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Does proximity foster collaboration? exploring the role of proximity in shaping relationship quality and knowledge flow in inter-organizational projects

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ABSTRACT

Inter-organizational projects (IOPs) are increasingly adopted to address complex and knowledge-intensive tasks across diverse industries. Effective inter-organizational knowledge flow is crucial for IOPs success but is often hindered by weak relational foundations, divergent systems, and limited collaboration history. Although prior studies identify trust and relational quality as central enablers of inter-organizational knowledge flow, they largely treat these relational conditions as pre-existing rather than examining how they are formed. As a result, the contextual antecedents that shape relational foundations—particularly the various forms of organizational proximity—remain insufficiently theorized in the project management literature. This gap is especially salient in IOPs, where organizations often lack collaboration history and operate under divergent governance systems. Drawing on transaction cost theory and social capital theory, this study examines how six dimensions of inter-organizational proximity—geographical, cultural, institutional, technological, policy, and goal—affect knowledge flow in IOPs, and whether this relationship is mediated by relationship quality. A sequential mixed-methods approach was employed, combining a three-wave survey of 272 professionals with semi-structured interviews in five representative IOPs. The results reveal a clear hierarchy: goal and cultural proximity are the primary drivers of relationship quality and knowledge flow, while technological proximity exhibits a significant negative impact on knowledge flow, a paradox attributed to perceived competition. Furthermore, geographical proximity has a moderate effect, and policy/institutional proximities are important but insufficient. Crucially, relationship quality serves as the central mechanism that translates structural proximity into effective collaboration. By bringing a knowledge governance and organizational proximity perspective to IOPs, this study contributes to the project management literature on the structural antecedents of relational conditions and offers practical guidance for partner selection and knowledge governance in complex, multi-organizational environments.

1. Introduction

With increasing task complexity and resource interdependence, inter-organizational projects (IOPs) have become a prevalent organizational form across sectors such as construction, biotechnology, and IT (Roehrich et al., 2024; Sun et al., 2024; Tannir et al., 2024). Defined as temporary collaborations among independent organizations to achieve shared goals, IOPs enable the pooling of diverse expertise, distribution of risks, and pursuit of innovation in ways that internal projects cannot achieve (Areias & Eiriz, 2013; Liu et al., 2021; Martinsuo & Ahola, 2022). However, while IOPs offer strategic advantages, their temporary and cross-boundary nature also introduces significant challenges, especially in knowledge governance (Musawir et al., 2017; Ning & Zwikael, 2024; Tannir et al., 2024).

Among these, the effective flow of knowledge across organizational boundaries has emerged as a critical determinant of project performance, influencing decision-making, innovation, and integration of distributed expertise (Mighaninejad & Jafarpanah, 2024; Zhou et al., 2024). Yet, knowledge flow in IOPs is frequently constrained by weak relational foundations, divergent organizational systems, and limited

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collaboration history (Jones & Lichtenstein, 2008; Wang et al., 2025; Zhou et al., 2024). For instance, Barbosa et al. (2017) reported that large construction projects typically face delays and cost overruns, often due to poor collaboration and ineffective knowledge sharing among project partners (Barbosa et al., 2017). A well-known example is the Crossrail project in the UK, where fragmented knowledge coordination across multiple organizations contributed to major integration failures, highlighting the costly risks of inadequate knowledge governance in temporary, multi-party settings (Muruganandan et al., 2022; Whyte et al., 2022).

Despite growing attention to knowledge governance in projects, several critical gaps persist in the project management literature. First, although knowledge governance has long been a central theme in project-based research, most existing studies focus on intra-organizational projects, where knowledge flows within shared cultural contexts and relatively stable routines (Argote, 2024; Jia et al., 2025; Pemsel & Müller, 2012). In contrast, IOPs, which involve temporary collaboration among independent actors, present unique governance challenges that remain underexplored (Sydow & Braun, 2018). Second, existing research often treats formal governance (e.g., contracts, structures) and informal relational (e.g., trust, shared norms) as separate domains, with limited attention to how broader contextual conditions shape relationship quality and knowledge flow (Pemsel & Müller, 2012). This fragmented view constrains our understanding of how collaboration unfolds across organizational boundaries.

To address these gap, this study introduces the concept of inter-organizational proximity, a multidimensional construct rooted in economic geography that refers to the degree of similarity or "closeness" between organizations across various dimensions, including geographical, cultural, institutional, technological, policy, and goal (Boschma, 2005a; Chumnangoon et al., 2021; Knoben & Oerlemans, 2006). While proximity has been extensively studied in regional innovation systems and cluster research, its application to temporary, project-based inter--organizational contexts remains scarce (Ferretti et al., 2022; Tandon et al., 2024). We propose that proximity dimensions serve as contextual conditions that shape the emergence of relationship quality, which in turn mediates their impact on knowledge flow. Grounded in transaction cost theory (TCT) and Social Capital Theory (SCT), this study develops a theoretical model in which the six dimensions of proximity are hypothesized to affect inter-organizational knowledge flow through the mediating mechanism of relationship quality. According to TCT, we argue that organizational proximity—such as geographical closeness and shared institutional norms—can reduce coordination costs, thereby facilitating more efficient collaboration (Gulati & Singh, 1998; Williamson, 1981). Based on SCT, we propose that shared goals and cultural values foster trust, communication, and mutual identification, which are essential for effective knowledge exchange (Inkpen & Tsang, 2005; Nahapiet & Ghoshal, 1998a). By integrating these perspectives, we theorize how different dimensions of inter-organizational proximity shape relationship quality and knowledge flow in IOPs.

To test this model, we employed a sequential mixed-methods design. We first collected three-wave survey data from 272 IOP professionals to test the hypotheses using Structural Equation Modeling. We then conducted semi-structured interviews with managers from five projects to complement and contextualize the quantitative results. This approach bridges statistical generalization and contextual depth. The study addresses two research questions:

RQ1: How do different proximity dimensions differentially influence relationship quality and knowledge flow in IOPs?

RQ2: To what extent does relationship quality mediate the effects of proximity on knowledge flow in IOPs?

This study offers several theoretical and practical contributions. Theoretically, it advances project management by introducing proximity as a contextual antecedent of relationship quality and knowledge flow, thereby reconfiguring the understanding of knowledge governance in temporary, multi-organizational settings. It challenges the assumption that all proximity dimensions are beneficial by revealing their differentiated effects—such as the enabling roles of goal and cultural proximity and the potentially inhibiting role of technological proximity. It further contributes by integrating TCT and SCT to develop a framework that bridges structural and relational perspectives. Practically, the study provides guidance for IOP managers in partner selection and knowledge governance, enabling more effective collaboration in complex, cross-organizational project environments.

