coordination through consistency rather than discretion. Although these levers often co-occur in practice, they operate through analytically separable mechanisms and cannot be reduced to a single dimension of governance intensity (Van de Ven et al., 1976). Research in operations and supply chain contexts similarly treats these elements as foundational but distinct means of structuring cross-organizational coordination and control (Sousa & Voss, 2008). Accordingly, supply chain governance can be understood as the deliberate configuration of centralization, formalization, and standardization across firm boundaries to shape coordination and performance outcomes (Ralston et al., 2015).

A central assumption in organizational design theory is that centralization enhances coordination and control by concentrating decision authority and information processing in a

focal unit capable of resolving interdependencies. Galbraith's (1973) information-processing perspective argues that when tasks are interdependent, organizations improve performance by increasing their capacity to process information, with centralized authority serving as a primary mechanism. By consolidating decision rights and channeling information upward, centralization enables escalation, sensemaking, and alignment across dispersed activities. In supply chains, centralized governance allows focal firms to interpret system-level information, adjudicate trade-offs, and enforce consistent responses across multiple partners (Germain, Claycomb, & Dröge, 2008). Empirical research associates centralized decision-making with tighter coordination, reduced variability, and stronger integration of logistics and operational processes (Chen, Daugherty, & Landry, 2009). Network-level analyses further suggest that concentrated authority positions enable focal actors to shape flows of information and materials across supply networks (Kim, Choi, Yan, & Dooley, 2011). Thus, centralization is theorized to improve supply chain performance by structuring authority and information flows to support coherent system-wide action.

While centralization concentrates on decision authority, formalization coordinates interorganizational behavior by stabilizing expectations through rules, procedures, and contracts. Weber's (1947) account of bureaucracy emphasizes formal rules as the basis of rational-legal authority, enabling predictable and calculable action in complex systems by specifying appropriate conduct independently of personal discretion. In interorganizational settings, formalization reduces uncertainty by clarifying roles, responsibilities, and acceptable responses across organizational boundaries. Subsequent organizational research shows that formalization can function as an enabling mechanism when rules codify accumulated knowledge and support task execution rather than merely enforcing compliance (Adler & Borys, 1996). In supply chains,

formal contracts and standardized procedures provide shared reference points that mitigate opportunism and align partner expectations over time (Poppo & Zenger, 2002). Recent work further highlights the role of formalization in stabilizing collaboration within complex supply chain networks by reducing ambiguity and coordination failure (Liu, De Winne, De Cooman, Smet, & Lattanzi, 2025). Formalization is therefore theorized to enhance predictability and reliability in supply chains through explicit, rule-based governance rather than through authority concentration alone.

Standardization coordinates supply chain activity by specifying uniform processes, interfaces, and technical specifications, enabling scalability without requiring centralized authority or extensive contractual oversight. In organizational design theory, standardization operates as a distinct coordinating mechanism that aligns behavior through shared templates and routines, allowing complex systems to function reliably despite limited supervision (Mintzberg, 1979). From a governance perspective, standardized processes reduce transaction costs by limiting ongoing negotiation and adaptation, facilitating repeatable exchanges across organizational boundaries (Williamson, 1985). In supply chains, standardization supports efficiency by enabling interoperability among partners, accelerating throughput, and reducing variability associated with idiosyncratic practices (Koufteros et al., 2005). These benefits are typically theorized as capability-neutral, implicitly assuming that participating actors possess the technical, organizational, and analytical capacity required to enact standardized processes as intended. Standardization also lowers barriers to participation by allowing a broader range of actors to integrate into supply networks without bespoke coordination arrangements. These benefits, however, implicitly assume alignment between standardized requirements and the technical, organizational, and analytical capabilities of participating partners. When such

alignment holds, standardization enables efficient coordination and broad participation; when it does not, standardized systems may exclude or constrain actors whose capabilities diverge from embedded assumptions (Moshtari & Seepma, 2025).