2. Literature review and hypotheses development

2.1. Inter-organizational knowledge flow in project contexts

Inter-organizational knowledge flow refers to the movement of explicit and tacit knowledge between organizations engaged in collaborative arrangements (Anand et al., 2021; Argote, 2024). Compared to other related constructs such as knowledge sharing or knowledge transfer, knowledge flow emphasizes a broader and more systemic process that includes not only the voluntary provision of knowledge, but also its transmission, acquisition, integration, and transformation within collaborative settings . This construct is particularly suited for IOPs, where knowledge does not merely get "shared" in a linear fashion but flows reciprocally through formal structures and informal relationships. In project-based settings, particularly in IOPs, efficient knowledge flow is critical for innovation, problem-solving, and project success (Argote, 2024; Loebbecke et al., 2016). However, temporary project structures, limited collaboration history, and organizational heterogeneity often obstruct effective knowledge flow in IOPs (Braun & Sydow, 2024; Liu et al., 2021; Zhang et al., 2022).

Previous research has primarily focused on intra-organizational knowledge governance mechanisms such as knowledge repositories, codification strategies, and team-based learning systems (Pemsel et al., 2014; Pemsel & Söderlund, 2024; Reich et al., 2014). These studies emphasize how project teams within a single organization capture and disseminate knowledge across project phases or among departments. However, IOPs differ fundamentally in that knowledge must flow across organizational boundaries, without shared culture, information systems, or governance structures (Mighaninejad & Jafarpanah, 2024). Consequently, frameworks developed for intra-organizational knowledge management may not fully capture the relational and structural complexities of knowledge flow in IOP settings.

To address this gap, researchers have increasingly turned to governance mechanisms to explain knowledge flow in collaborative settings. One stream of literature emphasizes formal governance, including contractual safeguards, hierarchical control, and standardization (Fernandes et al., 2023; Kujala et al., 2021; Pemsel et al., 2014). Another stream highlights informal mechanisms, such as trust, relational embeddedness, and social interaction, which facilitate tacit knowledge flow (Ning & Zwikael, 2024; Tannir et al., 2024; Zwikael et al., 2023). However, these two streams are often treated in isolation, overlooking how contextual conditions—such as alignment in organizational goals, systems, or cultures—shape the formation of relationships and the enactment of governance mechanisms in the first place.

Addressing this limitation, this study introduces inter-organizational proximity as a structural antecedent that shapes both relational dynamics and knowledge flow in IOPs. By conceptualizing proximity as a multidimensional construct, we aim to build a more integrated understanding of how structural and relational mechanisms jointly shape knowledge governance in temporary, cross-organizational projects.

2.2. Proximity and its role in inter-organizational collaboration

Proximity theory, originating from economic geography, initially emphasized the role of geographical proximity in enabling face-to-face interactions, reducing transaction costs, and facilitating tacit knowledge exchange (Boschma, 2005a; Monge et al., 1985). Over time, the

concept expanded to include multiple non-spatial dimensions—such as cultural, institutional, technological, policy, and goal proximity—to capture the multifaceted nature of inter-organizational collaboration (Dutta et al., 2022; Houessou et al., 2023). While this multidimensional framework offers valuable theoretical breadth, proximity research still faces several critical challenges. First, definitional ambiguity and measurement inconsistencies persist across studies, with considerable overlap between dimensions and lack of consensus on their operationalization (Fernández et al., 2021; van Zoonen et al., 2023). Second, although many studies explore individual proximity dimensions in isolation, few compare their relative impacts within a unified empirical setting, limiting both theoretical precision and practical relevance (Davids & Frenken, 2018). Third, emerging evidence suggests that the effects of proximity are not universally positive. Certain dimensions may generate diminishing or even negative returns, such as technological proximity inducing competitive tensions, thereby challenging the conventional assumption that "closer is always better" (Davids & Frenken, 2018; Holdt Christensen & Pedersen, 2018).

To theorize how proximity dimensions shape knowledge flow, we integrate insights from TCT and SCT. From the perspective of TCT, proximity acts as a structural mechanism reducing transaction costs by lowering the complexity, uncertainty, and potential for opportunistic behaviors in collaboration (Gulati & Singh, 1998; Williamson, 1981). For example, geographical proximity facilitates face-to-face interactions, significantly lowering coordination and communication costs; cultural proximity reduces misunderstandings and conflicts arising from cultural differences; policy proximity minimizes regulatory conflicts and compliance costs; goal proximity enhances strategic alignment and reduces goal ambiguity; institutional proximity decreases frictions stemming from divergent governance structures and practices; and technological proximity reduces coordination difficulties in technical integration.

Complementarily, SCT highlights how proximity influences relational mechanisms such as trust, communication, and commitment, which constitute the relational capital necessary for effective knowledge transfer and integration(Inkpen & Tsang, 2005; Jones & Lichtenstein, 2008; Nahapiet & Ghoshal, 1998a). Specifically, geographical proximity promotes frequent informal interactions, facilitating stronger interpersonal relationships and trust-building; cultural proximity fosters shared norms, values, and language, enhancing mutual understanding and relationship quality; policy and institutional proximities reduce uncertainty, thus enhancing procedural trust and relational stability; goal proximity strengthens partners' shared purpose and mutual commitment; and technological proximity, when viewed as complementary rather than competitive, enhances cognitive alignment and trust in partners' capabilities.

By situating proximity as a contextual antecedent influencing relational capital formation, we propose the following hypotheses:

Hypothesis 1. Inter-organizational proximity positively influences knowledge flow in IOPs. Specifically, the higher the levels of geographical (H1a), cultural (H1b), policy (H1c), goal (H1d), institutional (H1e), and technological (H1f) proximity among organizations, the more efficient the knowledge flow in IOPs.

Hypothesis 2. Inter-organizational proximity positively influences relationship quality in IOPs. Specifically, the higher the levels of geographical (H2a), cultural (H2b), policy (H2c), goal (H2d), institutional (H2e), and technological (H2f) proximity among organizations, the better their relationship quality in IOPs.

2.3. Relationship quality and its mediating role

In IOPs, collaboration is often hampered by organizational unfamiliarity, divergent goals, and limited relational history (Tannir et al., 2024). As a result, establishing high-quality inter-organizational relationships becomes essential to overcoming barriers to collaboration and knowledge flow (Siemieniako et al., 2022). Relationship quality refers to the overall state of trust, commitment, and communication between partnering organizations (Bachmann & Inkpen, 2011; Crosby et al., 1990). It reflects not only the willingness to cooperate but also the confidence in mutual reliability and alignment of interests.

From the perspective of SCT, relationship quality constitutes a key form of relational capital that enables the voluntary exchange of valuable resources, particularly tacit knowledge (Loebbecke et al., 2016). High-quality relationships promote frequent and transparent communication, reduce uncertainty, and encourage partners to share sensitive or experience-based knowledge without fear of opportunism (Houessou et al., 2023; Saukko et al., 2020). In temporary and cross-cultural settings like IOPs, where formal contracts are often insufficient to address all contingencies, the presence of strong relational mechanisms becomes even more critical.

Despite recognizing the importance of relationship quality, existing studies predominantly consider it an independent predictor of knowledge flow outcomes (Siemieniako et al., 2022), neglecting its potential mediating role between structural antecedents and knowledge flow. We argue that relationship quality mediates the relationship between proximity and knowledge exchange; structural proximity dimensions establish relational conditions necessary to form high-quality relationships, which in turn facilitate efficient knowledge flows.

Integrating these arguments, we propose the following hypotheses:

Hypothesis 3. (H3): Relationship quality has a positive effect on knowledge flow in IOPs.

Hypothesis 4. (H4a–H4f): Relationship quality mediates the relationship between inter-organizational proximity and knowledge flow in IOPs. Specifically, the higher the levels of (H4a) geographical, (H4b) cultural, (H4c) policy, (H4d) goal, (H4e) institutional, and (f) technological proximity, the better the relationship quality, which in turn enhances knowledge flow.

Fig. 1 illustrates the conceptual framework, depicting the direct effects of the six proximity dimensions on both knowledge flow and relationship quality, as well as the mediating role of relationship quality. (Fig. 2)

3. Methodology

3.1. Research design

This study employs a sequential explanatory mixed-methods design to examine how inter-organizational proximity influences knowledge flow and relationship quality in IOPs. The quantitative phase tested the theoretical model and hypotheses using survey data analyzed through structural equation modeling, following guidelines for rigor and transparency in project management research (Zwikael, 2021). The subsequent qualitative phase, involving semi-structured interviews, provided contextual depth to interpret significant quantitative findings, aligning with best practices in mixed-methods research for bridging the qualitative–quantitative divide (Venkatesh et al., 2013).

3.2. Quantitative research

3.2.1. Variable measurement

All constructs in this study were measured with reflective items on a 7-point Likert scale, ranging from 1 ("Strongly Disagree") to 7 ("Strongly Agree"). Well-established scales from prior literature were adapted to the context of IOPs. The adaptation process primarily involved rewording items to reflect the project-based and inter-organizational nature of the collaboration. The initial questionnaire was refined through reviews by three academic experts and a pilot study with 30 professionals, which confirmed the clarity, face validity, and

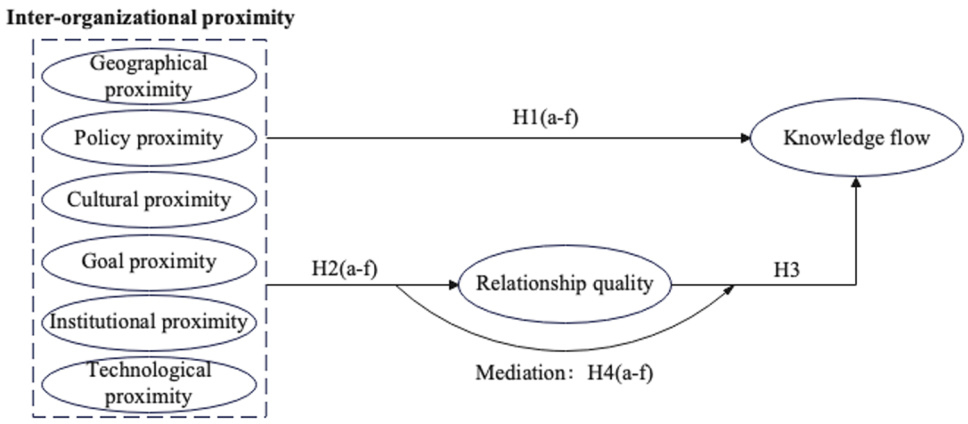

Fig. 1. Research model.

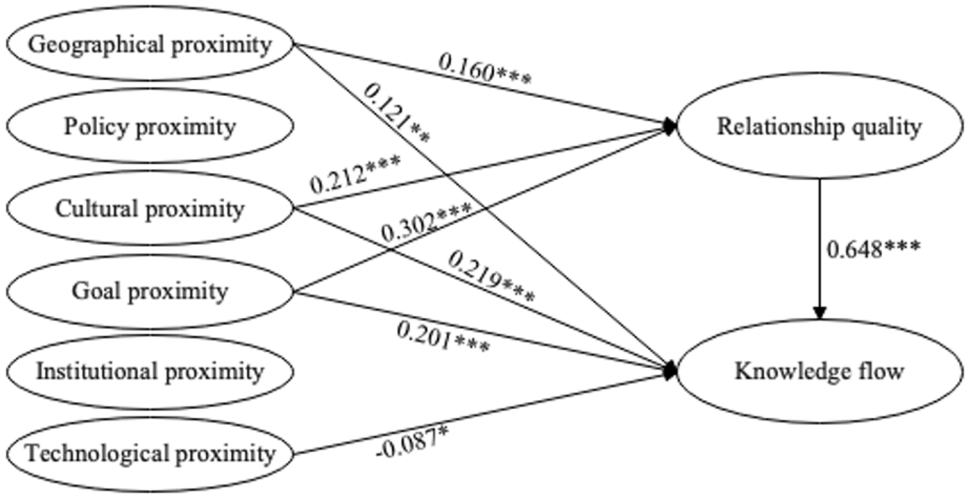

Fig. 2. Results of main effects.
Note: Solid lines indicate significance of path coefficients; dashed lines indicate that they are not significant. "***" represent "$p < 0.001$", "**" represent "$p < 0.01$".

preliminary reliability of all measures. The final measurement items are provided in Appendix A.

3.2.1.1. Inter-organizational proximity. This study conceptualizes inter-organizational proximity as a multidimensional construct comprising six distinct dimensions. The measurement scales were adapted from seminal and contemporary studies in proximity and alliance literature.

- Geographical Proximity was measured with three items assessing the ease of face-to-face interaction, adapted from Bathelt and Henn (2014).
- Policy Proximity was measured with three items evaluating the alignment of regulatory and political environments, adapted from Hong and Su (2013).
- Cultural Proximity was measured with three items capturing the similarity in values and work habits, adapted from the conceptualization of Duan et al. (2021) and subsequent operationalizations.
- Goal Proximity was measured with three items gauging the alignment of strategic objectives and priorities, adapted from the goal congruence literature in strategic alliances, informed by Hansen (2015).
- Institutional Proximity was measured with three items focusing on the similarity of organizational structures and management routines, adapted from the framework of Boschma (2005b).
- Technological Proximity was measured with three items concerning the overlap in knowledge bases and technical competencies, adapted from the technological proximity concept in Boschma (2005a).

3.2.1.2. Relationship quality. we extracted relevant items from the Inter-organizational Relationship Quality Scale (IORQS) proposed by Moorman (1992) and the Relationship Quality Scale (RQS) proposed by Hennig-Thurau (2002). These scales have been validated and widely applied across multiple industries and academic studies. We adapted these items to fit the context of IOPs and made appropriate modifications to align with our research objectives. Ultimately, 12 items are employed covering four key dimensions: trust, commitment, communication, and satisfaction. Through these items, we can comprehensively assess the inter-organizational relationship quality within IOPs.

3.2.1.3. Knowledge flow. Knowledge flow was measured using a six-item scale adapted from Rhodes et al. (2008). The scale captures the effectiveness of both explicit knowledge (e.g., documents, reports) and tacit knowledge (e.g., expertise, know-how) sharing between partner organizations, assessing the overall smoothness and depth of the knowledge transfer process within IOPs.