Taken together, the supply chain management literature largely assumes a stable mapping between organizational design elements and desirable system-level outcomes. Centralization, formalization, and standardization are routinely theorized as structural means through which firms enhance coordination, alignment, and responsiveness across supply chains. Scholarly work bridging organization theory and supply chain management treats these design elements as mechanisms that allow supply chains to function as coherent competitive units rather than fragmented collections of firms (Ketchen Jr & Hult, 2007). Empirical research reinforces this logic by modeling governance and integration structures as reliable drivers of operational and financial performance across varied contexts (Ralston et al., 2015). Even when uncertainty is acknowledged, organizational design elements are typically positioned as stabilizing responses that enhance information processing and coordination capacity (Flynn et al., 2016). As a result, much of the literature implicitly assumes that configuring these design levers will reliably translate into improved coordination and performance, establishing a strong baseline logic for supply chain design.

Despite their prominence, these assumed design-outcome relationships rest on a set of enabling conditions that are rarely articulated explicitly. Centralization presumes that relevant information can be accessed, aggregated, and deliberated upon by those holding decision authority in a timely and intelligible manner. Formalization assumes that rules and contracts are interpretable, enforceable, and aligned with the situated realities of interorganizational work. Standardization presupposes that participating actors possess the technical, organizational, and

analytical capabilities required to enact standardized processes as intended. When these conditions hold, organizational design elements are expected to function as stabilizing mechanisms that reliably produce coordination and performance. When they do not, these same design logics may weaken or break down. Making these assumptions explicit is therefore essential for understanding the limits of organizational design theories in supply chain contexts.

DIGITALIZATION AND THE EMERGENCE OF DISTANCE

Digitalization has become a defining condition of contemporary supply chains, as coordination, decision-making, and interorganizational interaction are increasingly enacted through digitally generated artifacts rather than direct human exchange. Beyond the digitalization of discrete tasks, the product, process, and transactional information are integrated into digital representations that actively structure how supply chain activities are executed, monitored, and adjusted across organizational boundaries (Holmström et al., 2019). As a result, supply chains are no longer governed solely through contracts and hierarchical authority, but through digitally embedded coordination logics that shape information access, sequencing, and responsiveness in everyday interaction (Ketokivi & Mahoney, 2020). This pervasive digitalization of core governance processes establishes the conditions under which traditional assumptions about how governance operates at the buyer-supplier interface warrant reconsideration particularly with respect to access, deliberation, and capability alignment (Lumineau et al., 2025).

Despite this embedding of digitalization into core supply chain activities, much SCM and OM research continues to treat digital technologies as orthogonal to governance design. In this dominant view, information systems are conceptualized as efficiency-enhancing infrastructure that improve information quality, coordination, and responsiveness while leaving underlying organizational design choices and governance logics unchanged (Rai, Patnayakuni, & Seth,

2006). Digital technologies are thus positioned as supports that strengthen existing control and coordination mechanisms, particularly under conditions of complexity and uncertainty, rather than as elements that reshape how governance is enacted at the interface (Ketchen, Crook, & Craighead, 2014). Even studies that acknowledge heterogeneity across interorganizational contexts emphasize the adaptability of interorganizational systems as a means of mitigating distance, implicitly assuming that technology facilitates alignment without altering the interaction conditions through which governance operates (Dong et al., 2017). This orthogonal framing limits theoretical attention to why formally similar governance designs increasingly yield uneven, unstable, or counterintuitive coordination outcomes once interaction is digitally driven.

The assumption that digital technologies merely support existing governance arrangements becomes increasingly untenable as digital systems shift from augmenting human judgment to actively substituting it. Early work on informatization already highlighted that digital technologies do not simply increase information availability but embed logics of control, evaluation, and action directly into technical systems, thereby relocating discretion from human actors to encoded routines (Zuboff, 1988). Building on this insight, sociomaterial perspectives demonstrate that when organizational activity is enacted through digital interfaces, interaction conditions are constituted through categories, sequences, and affordances inscribed in technology rather than negotiated through situated human engagement (Orlikowski, 2007). Contemporary digital transformation intensifies this dynamic through agency reversal, as algorithms increasingly initiate, sequence, and constrain operational decisions, positioning humans as supervisors of system-driven action rather than primary decision makers (Angelopoulos et al., 2023). We draw on these insights not to advance a sociomaterial ontology, but to explain how

digitalization alters the structure of decision situations in ways that existing governance theories do not fully anticipate.