3.2.2. Sample and data collection

We selected international construction projects (ICPs) as the empirical setting for this study. These projects are temporary and involve

multiple participating organizations, which align with the essential characteristics of IOPs. Moreover, they involve partners from different countries and organizational backgrounds, resulting in significant cultural diversity and institutional heterogeneity. These features make ICPs a suitable context for our research. Consistent with the perceptual approach widely used in organizational-climate research (Glick, 1985; Meyer et al., 2014), we adopt the individual project-team member as the unit of analysis, because knowledge flow in IOPs ultimately originate from personal perceptions and behaviors. Data were collected in partnership with two international construction firms; senior managers facilitated access to overseas project offices.

We administered three survey waves to the same participant pool: T1 (proximity) via team WeChat groups; T2 (relationship quality) and T3 (knowledge flow) via email to respondents who consented to be re-contacted and provided an email address for matching. Two-week lags separated waves. We obtained 387 valid responses at T1, 294 at T2, and 284 at T3; after matching and cleaning (removing submissions completed unrealistically fast, straight-lining, and incorrect responses to reverse-coded items), the final matched sample was $N = 272$ (70.2 % of T1). Respondent demographics are reported in Table 1. We received ethics approval from Institutional Review Board of Southeast University (Approval No SEUIRB202509006); participation was voluntary and anonymous with informed consent.

3.2.3. Data analysis

The quantitative data were analyzed using a multi-step process. First, reliability was assessed via Cronbach's alpha and composite reliability (CR). Confirmatory factor analysis was performed to assess convergent and discriminant validity, with model fit indices reported. Structural equation modeling was used to test the hypothesized paths, followed by bootstrapping (5000 samples) to examine mediation effects. All analyses were conducted using Mplus 7.0.

3.3. Qualitative research

To further explore and validate findings from the quantitative analysis, we conducted qualitative semi-structured interviews. This qualitative phase provided deeper insights into how specific proximity dimensions impact relationship quality and knowledge flow within IOPs and aimed to contextualize and interpret the quantitative results.

Table 1
Demographic information on survey participants ($N = 272$).

Item	Category	Amount	Percentage (%)
Gender	male	166	61.03 %
	female	106	38.97 %
Age	<25	22	8.09 %
	25–35	114	41.91 %
	36–45	78	28.68 %
	46–55	42	15.44 %
	>55	16	5.88 %
Years of Experience	<3 years	24	8.82 %
	3–5 years	40	14.71 %
	6–10 years	61	22.43 %
	11–15 years	48	17.65 %
	16–20 years	39	14.34 %
	>20 years	42	15.44 %
Position	Top management team	14	5.15 %
	Project manager	39	14.34 %
	Department manager	45	16.54 %
	Project engineer	90	33.09 %
	other	98	36.03 %
Project duration	6 months or below	18	6.62 %
	7–12 months	51	18.75 %
	13–24 months	101	37.13 %
	25 months or above	102	37.50 %

3.3.1. Sampling and data collection

We conducted a series of semi-structured interviews with senior project leaders from five representative IOPs projects, covering diverse project types and geographical locations. A total of 10 experienced project leaders holding key managerial and technical roles participated in the study, ensuring rich contextual diversity and valuable insights into collaborative dynamics. Each interview lasted approximately 40 to 60 min and was conducted via secure online video conferencing platforms. All interviews were audio-recorded with participants' informed consent and subsequently transcribed verbatim using professional transcription software. Table 2 provides details about the interview samples and corresponding project characteristics.

3.3.2. Interview guide

The semi-structured interview guide was organized into four sequential sections, beginning with an introduction to establish context, followed by an overall discussion of proximity's role, in-depth exploration of each proximity dimension, and concluding with an opportunity for additional insights or examples. A complete list of the interview questions can be found in Appendix B.

3.3.3. Data analysis

Qualitative data were analyzed using thematic content analysis following (Braun & Clarke, 2006) six-phase framework. To ensure rigor and enhance trustworthiness, two independent researchers coded each transcript, with discrepancies resolved through iterative discussions. A third researcher reviewed the final codebook and themes for validity and consistency. Emergent themes were then systematically compared against the quantitative results to provide deeper understanding, validate the initial findings, and illuminate complex mechanisms by which proximity dimensions influenced knowledge flow and relationship quality in IOPs.

4. Result

4.1. Quantitative results

4.1.1. Reliability and validity test

Reliability refers to the consistency of a measure, and it is often evaluated using Cronbach's Alpha and CR (Fornell & Larcker, 1981). As a widely used measure of internal consistency, Cronbach's Alpha values above 0.7 indicate acceptable reliability (Nunnally, 1978). In this study, all latent variables exhibit Cronbach's Alpha values above 0.7, as shown in Table 3, indicating that the scales used are reliable. CR values above 0.7 are considered acceptable for reliability (Fornell & Larcker, 1981). All latent variables in the measurement model achieved CR values greater than 0.7, demonstrating consistent reliability across constructs. This confirms that the items are consistently measuring the constructs.

Table 2
Details about the interview samples and corresponding project.

Project	Project Type	Number of Companies in IOPs	Project Location	Interviewees' Positions
Project 1	Transportation	3	Kuwait	Project Manager, MEP Manager
Project 2	Building Construction	2	Serbia	Project Manager, Structural Engineer
Project 3	Transportation	3	Zambia	Project Manager, Chief Project Designer
Project 4	Manufacturing	3	Pakistan	Project Manager, Project Supervisor
Project 5	Building Construction	2	Hong Kong	Project Manager, Project Cost Manager

Table 3
Reliability and validity test of measure model.

Latent variable	Item	FL	Mean	SD	Alpha	CR	AVE
Geographical proximity	GP1	0.886	3.849	1.000	0.855	0.856	0.666
	GP2	0.764	4.040	0.946			
	GP3	0.795	3.710	0.991			
Policy proximity	PP1	0.732	3.985	0.897	0.806	0.807	0.584
	PP2	0.841	3.912	0.941			
	PP3	0.713	3.971	0.913			
Cultural proximity	CP1	0.776	2.765	1.186	0.828	0.829	0.618
	CP2	0.769	2.809	1.268			
	CP3	0.813	2.699	1.129			
Goal proximity	GOP1	0.836	4.375	0.828	0.894	0.896	0.743
	GOP2	0.899	4.279	0.886			
	GOP3	0.849	4.125	0.937			
Institutional proximity	IP1	0.867	3.842	1.002	0.863	0.869	0.688
	IP2	0.810	3.662	1.043			
	IP3	0.811	3.463	1.250			
Technological proximity	TP1	0.793	3.842	1.178	0.832	0.833	0.625
	TP2	0.791	3.849	1.068			
	TP3	0.788	3.875	1.083			
Relationship quality	RQ1	0.834	4.320	0.701	0.945	0.949	0.609
	RQ2	0.771	3.978	0.933			
	RQ3	0.751	4.254	0.809			
	RQ4	0.789	4.040	0.934			
	RQ5	0.795	4.066	0.919			
	RQ6	0.808	3.588	1.093			
	RQ7	0.790	3.801	1.065			
	RQ8	0.844	3.996	1.183			
	RQ9	0.722	3.868	1.092			
	RQ10	0.735	3.860	1.098			
	RQ11	0.731	3.930	1.001			
	RQ12	0.783	3.879	1.068			
Knowledge flow	KF1	0.805	4.320	0.827	0.896	0.900	0.602
	KF2	0.826	4.272	0.787			
	KF3	0.853	3.871	0.988			
	KF4	0.782	3.768	1.017			
	KF5	0.689	4.151	0.848			
	KF6	0.682	4.191	0.806			

Note: SD denotes standard deviation; Alpha denotes Cronbach's Alpha.