Because digitalization alters the structure of decision situations, established organizational design accounts become insufficient to the extent that they presuppose stable interaction conditions through which governance mechanisms operate. In particular, design arguments about centralization and formalization typically assume that actors can translate formal authority into effective coordination through reliable access to relevant information, opportunities for deliberation, and reciprocal adjustment across boundaries (Cäker, 2008). Yet digitally enacted governance increasingly routes interdependence through learning algorithms whose black-boxed performance, comprehensive digitalization, and anticipatory quantification reconfigure what can be seen, when action must occur, and how discretion is exercised, thereby shifting coordination and control away from negotiated interaction toward system-performed ordering (Faraj, Pachidi, & Sayegh, 2018). These conditions (access, deliberation, and capability alignment) constitute minimal preconditions for organizational design choices to operate as theorized, making their disruption especially consequential for governance effectiveness. In supply chains where uncertainty is multilevel and often equivocal, such reconstitution undermines the core contingency assumption that structural choices and integration processes can be aligned to environmental demands through human comprehension and information processing (Flynn et al., 2016).

This disruption of access, deliberation, and capability alignment under digitalization calls for a construct that captures how interaction conditions are reconstituted at the organizational boundary. We introduce digitally induced distance as an interface-level condition that reflects how digitalization reshapes the effective proximity between buyers and suppliers, independent of

formal structure or geographic separation. Prior research demonstrates that distance can arise from task design, asset specificity, and coordination requirements that differentially constrain actors' ability to engage, adapt, and respond, even when exchange relationships are formally intact (De Vita et al., 2011). Digital systems intensify these effects by embedding assumptions about speed, precision, and attentional focus into workflows, increasing the likelihood of judgment strain and error when task demands exceed actors' cognitive and organizational capacities (Bendoly, 2011). Digitally induced distance thus conditions how governance mechanisms perform rather than constitute a performance outcome in itself, providing a theoretical lens for explaining why identical design choices yield divergent outcomes when interaction conditions are shaped by digital interfaces rather than organizational choice alone.

DIGITALLY INDUCED DISTANCES AS MODERATORS OF DESIGN OUTCOMES

Organizational design theory assumes that structural elements such as centralization, formalization, and standardization exert relatively stable effects on coordination and performance, contingent on alignment with task and environmental conditions (Donaldson, 2001). Extending this logic to digitalized supply chains requires recognizing that digital infrastructures do more than transmit information; they reconfigure how authority, interaction, and coordination are enacted across organizational boundaries. Recent work highlights that digitalization introduces new forms of distance that alter information access, interaction timing, and capability requirements, even when formal governance structures remain unchanged (Angelopoulos et al., 2023; Flynn et al., 2016). These forms of distance map onto the enabling conditions typically taken for granted in design arguments, namely access to authority, time for deliberation, and capability alignment in enactment. These digitally induced distances do not replace organizational design choices, but condition how such choices operate in practice. As a

result, the coordination and performance outcomes typically associated with organizational design elements may weaken or distort under specific digital conditions. Conceptualizing distance as a moderating construct thus allows organizational design theory to extend to digitalized supply chains without abandoning its core assumptions. This perspective sets the stage for examining how distinct forms of digitally induced distance reshape the effectiveness of centralization, formalization, and standardization in supply chain governance. Figure 1 presents our conceptual model, illustrating how digitally induced distance operates as an interface-level moderating condition that shapes the relationships between organizational design elements and governance outcomes, with each distance aligned to its primary theoretical linkage.

Insert Figure 1 here

Buyer-Access Distance and Centralization

Buyer-access distance refers to the fragmentation or loss of direct access to authoritative decision makers resulting from digital interfaces, portals, and role separation in supply chains. As interactions are rerouted through standardized platforms and automated workflows, suppliers are increasingly buffered from those holding decision authority. Prior research shows that such impact can obscure who has authority to decide, interpret exceptions, or revise requirements, even when formal governance structures remain intact (Cäker, 2008). Digitalization further redistributes activities and decision rights across organizational and technological layers, reducing opportunities for direct interaction between suppliers and focal buyers (Holmström et

al, 2019). Although these arrangements may improve scalability, they simultaneously increase distance at the interface where escalation and clarification would otherwise occur. Governance in such infrastructures can thus decouple interaction from authority by embedding decision logic in digitalized systems rather than interpersonal relationships (Lumineau et al., 2025). Buyer-access distance therefore captures a form of separation defined not by geography or hierarchy, but by constrained access to authoritative actors and decision-makers.

Centralization is traditionally expected to enhance coordination by concentrating decision authority and information processing within a focal actor capable of resolving interdependencies (Galbraith, 1973). However, the coordination benefits of centralization depend on effective escalation and sensemaking across organizational boundaries. Buyer-access distance preserves formal control by maintaining centralized decision rights yet weakens coordination by limiting suppliers' ability to surface issues, seek clarification, and contribute contextual information upward. As digital interfaces filter and routinize communication, signals from suppliers may be delayed, stripped of nuance, or prevented from reaching those best positioned to interpret them. Research on supply chain uncertainty suggests that when information access is constrained, centralized structures lose their capacity to process equivocal inputs effectively, even if authority remains formally intact (Flynn et al., 2016). Network perspectives further indicate that control can be exercised without corresponding influence over information flows when boundary positions restrict interaction (Kim et al., 2011). Buyer-access distance therefore conditions the effects of centralization by decoupling authority from interaction, preserving control while degrading coordination at the supplier boundary.

Together, these arguments suggest that the coordination advantages typically attributed to centralized supply chain governance are contingent on suppliers' access to authoritative buyers, motivating the following proposition:

Proposition 1: *Buyer-access distance moderates the relationship between centralization and coordination outcomes in supply chains, such that the coordination benefits of centralization diminish as buyer-access distance increases.*

Time-Compression Distance and Formalization

Time-compression distance refers to algorithmically imposed acceleration of decision cycles that reduces opportunities for deliberation, reflection, and adaptive response in interorganizational interactions. Classic work on bounded rationality emphasizes that effective decision-making depends not only on information availability but also on sufficient time for search, evaluation, and judgment (Simon, 1947). Digitalized supply chain systems increasingly compress decision windows by automating workflows, enforcing rapid response requirements, and sequencing interdependent tasks at machine tempo rather than human cadence. Behavioral operations research shows that such compression shifts cognition toward heuristic and reactive processing (Bendoly, 2011). Under acute time pressure, decision makers experience heightened stress that degrades judgment quality and increases error, particularly in complex tasks (Burkhardt, Nitsch, Spinler, & van Wassenhove, 2023). In interorganizational settings, compressed timelines propagate across firm boundaries, constraining collective coordination. Time-compression distance thus captures a temporal form of separation defined by reduced decision latitude rather than physical or organizational distance.

Formalization is typically theorized to stabilize coordination by providing rules and procedures that reduce ambiguity and enable scalable interaction. When time for interpretation and adaptation is available, formalized rules can function as enabling devices that support judgment and learning (Adler & Borys, 1996). Under high time-compression distance, however, the effects of formalization change. As decision windows narrow, rules are more likely to be applied mechanically, constraining the interpretive work through which formal rules are enacted and adapted across boundaries, and increasing misapplication in novel or ambiguous situations. Prior research shows that tightly specified procedures under time pressure exacerbate stress, trigger defensive behavior, and encourage compliance over problem resolution (Carter et al., 2004; Hawkins, Gravier, & Wittmann, 2010). Evidence from disrupted and humanitarian supply chains further suggests that rigid formalization under compressed timeframes undermines coordination by limiting improvisation and responsiveness (Kovács & Falagara Sigala, 2021). Time-compression distance therefore moderates formalization by transforming rules from stabilizing coordination devices into sources of strain and error.