Validity is assessed in terms of convergent and discriminant validity. Convergent validity is evaluated through factor loadings (FL) and the Average Variance Extracted (AVE). In this study, most factor loadings are above the acceptable threshold of 0.7, indicating that the items are strongly associated with their respective constructs (Hair et al., 2012). AVE values above 0.5 indicate that a construct explains more than half of the variance of its indicators (Fornell & Larcker, 1981). As shown in Table 3, all constructs have AVE values exceeding 0.5, confirming convergent validity.

Discriminant validity ensures that each construct is distinct from others. This was assessed by comparing the square root of the AVE for each construct with its correlations with other constructs (Fornell & Larcker, 1981). Table 4 shows that the square root of the AVE for each construct is greater than its correlations with other constructs, confirming discriminant validity. This demonstrates that each construct measures a unique dimension within the theoretical model.

4.1.2. Model fitness test

The model fitness was evaluated using a range of fit indices across absolute, incremental, and parsimonious categories. The results indicate a satisfactory model fit, with most indices either meeting or closely approaching the recommended thresholds. Specifically, absolute fit indices such as the Chi^2 /df (1.169) and the RMSEA (0.025) demonstrate a good model fit, while incremental fit indices like the CFI (0.984) and TLI (0.982) further confirm the model's adequacy. Parsimonious fit indices, including PGFI, PNFI, and PCFI, also exceed the acceptable thresholds, supporting the model's simplicity and efficiency in representing the underlying constructs. These findings collectively suggest that the model provides a robust fit to the data and is well-suited for subsequent analysis.(Table 5)

4.1.3. Hypothesis test

4.1.3.1. Main effects. The main effects analysis, as shown in Table 6,

Table 4
Discriminant validity analysis.

	GP	PP	CP	GOP	IP	TP	RQ	KF
Geographical proximity	0.816							
Policy proximity	0.403	0.764						
Cultural proximity	0.32	0.317	0.786					
Goal proximity	0.327	0.258	0.253	0.862				
Institutional proximity	0.419	0.404	0.398	0.397	0.83			
Technological proximity	−0.254	−0.258	−0.139	−0.288	−0.27	0.791		
Relationship quality	0.505	0.394	0.472	0.634	0.578	−0.387	0.78	
Knowledge flow	0.466	0.341	0.311	0.428	0.382	−0.345	0.665	0.776

Note: The diagonals are the square roots of the AVE.

Table 5
The recommended and actual value of fit indices.

Type	Index	Recommended value	Actual value
	Chi^2/df	<3	1.169
Absolute fit	GFI	>0.90	0.984
	RMR	<0.05	0.037
	RMSEA	<0.10	0.025
Incremental fit	NFI	>0.90	0.901
	IFI	>0.90	0.984
	TLI	>0.90	0.982
	CFI	>0.90	0.984
Parsimonious fit	PGFI	>0.50	0.752
	PNFI	>0.50	0.810
	PCFI	>0.50	0.884

reveals how various proximities impact relationship quality and knowledge flow, with some factors demonstrating significant positive effects while others show minimal or negative influence.

In terms of factors influencing relationship quality, goal proximity (H1d) exhibited the strongest positive effect ($\beta = 0.302$, $p < 0.001$), highlighting that shared goals significantly enhance relationship quality. Cultural proximity (H1c) also had a substantial positive effect ($\beta = 0.212$, $p < 0.001$), suggesting that cultural alignment fosters stronger relational ties. Geographical Proximity (H1a) positively impacted relationship quality ($\beta = 0.160$, $p < 0.001$), supporting the role of physical closeness in promoting collaboration. In contrast, policy proximity (H1b, $\beta = 0.024$, $p = 0.631$), institutional proximity (H1e, $\beta = 0.094$, $p = 0.129$), and technological proximity (H1f, $\beta = -0.069$, $p = 0.258$) did not significantly affect relationship quality, indicating these dimensions may not be primary drivers of relational enhancement in IOPs.

Regarding knowledge flow, relationship quality (H3) emerged as the most substantial factor ($\beta = 0.648$, $p < 0.001$), underscoring its pivotal role in facilitating knowledge flow. Cultural proximity (H2c) had a notable positive effect on knowledge flow ($\beta = 0.201$, $p < 0.001$), followed by cultural proximity (H2c; $\beta = 0.219$, $p < 0.001$) and geographical proximity (H2a; $\beta = 0.121$, $p < 0.01$), reinforcing how alignment in these areas supports effective knowledge flow. Interestingly, technological proximity (H2f) exhibited a significant negative effect on knowledge flow ($\beta = -0.087$, $p < 0.05$), suggesting that excessive technological similarity might impede knowledge flow. Policy proximity (H2b, $\beta = 0.066$, $p = 0.332$) and institutional Proximity (H2e, $\beta = -0.067$, $p = 0.240$) were not significant.

In summary, goal, cultural, and geographical proximities were significant contributors to relationship quality, while relationship quality itself had the most substantial positive effect on knowledge flow. Additionally, cultural, goal, and geographical proximities supported knowledge flow, with technological proximity showing a unique negative impact. These results highlight the importance of relational and cultural proximities in fostering knowledge exchange in collaborative settings.

4.1.3.2. Mediating effects. The mediating effects of relationship quality between proximity dimensions and knowledge flow were tested using bootstrapping with 5000 samples (Table 7). Goal proximity (H4d; indirect effect = 0.197, 95 % CI [0.123, 0.345], $p = 0.001$), cultural proximity (H4c; indirect effect = 0.138, 95 % CI [0.036, 0.205], $p = 0.017$), and geographical proximity (H4a; indirect effect = 0.102, 95 % CI [0.043, 0.177], $p = 0.022$) showed significant indirect effects, with confidence intervals excluding zero, supporting partial mediation through relationship quality. Technological proximity (H4f; indirect effect = −0.047, 95 % CI [−0.127, 0.032], $p = 0.070$) did not exhibit a significant indirect effect, as the CI included zero. Similarly, policy proximity (H4b; indirect effect = 0.016, 95 % CI [−0.039, 0.088], $p = 0.545$) and institutional proximity (H4e; indirect effect = 0.067, 95 % CI [−0.048, 0.214], $p = 0.134$) showed no mediation.