Together, these arguments suggest that the stabilizing effects of formalized governance depend critically on the temporal latitude available for interpretation and response, leading to the following proposition:

Proposition 2: *Time-compression distance moderates the relationship between formalization and scalability outcomes in supply chains, such that the stabilizing effects of formalized governance diminish as time-compression distance increases.*

Capability Distance and Standardization

Capability distance refers to the misalignment between standardized digital process requirements and suppliers' technical, analytical, or organizational capabilities. As supply chains increasingly rely on standardized digital interfaces, compliance requires not only adherence to specifications but also the ability to generate, interpret, and act on codified data. Prior research shows substantial variation in suppliers' capacity to invest in and adapt to such requirements, particularly when standardization entails relationship-specific technological or organizational adjustments (De Vita et al., 2011). Digital platforms often amplify these differences by embedding assumptions about process maturity, data quality, and responsiveness into standardized workflows (Do & Stevenson, 2025). Although such systems are designed to enable scalability, they implicitly privilege suppliers whose capabilities align with these embedded assumptions. Governance infrastructures in such conditions can therefore reproduce or intensify capability asymmetries rather than neutralize them (Lumineau et al., 2025). Capability distance captures a structurally induced misfit between standardized governance designs and heterogeneous supplier capabilities.

Standardization is typically theorized as an efficiency-enhancing mechanism that reduces variation and simplifies coordination. From a transaction cost perspective, standardized processes lower coordination costs by limiting bespoke adaptation and negotiation (Williamson, 1985). When capability distance is high, however, standardization alters participation rather than merely improving efficiency. Suppliers lacking requisite capabilities may be unable to comply, even when otherwise productive or innovative. Research suggests that standardized governance can function as a screening mechanism that advantages well-resourced or centrally positioned suppliers (Kim & Zhu, 2018). Evidence from humanitarian and development-oriented supply

chains shows that rigid standardization can exclude capable actors whose practices diverge from standardized templates (Moshtari & Seepma, 2025). Capability distance thus moderates standardization by shifting it from a coordination mechanism to a participation filter that reshapes network boundaries.

Together, these arguments indicate that the efficiency and inclusiveness of standardized supply chain governance depend on the degree of alignment between standardized process requirements and supplier capabilities, motivating the following proposition:

Proposition 3: *Capability distance moderates the relationship between standardization and participation outcomes, such that standardized processes increasingly exclude capable suppliers as capability distance increases.*

Conceptual Boundary of Digitally Induced Distance

Digitally induced distance is conceptually distinct from established proximity and distance constructs such as geographic, institutional, or cognitive distance. Whereas those forms of distance are typically extrinsic characteristics of exchange partners or environments, the distances theorized here arise from digital configuration rather than from partner attributes or relational history. Buyer-access, time-compression, and capability distances can therefore vary within otherwise proximate buyer-supplier relationships and even within the same transaction category. As such, digitally induced distance does not capture how far partners are from one another, but how digitally configured interaction conditions restructure access, time, and participation during exchange.

We further distinguish digitally induced distance from behavioral outcomes induced by governance choices. Centralization, formalization, and standardization are organizational design

decisions that shape authority, rules, and coordination responsibilities, whereas digitally induced distance reflects properties of the digital interaction layer through which these governance mechanisms are enacted. Interface design, workflow routing, algorithmic pacing, and interaction protocols are often shaped by platform architectures, legacy systems, vendor templates, and compliance constraints that are not reducible to governance intent. Because these digitally configured conditions can differ under identical governance structures, we theorize digitally induced distance as analytically separable from governance choices and appropriate to model as a conditioning factor on their effects.

This conceptualization is informed by, but distinct from, several adjacent literatures. Research on proximity and distance emphasizes how geographic, institutional, and cognitive closeness facilitate coordination and learning among exchange partners (Boschma, 2005), while platform governance studies highlight how digital architectures and rules structure participation and control in multisided systems (Parker, Van Alstyne, & Choudary, 2016; Tiwana, 2013). Control theory further explains how different governance forms shape behavior and outcomes through authority, rules, and norms (Merchant & Van der Stede, 2007; Ouchi, 1979). Digitally induced distance complements these perspectives by shifting attention to how digitally configured interaction conditions condition the effectiveness of established governance mechanisms without replacing or subsuming these theories.

APPLICATION TO SUPPLY CHAIN GOVERNANCE

Building on the conceptualization of digitally induced distance as an interface-level condition, we turn to procurement as an illustrative governance context in which these dynamics are especially salient. Procurement occupies a structurally central position in supply chains,

combining concentrated decision authority with frequent, execution-oriented interaction at the buyer-supplier interface, making it a critical locus for understanding how governance mechanisms condition coordination under uncertainty (Flynn et al., 2016; Ketchen Jr & Hult, 2007). We examine specific procurement technologies not to evaluate their performance implications, but to explicate how distinct forms of digitalization reconfigure interaction conditions at the buyer-supplier boundary, thereby inducing different types of distance that shape organizational and supply chain design outcomes. This perspective contrasts with prior work that treats interorganizational systems primarily as adaptive or efficiency-enhancing infrastructures that mitigate preexisting forms of distance, rather than as governance mechanisms that actively restructure access, cadence, and capability requirements in use (Dong et al., 2017).

Following the positioning of procurement technologies as illustrative governance mechanisms, portal-based procurement systems exemplify how digitalization can induce buyer-access distance by reconfiguring interaction pathways at the supplier boundary. Procurement portals centralize decision authority while routing supplier engagement through standardized, role-segregated interfaces that separate sourcing, purchasing, and approval activities, thereby narrowing suppliers' effective access to actors with discretionary authority. While such architectures function to enhance control, transparency, and accountability, they constrain escalation and sensemaking by forcing complex contingencies to be translated into predefined categories rather than addressed through dialogic interaction (Cäker, 2008). Consistent with arguments on digital encapsulation, portals redistribute coordination activities across organizational roles and digital artifacts, weakening boundary-spanning interaction even as formal authority remains centralized (Holmström et al., 2019). This fragmentation of authoritative access illustrates buyer-access distance as an outcome of portal-based governance,

shaping coordination and relational dynamics despite unchanged structural control arrangements (Lumineau et al., 2025).

Where buyer-access distance arises from fragmented interaction pathways, reverse-auction mechanisms illustrate how digitalization can induce time-compression distance by restructuring the temporal conditions of decision-making. Electronic reverse auctions impose fixed, algorithmically enforced bidding windows that intensify competitive pressure while sharply curtailing opportunities for deliberation, information exchange, and adaptive response, transforming procurement interactions into highly time-bounded events (Carter et al., 2004). Empirical and experimental research in operations management shows that such compressed temporal regimes elevate stress, increasing reliance on heuristics and reducing judgment quality when decision speed exceeds actors' cognitive capacity to process uncertainty (Bendoly, 2011). Under conditions of repeated, high-uncertainty decision making, diminished adjustment and error detection can cause formalized governance mechanisms to amplify rather than stabilize behavioral variability, particularly when procurement decisions must be made at scale (Burkhardt et al., 2023). Time-compression distance thus captures how reverse auctions condition the effectiveness of formal procurement governance by imposing decision speeds that can outpace adaptive sensemaking at the buyer–supplier interface.

If reverse auctions compress the temporal conditions of interaction, chatbot-based procurement systems illustrate how digitalization can reconfigure participation by embedding elevated capability requirements into standardized governance processes. Conversational agents and AI-enabled procurement assistants translate sourcing activities into structured dialogues that presume proficiency in digital interaction, data interpretation, and system navigation, thereby shifting coordination from relational exchange to technology-driven execution. Although such

systems are designed to scale standardization and reduce transaction costs, their use makes participation and responsiveness increasingly contingent on suppliers' digital, analytical, and organizational capabilities (De Vita et al., 2011). As agency becomes embedded in algorithmic systems that guide and filter procurement interaction, differences in effective participation become visible through delayed responses, reduced visibility, or constrained engagement for suppliers lacking requisite capabilities (Angelopoulos et al., 2023). This divergence illustrates capability distance as a digitally induced separation through which standardized chatbot-based governance yields uneven coordination outcomes at the buyer-supplier interface (Cui, Li, & Zhang, 2022).