In summary, the mediating effects of relationship quality vary across different proximities. geographical, cultural, goal, and technological proximities demonstrate partial mediation effects, indicating that relationship quality is an essential pathway linking these proximities to knowledge flow. Conversely, policy and institutional proximities showed no significant mediation, suggesting these proximities do not exert a significant indirect effect on knowledge flow through relationship quality.

4.2. Qualitative results

To complement and interpret the quantitative findings, thematic analysis was conducted on the interview transcripts from five IOPs. The analysis aimed to explore how different proximity dimensions influenced inter-organizational relationship quality and knowledge flow.

4.2.1. Goal proximity as a strategic and relational anchor

A dominant theme across all interviews was the pivotal role of goal

Table 7
Results of mediating effects.

Path	Effect	SE	95 % confidence interval			Result
			Lower	Upper	P	
H4a: GP→RQ→KF	0.102	0.035	0.043	0.177	0.022	Supported
H4b: PP→RQ→KF	0.016	0.032	−0.039	0.088	0.545	Not Supported
H4c: CP→RQ→KF	0.138	0.043	0.036	0.205	0.017	Supported
H4d: GP→RQ→KF	0.197	0.057	0.123	0.345	0.001	Supported
H4e: IP→RQ→KF	0.067	0.043	−0.048	0.214	0.134	Not Supported
H4f: TP→RQ→KF	−0.047	0.024	−0.127	0.032	0.070	Not Supported

Table 6
Hypotheses test of the theoretical model.

Path	Standardized path coefficient(β)	SE	CR	*p*	result
H1a: GP→RQ	0.160	0.036	4.442	***	Supported
H1b: PP→RQ	0.024	0.050	0.480	0.631	Not supported
H1c: CP→RQ	0.212	0.034	6.235	***	Supported
H1d: GOP→RQ	0.302	0.045	6.711	***	Supported
H1e: IP→RQ	0.094	0.062	1.516	0.129	Not supported
H1f: TP→RQ	−0.069	0.061	−1.131	0.258	Not supported
H2a: GP→KF	0.121	0.048	2.521	**	Supported
H2b: PP→KF	0.066	0.068	0.970	0.332	Not supported
H2c: CP→KF	0.219	0.048	4.562	***	Supported
H2d: GOP→KF	0.201	0.051	3.943	***	Supported
H2e: IP→KF	0.067	0.057	1.175	0.240	Not supported
H2f: TP→KF	−0.087	0.042	−2.071	*	Supported (negative)
H3: RQ→KF	0.648	0.116	5.586	***	Supported

Note: "***" represent "$p < 0.001$", "**" represent "$p < 0.01$".

proximity in shaping effective inter-organizational relationships. Participants emphasized that shared project goals and aligned strategic priorities significantly enhanced trust, reduced conflict, and promoted open communication. As one project manager in Serbia noted, "When both sides are pushing in the same direction, even cultural misunderstandings don't escalate. Goal alignment makes it easier to forgive small issues." This perception reinforces the quantitative finding that goal proximity was the strongest predictor of relationship quality. Interviewees explained that goal alignment facilitated joint problem-solving and fostered a collaborative atmosphere, acting as both a cognitive and emotional anchor for sustained knowledge exchange.

4.2.2. The duality of technological proximity

Another salient insight emerged regarding technological proximity, which was found to have a statistically significant negative effect on knowledge flow. Participants reported that while technological similarity reduced the complexity of knowledge integration, it also heightened perceived competition between partners, particularly in domains involving proprietary tools or overlapping technical expertise. A technical director in Kuwait explained, "We are highly protective of our core technologies and knowledge, especially when the partner has similar expertise—because in the next project, they could become our competitor." This finding enriches our understanding of technological proximity within the context of IOPs. Unlike the general expectation that proximity facilitates knowledge exchange, the temporary and high-stakes nature of IOPs may alter this effect. In settings where partners are both collaborators and potential future competitors, technological similarity can provoke protective behavior and lead to knowledge withholding. These insights highlight the need to consider how the competitive dynamics and limited relational history inherent in IOPs shape the role of proximity in inter-organizational knowledge processes.

4.2.3. Insights from other proximity dimensions

Cultural proximity was described as emotionally impactful. Several participants noted that shared language, customs, and informal social interaction fostered stronger bonds. A project manager in the Hong Kong-based project shared, "After we celebrated Mid-Autumn Festival together, I felt like the local engineers trusted me more, and we had more informal discussions." These cultural connections were seen as trust enhancers, contributing to smoother relationship management.

Geographical proximity was increasingly viewed as less critical due to advancements in remote collaboration. While physical closeness was once necessary for coordination, digital tools were now seen as sufficient. However, some interviewees noted that initial trust formation was still easier when partners were co-located during early project phases.

Policy and institutional proximity were often described as "necessary but not sufficient". While similarity in legal, regulatory, or organizational systems helped avoid misunderstandings, participants agreed that these factors alone were insufficient to trigger meaningful collaboration or sustained knowledge flow. In some cases, excessive formal similarity was perceived as creating rigidity that limited flexibility and responsiveness.

5. Discussion

5.1. General discussion

IOPs represent a key context for examining inter-organizational collaboration, as their temporary and heterogeneous nature amplifies knowledge flow challenges. This study investigated how inter-organizational proximity shapes relationship quality and knowledge flow in IOPs. Drawing on a sequential mixed-methods approach, we provide empirical evidence on how different proximity dimensions influence collaboration dynamics in temporary, multi-organizational project settings.

5.1.1. Core-driving proximities: goal and culture

Quantitative findings reveal that goal proximity and cultural proximity emerged as the strongest enablers in IOPs. This aligns with SCT, which posits that shared understandings and alignment foster trust and reciprocity (Nahapiet & Ghoshal, 1998b). In IOPs, where collaboration history is absent and relational foundations weak, goal alignment acts as a strategic anchor, fostering a shared identity focused on project outcomes. Our qualitative data confirm this: participants reported that shared goals allowed them to "forgive small issues," transforming potential conflicts into collaborative problem-solving. Similarly, cultural proximity, encompassing shared values, language, and norms, serves as a relational lubricant, accelerating trust development and tacit knowledge flow through informal communication. This suggests that in IOPs, relational dimensions may outweigh structural ones for success.

5.1.2. The paradox of technological proximity

Technological proximity showed a statistically significant negative effect on knowledge flow. This contradicts the cognitive proximity argument, which posits that similar knowledge bases facilitate learning and communication (Boschma, 2005a). We argue that IOPs' temporary context creates a boundary condition. In stable alliances or clusters, technological similarity fosters sustained collective learning. However, in IOPs, partners are often both collaborators and future competitors. Interview data reveal that overlapping expertise heightens competitive threat, particularly for proprietary knowledge (e.g., "In the next project, they could become our competitor," Project Manager, Project 4). This triggers defensive behaviors and knowledge withholding, rather than exchange. The finding refines proximity theory by introducing temporal and competitive contingencies, aligning with coopetition and knowledge hiding literature(Anand et al., 2022; Arain et al., 2024).