Taken together, the preceding illustrations underscore that digitally induced distance is not a property of particular technologies, but an emergent effect of how digitalization reconfigures interaction conditions at the buyer-supplier interface. Procurement portals, reverse auctions, and chatbot-based systems each reshape access, temporal pacing, and capability requirements in distinct ways, yet none induces a single, isolated form of distance; instead, distance arises from the specific configuration and use of these technologies within broader governance designs. Consistent with contingency theory, governance effectiveness depends not on the presence of a given technology but on the alignment between digital interaction conditions and task, relational, and environmental demands (Donaldson, 2001). A sociomaterial perspective further highlights that these effects are enacted through ongoing practice, as human and digital agencies become constitutively entangled, allowing the same technology to generate multiple, shifting distances over time (Orlikowski, 2007). Recognizing the non-exclusive and dynamic nature of digitally induced distance clarifies why digital transformation can produce

heterogeneous governance outcomes even under formally similar designs (Angelopoulos et al., 2023).

DISCUSSION

This paper examines why well-established organizational design principles increasingly fail to produce their expected coordination outcomes in digitalized supply chains. Drawing on organizational design theory, we argue that centralization, formalization, and standardization do not operate as stable levers once governance is enacted through digital infrastructures that influence interaction at the buyer-supplier interface. Rather than uniformly enhancing coordination, control, or efficiency, these design elements become conditionally effective as digital systems reshape how authority is accessed, how quickly decisions must be made, and who can meaningfully participate in execution. By conceptualizing digitally induced distance as a moderating condition, this paper extends organizational design theory to explain why formally sound governance designs can yield uneven, unstable, or counterintuitive outcomes under digitalization.

A central insight of organizational design theory is that structural choices improve coordination by aligning authority, rules, and routines with task interdependence and environmental demands (Donaldson, 2001). However, these arguments rest on a set of enabling conditions that are rarely made explicit. Centralization presumes that those holding decision authority can access relevant information and engage in sensemaking across organizational boundaries. Formalization assumes that rules and procedures can be interpreted, adapted, and applied with sufficient deliberation to stabilize interaction. Standardization presupposes that participating actors possess the technical, organizational, and analytical capabilities required to

enact uniform processes as intended. When these conditions hold, organizational design elements are expected to function as reliable mechanisms for coordination and performance.

Digitalization systematically disrupts these enabling conditions by reconstituting interaction at the buyer-supplier interface. As governance is increasingly enacted through interfaces, workflows, and algorithmic systems, access to authority is filtered, temporal latitude for interpretation and adjustment is compressed, and participation thresholds are embedded into routine execution. These changes do not alter formal governance structures directly, but they reshape the conditions under which such structures are enacted in practice. Digitally induced distance thus emerges from the configuration and use of digital systems, conditioning how organizational design choices perform rather than determine outcomes independently. This perspective clarifies why governance arrangements grounded in well-established design principles may weaken or distort once interaction is influenced through digital infrastructure rather than sustained through direct organizational engagement.

Extending Organizational Design Theory Through Digitally Induced Distance

Viewing digitally induced distance as a conditioning feature of governance extends organizational design theory by relaxing its implicit assumption of stable interaction conditions. Classic contingency arguments hold that structural elements such as centralization, formalization, and standardization can be aligned with task and environmental demands to improve coordination and performance. Our analysis suggests that this alignment logic remains intact, but that its effectiveness depends on whether the conditions under which governance is enacted support access to authority, temporal latitude for interpretation, and capability alignment in execution. When these conditions are reconstituted at the buyer-supplier interface, established design levers may no longer operate as theorized, even when their formal specification remains

unchanged. Digitally induced distance thus specifies an interface-level contingency that complements, rather than displaces, existing organizational design accounts.

This perspective also shifts the locus of organizational design from formal structures alone to the conditions through which governance is enacted in practice. Authority, rules, and standards increasingly take effect through routinized interaction patterns that structure escalation, interpretation, and participation across organizational boundaries. As these conditions stabilize over time, organizational design choices are realized less through episodic managerial intervention and more through the patterned enactment of governance in everyday interaction. Recognizing the enactment conditions of governance as analytically central highlights how organizational design operates not only through formal allocation of authority and rules, but through the sustained configuration of interaction at the interface where coordination occurs.