5.1.3. Context-enabling proximities: policy, institutional, and geographical

In contrast to the core-driving proximities, policy, institutional, and geographical dimensions function primarily as contextual enablers. Policy and institutional proximity appear as necessary but insufficient conditions for successful collaboration. While they reduce initial friction and transaction costs as predicted by TCT, their presence alone does not ensure deep relational engagement. This reflects a distinction between proximity as an enabler versus proximity as a driver (Balland et al., 2015), a nuance that pure quantitative models often overlook. Geographical proximity demonstrated a modest positive effect, consistent with studies that emphasize ease of coordination in co-located teams (Chumnangoon et al., 2021; Ferretti et al., 2022). However, interview data suggested its role has diminished in the era of virtual collaboration—reinforcing the notion that proximity effects are context-dependent and hierarchical (Kellerman, 2022). Together, these structural dimensions provide a foundation but require relational activation for impact.

5.1.4. The central mediating role of relationship quality

Mediation analysis provides a key bridge between structural antecedents and behavioral outcomes. Relationship quality—comprising trust, commitment, and communication—emerged as the central pathway through which goal, cultural, and geographical proximities enhance knowledge flow. This finding challenges studies that treat relationship quality as an exogenous variable (Siemieniako et al., 2022), instead theorizing it as a dynamic, emergent property of the project context. It is not merely that good relationships help; rather, specific structural conditions (like shared goals) are instrumental in creating these good relationships in the first place. This perspective integrates TCT, which focuses on reducing transaction costs through structural alignment, with SCT, which emphasizes relational capital. In sum, structural proximity translates into collaborative behavior by enabling relational quality in IOPs.

5.2. Theoretical contribution

This study makes three key theoretical contributions to the literature on project management, knowledge governance, and inter-organizational collaboration.

5.2.1. To knowledge governance theory: proposing proximity as strategic antecedents

This study reorients knowledge governance theory by shifting its focus from intra-organizational mechanisms to the inter-organizational antecedents of knowledge flow. We introduce multidimensional proximity as a pivotal set of antecedent conditions, thereby extending the theory's concern from "how to manage knowledge within a partnership" to "how to strategically configure partnerships" for knowledge-based success. By demonstrating the superior effectiveness of goal and cultural proximity over formal alignments, we offer a proactive, partner-selection lens to knowledge governance, enhancing its applicability to the transient and fragmented context of IOPs.

5.2.2. To proximity theory: revealing a hierarchy and contextual contingencies

This study advances proximity theory by demonstrating that its effects are not uniform but are structured by a clear hierarchy and are context-dependent. We establish that in IOPs, goal and cultural proximity are primary drivers, while technological proximity can inhibit knowledge flow due to perceived competition. This finding challenges the assumption that "closer is always better" and delineates the temporary and competitive nature of IOPs as a key boundary condition for technological proximity. Furthermore, we show that institutional, policy, and geographical proximities serve as foundational yet insufficient conditions. Collectively, these insights foster a more differentiated and contingent understanding of how proximity operates under conditions of bounded time and limited relational history.

5.2.3. To project governance theory: unlocking the mediating role of relationship quality

This study integrates Transaction Cost Theory (TCT) and Social Capital Theory (SCT) by empirically testing a sequential mediation model. We demonstrate that structural proximity dimensions (addressed by TCT) first cultivate high-quality relationships (addressed by SCT), which in turn enable knowledge flow. This finding clarifies a central mechanism in project governance by showing how static structural conditions are translated into dynamic collaboration. We thereby position relationship quality as the essential mediating mechanism that links structural alignment to behavioral outcomes, providing a more holistic and process-oriented understanding of governance in temporary settings.

5.3. Practical implications

This study offers actionable insights for IOPs to enhance collaboration, relationship quality, and knowledge flow. By analyzing the effects of proximity dimensions and relationship quality, this research identifies practical strategies for optimizing inter-organizational cooperation in complex, cross-cultural environments.

5.3.1. Leveraging goal and cultural proximity to drive collaboration

Our findings underscore the critical role of goal proximity and cultural proximity in facilitating both relationship quality and knowledge flow. Shared goals align organizational priorities, minimize conflicts, and promote collective commitment, while cultural proximity enhances mutual understanding and communication efficiency. To capitalize on these dimensions, IOPs should conduct goal alignment workshops during the project initiation phase to establish a unified direction and shared objectives. Additionally, invest in cross-cultural training programs to reduce misunderstandings and promote team cohesion.

5.3.2. Balancing technological proximity for effective knowledge exchange

While previous studies suggest that shared technological foundations facilitate collaboration, our findings reveal a significant negative impact of technological proximity on knowledge flow, potentially due to heightened competition and knowledge protection. To address this, IOPs should encourage technological complementarity by selecting partners with complementary rather than overlapping technical capabilities, thereby reducing competitive tensions. Additionally, establishing clear knowledge flow agreements through contractual frameworks that protect intellectual property while incentivizing open collaboration is essential.

5.3.3. Mitigating the limitations of geographical proximity

While geographical proximity positively influences knowledge flow, its impact is moderated by advances in communication technology. To maximize the benefits of physical closeness while addressing its limitations, IOPs should adopt virtual collaboration tools such as Microsoft Teams or Asana to facilitate real-time collaboration, even for geographically dispersed teams. Enhancing trust through periodic face-to-face interactions, such as biannual on-site visits, can further strengthen team dynamics and enhance tacit knowledge exchange.

5.3.4. Recognizing the structural role of policy and institutional proximity

Policy proximity and institutional proximity serve as foundational elements for ensuring compliance and stability, but they do not actively enhance knowledge flow or relationship quality. To maximize their utility, IOPs should standardize regulatory processes by developing clear, transparent procedures that align with international standards to reduce conflicts and delays. Facilitating policy alignment early through cross-border legal and policy advisors during contract negotiation stages can resolve potential discrepancies and ensure smoother project execution.

5.3.5. Strengthening relationship quality as a central enabler

Relationship quality emerged as a critical mediator between proximity dimensions and knowledge flow, emphasizing the need for strong inter-organizational trust, communication, and commitment. To enhance relationship quality, IOPs should invest in team-building activities such as informal gatherings, workshops, and retreats to foster interpersonal trust. Additionally, appointing communication facilitators—such as liaison officers or cultural mediators—can effectively bridge gaps between teams from different organizations or regions.

These practical implications highlight the need for IOPs to adopt an approach to managing proximity and relationship quality. By strategically leveraging proximity dimensions, balancing technological similarity, and fostering strong inter-organizational relationships, IOPs can create an environment conducive to knowledge sharing and innovation. These insights not only address the unique challenges of cross-border projects but also provide actionable guidance for practitioners seeking to optimize collaboration in global construction ventures.

5.4. Limitations and future directions

This study has several limitations that offer pathways for future research. First, although the three-wave time-lagged survey design reduces concerns about simultaneity, it remains observational and therefore cannot definitively confirm the causal chain from proximity to relationship quality and then to knowledge flow. Second, the focus on international construction projects within a specific region may limit the transferability of the identified proximity hierarchy to other industries or cultural contexts. Third, the reliance on perceptual measures from a single informant per project, despite procedural controls, carries a risk of common method bias.