Digital Technologies as Governance-Moderating Mechanisms

Much of the supply chain and operations literature conceptualizes digital technologies as infrastructural supports that enhance information quality, transparency, and coordination while remaining orthogonal to governance design. In this view, digital systems are treated as efficiency-enhancing tools that strengthen the execution of existing governance arrangements, particularly under conditions of complexity and uncertainty. While this framing has generated important insights into digital integration and operational performance, it largely abstracts from how digitalization reshapes the interaction conditions through which governance is enacted at organizational boundaries.

Reconceptualizing digital technologies as governance-moderating mechanisms shifts attention from technological presence to how digital systems structure interaction in practice.

Digital interfaces configure access to authoritative actors, impose temporal pacing on decision processes, and embed participation thresholds into routine execution by encoding assumptions about speed, precision, and capability. In doing so, digital systems do not merely support governance arrangements but actively shape how they are enacted and experienced. From this perspective, digitally induced distance provides a conceptual lens for understanding how digitalization conditions governance effectiveness by stabilizing particular interaction conditions at scale, even when formal governance structures remain unchanged.

Boundary Conditions and Governance Complements

The effects of digitally induced distance are contingent rather than uniform across supply chain contexts. Distance becomes most consequential in governance settings characterized by frequent exceptions, high task equivocality, and heterogeneous supplier capabilities, where effective coordination depends on timely interpretation, escalation, and adjustment at the buyer-supplier interface. In contrast, in highly routinized environments with stable demand, limited uncertainty, and homogeneous partners, governance may operate with relatively few coordination breakdowns even when interaction is constrained. Digitally induced distance therefore does not uniformly undermine governance effectiveness; instead, it shapes when and where established governance arrangements are most vulnerable to disruption.

The organizational consequences of digitally induced distance also depend on the presence of complementary governance arrangements that enable adjustment when standardized or system-embedded processes break down. Mechanisms such as escalation pathways, exception handling procedures, and opportunities for human intervention can buffer the effects of distance by reintroducing interpretive flexibility and dialogic interaction at critical moments. From a theoretical perspective, these complements do not replace governance but condition its operation

by preventing distance from accumulating unchecked. Recognizing the role of such complements clarifies that governance effectiveness depends not only on the configuration of digital systems but also on how organizations design the surrounding structures that allow distance to be identified, managed, and mitigated over time.

Implications for Future Research

This theory opens several avenues for empirical research on digitalization and its interaction with governance. Future studies could operationalize digitally induced distance at the interface level by examining how access to authority, temporal latitude for decision making, and participation thresholds are structured through digital systems in practice. Such work would benefit from research designs that move beyond cross-sectional performance associations to capture how distance emerges, stabilizes, and evolves over time, including longitudinal field studies, process analyses, and experiments that manipulate interaction conditions directly. By treating distance as an outcome of digitalization rather than an exogenous constraint, researchers can more precisely examine how governance mechanisms perform under varying digital configurations.

Beyond measurement, this perspective invites new theoretical questions about the dynamics of governance in digitalized supply chains. Future research could examine how digitally induced distance accumulates or attenuates as systems scale, how actors adapt to or circumvent digitally constructed constraints, and how governance arrangements evolve when decision authority is increasingly delegated to algorithmic systems. Additional work might explore how suppliers respond strategically to participation thresholds embedded in digital interfaces, or how organizations recalibrate governance complements over time as digital

systems mature. Addressing these questions would deepen understanding of how digitalization reshapes governance not as a one-time design choice, but as an ongoing and contested process.

CONCLUSION

By showing how digital systems condition access, temporal pacing, and participation at the buyer-supplier interface, this paper demonstrates that established organizational design principles operate differently once governance is enacted through digital infrastructures. Rather than treating digital technologies as neutral supports, this perspective highlights their role in structuring the interaction conditions through which authority, rules, and standards take effect in practice. Recognizing digitally induced distance as an inherent and governable feature of digitalization shifts attention from the formal specification of governance arrangements to the ongoing configuration of interfaces through which coordination is enacted, offering a foundation for more intentional theorizing about governance in digitalized interorganizational settings.

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FIGURE 1
Conceptual Framework