Building directly on these limitations and our key findings, we propose three targeted research directions. First, longitudinal studies are needed to trace how the effects of proximity dimensions and relationship

quality evolve across different project phases, thereby testing the causal propositions of our model. Second, future research should investigate the technological proximity paradox uncovered in this study, exploring the governance mechanisms and contextual conditions that can mitigate its negative effects. Third, comparative studies across diverse industries and national cultures are essential to validate the generalizability of our framework and to delineate its boundary conditions.

6. Conclusion

Given the complexity of IOPs, understanding how to establish effective collaboration is critical for project success. This study investigates how different dimensions of proximity influence inter-organizational relationships and knowledge flow, emphasizing the mediating role of relationship quality.

Our findings yield three overarching conclusions. First, we establish a clear hierarchy of influence among proximity dimensions in IOPs. Goal and cultural proximity emerge as the primary drivers of collaboration, functioning as strategic anchors that foster shared identity and trust where relational history is absent. Second, we identify a critical paradox of technological proximity, where similarity in knowledge bases can trigger competitive concerns and knowledge withholding, thereby hindering rather than helping knowledge flow. This finding challenges the conventional wisdom of proximity theory and introduces the temporary, competitive context of IOPs as a key boundary condition. Third, we uncover the central mediating mechanism of relationship quality, demonstrating that structural proximities (like shared goals or policies) must first be translated into trust, commitment, and open communication to effectively enable knowledge flow.

This study contributes both theoretically and practically. Theoretically, it provides a more nuanced and contextualized understanding of proximity. It challenges the conventional wisdom by revealing a clear hierarchy among proximity dimensions and identifying the critical paradox of technological proximity in competitive, temporary settings. Furthermore, it advances knowledge governance theory by delineating the central mediating role of relationship quality, explaining how structural conditions are translated into collaborative knowledge flow. Practically, the findings provide actionable guidance for project managers in designing more collaborative and knowledge-enabling inter-organizational environments, particularly in cross-cultural or multi-party collaborations.

Future research could further explore how proximity dimensions evolve across different project phases and how their dynamic interplay with relationship quality affects long-term collaboration performance and learning. In doing so, scholars may continue building a more nuanced, process-oriented understanding of knowledge governance under temporary, uncertain, and interdependent project conditions.

CRediT authorship contribution statement

Yangzhi Yan: Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Liang Xiao:** Writing – review & editing, Software, Conceptualization. **Abubakar Sadiq Ibrahim:** Writing – review & editing, Software, Data curation, Conceptualization. **Xiaowei Luo:** Writing – review & editing, Supervision. **Xiaopeng Deng:** Writing – review & editing, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Measurement Scales and Item Sources

Response format: 7-point Likert (1 = strongly disagree, 7 = strongly agree).

A1. Proximity Constructs (Wave 1)

Construct	Code	Item
Geographical Proximity	GP1	Our organization and the partner organization are close enough for easy meetings.
	GP2	The distance to our partner makes communication convenient.
	GP3	The geographic distance between our organizations often hinders our project interactions. *(Reversed)*
Cultural Proximity	CP1	Our partner's cultural habits are similar to ours.
	CP2	We share common values with our partner.
	CP3	Cultural differences between our organizations lead to frequent misunderstandings in the project. *(Reversed)*
Policy Proximity	PP1	Our partner operates in a similar political context as we do.
	PP2	Our partner's regulatory policies align with ours.
	PP3	We share similar legal frameworks with our partner.
Goal Proximity	GOP1	Our project goals are aligned with those of our partner.
	GOP2	Our partner's strategic goals match ours.
	GOP3	Our collaboration priorities are aligned with our partner's.
Institutional Proximity	IP1	Our partner's organizational structure is similar to ours.
	IP2	Our partner's management style is aligned with ours.
	IP3	Our partner's rules and routines are compatible with ours.
Technological Proximity	TP1	We and our partner use the same technology platform.
	TP2	We share similar professional knowledge with our partner.
	TP3	We have comparable technological competencies with our partner.

A2. Inter-organizational Relationship Quality (Wave 2)

Construct	Code	Item
Relationship Quality	RQ1	We trust our partner organization during this collaboration.
	RQ2	Our partner organization reliably fulfills commitments and provides truthful information.
	RQ3	We believe our partner organization does not take advantage of us during the project.
	RQ4	Every organizations are committed to the success of this project and have invested resources.
	RQ5	Our partner organization shows dedication to achieving the project's goals.
	RQ6	Communication between our organization and our partner is clear, efficient, and transparent.
	RQ7	We regularly communicate with our partner to address project issues promptly.
	RQ8	Our partner organization responds promptly to our requests and concerns.
	RQ9	We are satisfied with the overall quality of our collaboration with the partner organization.
	RQ10	Our current collaboration with this partner encourages future engagement.
	RQ11	We sometimes doubt the reliability of our partner organization in this collaboration. *(Reversed)*
	RQ12	Communication with our partner often leads to misunderstandings or delays. *(Reversed)*

A3. Inter-organizational Knowledge Flow (Wave 3)

Construct	Code	Item wording
Knowledge Flow	KF1	Technical documents and manuals are frequently exchanged between our organizations.
	KF2	Our partner provides the required reports and technical data in a timely manner.
	KF3	Explicit knowledge, such as design specifications and standards, is effectively transferred between our organizations.
	KF4	Tacit knowledge is effectively shared with our partner through project collaboration.
	KF5	Our partner openly shares valuable experience and know-how during collaboration.
	KF6	We seldom gain useful valuable knowledge from our partner during project collaboration. *(Reversed)*

Appendix B. Semi-structured Interview Guide

Appendix B.

Section	Purpose	Example Questions
Introduction	Explain research background, objectives, and key terms	"I'd like to begin by briefly reviewing our study objectives."
Overall Impact of Proximity	Elicit general perceptions of how proximity shapes collaboration	"In your experience, how does proximity among partner organizations affect relationship quality and knowledge flow?" "Have you noticed whether being more 'similar' or 'closer' in some aspects helped or hindered collaboration?"
Dimension-Specific Probes	Explore each proximity dimension's effects on relationship quality and knowledge flow	Geographical proximity: "How does physical distance between sites influence coordination and knowledge exchange?" Cultural proximity: "Have cultural differences or similarities influenced trust or mutual understanding during collaboration?" Policy proximity: "Have regulatory or political differences between partners affected project implementation?" Goal proximity: "To what extent were you and your partners aligned in your project goals? How did that affect collaboration?" Institutional proximity: "How did similarities or differences in organizational structure and processes affect cooperation?" Technological proximity: "Did sharing similar technical platforms or tools make knowledge sharing easier or harder?"
Closing	Capture any additional insights or illustrative examples	"Are there any further observations or stories about how proximity influenced collaboration in your project that you'd like to share?" "Is there anything we didn't ask that you think is important to understanding how your organization worked with partners?"

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