JOURNAL OF GLOBAL TRENDS IN SOCIAL SCIENCE

JGTSS

Research article

https://doi.org/10.70731/c6wgxz82

Explaining Cost Performance in Belt and Road Transport Projects: Contractor Capabilities, Project Risk Management, and Cross-Cultural Communication

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Received 4 April 2026

Revised 9 May 2026

Accepted 24 May 2026

Published 28 May 2026

ISSN 2759-7830 (Online)
ISSN 2760-2508 (Print)

Abstract: The literature on cost performance in major transport infrastructure projects has expanded rapidly, yet much of it still explains overruns through macro conditions, project characteristics, or single-case narratives. Far less is known about how contractor-side capabilities are translated into cost outcomes in cross-border settings, particularly within Belt and Road Initiative (BRI) transport projects where institutional variation, technological demands, and multicultural collaboration are unusually salient. This article addresses that gap by examining contractor experience, contract management capability, technological complexity, and government support as antecedents of project cost performance, with project risk management capability as a mediator and cross-cultural communication effectiveness as a moderator. Drawing on a survey of 391 contractor project management personnel involved in railway and highway projects across Southeast Asia, East Africa, and Central Asia, the study applies partial least squares structural equation modeling. The results show that contractor experience, contract management capability, and government support have significant positive direct effects on cost performance, whereas technological complexity does not. All four antecedents significantly affect project risk management capability, which in turn improves cost performance. Mediation analysis shows a partial indirect effect for contract management capability and a full indirect effect for technological complexity, while the indirect effects of contractor experience and government support are not statistically significant. Cross-cultural communication effectiveness significantly strengthens the positive effect of project risk management capability on cost performance. The article contributes to BRI project management research by developing a contractor-centred explanation of cost performance, clarifying the differentiated roles of internal capabilities and external support, and showing that risk management and communication operate as distinct but complementary mechanisms in multinational project environments.

Keywords: Belt and Road Initiative; Transportation projects; Cost performance; Project risk management; Contract management capability; Cross-cultural communication

Introduction

Transport infrastructure has been one of the most visible operational arenas of the Belt and Road Initiative. Railways, highways, ports, and logistics corridors are expected to do more than move goods and passengers: they reorganize regional connectivity, shape trade facilitation, and influence the economic geography of host regions (Banerjee et al., 2020; Chen & Li, 2021; Ramasamy & Yeung, 2019; Zou et al., 2021). In this setting, cost performance is not a purely accounting outcome. It is closely tied to project viability, cash-

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flow stability, schedule integrity, contract relations, and the longer-term legitimacy of transnational infrastructure delivery. Once cost performance weakens, financing structures become more fragile, disputes intensify, public scrutiny rises, and the developmental narrative surrounding large projects becomes harder to sustain (Catalão et al., 2018; Cavalieri et al., 2019; Love et al., 2017).

That problem is hardly unique to BRI projects. Cost overruns have long been observed across transport infrastructure and large public works, and the causes are typically multifaceted. Previous studies have linked poor cost performance to weak front-end planning, design changes, contractual ambiguity, delays, institutional bottlenecks, supply-chain instability, and ineffective governance (Amini et al., 2022; Atapattu et al., 2023; Nuako et al., 2024; Wyke et al., 2022). Yet BRI transport projects add a further layer of complexity. They are often implemented across unfamiliar legal systems, multi-level governmental arrangements, uneven regulatory environments, and culturally heterogeneous teams. These conditions raise coordination costs and expose projects to risks that are not adequately captured by conventional, single-country cost overrun explanations (Deep et al., 2022; Kayembe et al., 2021; Wang et al., 2018).

A second limitation in the literature concerns level of analysis. A substantial body of work explains cost performance from macro or meso perspectives, focusing on policy, procurement systems, project type, or national context. Those are important explanations, but they leave a critical gap. On the ground, costs are shaped by contractors' decisions about resource deployment, contract administration, issue escalation, risk response, and team coordination. Contractor-side capabilities influence whether complexity is absorbed, whether disputes are contained, and whether external support is converted into operational advantage. Even so, the empirical literature has devoted less sustained attention to contractor experience, contract management capability, and project risk management capability as interconnected drivers of cost performance in cross-border transport projects (Diab et al., 2020; Iyer et al., 2019; Kakar et al., 2022; Zheng et al., 2020).

Cost performance in this context should be understood broadly. In large transport projects, cost outcomes are shaped not only by whether the final expenditure exceeds the initial estimate, but also by the stability of cash flow, the volume of change-order costs, the efficiency with which labour and equipment are used, and the degree to which cost control can be achieved without sacrificing quality or schedule. This broader interpretation is important for BRI projects because many are executed through long delivery chains that involve multiple jurisdictions, public actors, financiers, designers, and subcontractors. A project may remain nominally within budget while still absorbing substantial hidden costs through delay, claims, rework, or coordination inefficiency (Edwards et al., 2017; Love et al., 2018; Petersen, 2019). A contractor-centred framework is therefore especially useful because contractors are positioned at the point where these hidden cost pressures become operational realities.

The BRI setting also sharpens the relevance of a comparative, cross-regional design. Southeast Asia, East Africa, and Central Asia are linked by the broader BRI agenda, but they differ in market maturity, local state capacity, project ecology, and the extent of cultural and linguistic distance between lead contractors and host-country actors. These differences make them suitable locations for testing whether a general capability model can travel across contexts rather than merely explaining a single national case. A model that performs reasonably well across such settings is more valuable for theory and for practice than one derived from a narrow project cluster.

A third limitation is analytical fragmentation. Studies frequently discuss technological complexity, government support, communication problems, or risk management as separate topics. In practice, however, these factors interact. Technological complexity raises the burden on project control systems, but whether it harms cost outcomes depends on how effectively risk is identified and managed. Government support may ease administrative and financing pressure, but its benefits are not always transmitted through formal project routines. Cross-cultural communication may not reduce cost directly; rather, it may determine whether risk responses are understood, accepted, and implemented across multicultural teams. Without an integrated model, it is difficult to see how internal capabilities, contextual conditions, and project routines work together to shape cost performance (Brewer, 2008; Cao, 2021; Chenya et al., 2022; Gultom, 2019).

This article addresses these gaps by developing and testing a contractor-centred model of cost performance in BRI transportation projects. It treats contractor experience and contract management capability as strategic project resources, technological complexity as a contingent project condition, government support as an external enabling factor, project risk management capability as the principal transmission mechanism, and cross-cultural communication effectiveness as a boundary condition. The model is tested with survey data from 391 contractor project management personnel involved in railway and highway projects across Southeast Asia, East Africa, and Central Asia. The study therefore shifts the conversation from abstract explanations of cost overruns to the concrete question of how project actors convert capability into cost control under cross-border conditions.

The article makes three contributions. First, it extends contractor-focused project management research by explaining cost performance through a structured capability model rather than through isolated determinants. Second, it refines the application of a resource-based perspective in project settings by showing that not all antecedents work through the same mechanism: some act directly, while others are transmitted through project risk management capability. Third, it integrates cross-cultural communication into the cost-performance model not as a descriptive background feature but as a contingency that changes the strength of a key project-control relationship. The remainder of the article develops the theoretical framework and hypotheses, describes the research design, reports the empirical results, and discusses the implications for theory and practice.

Theoretical Background and Hypotheses Development

A capability-based view of cost performance in cross-border projects

Resource-based scholarship has long argued that performance differences emerge from heterogeneous resources and capabilities that are difficult to imitate and that are deployed more effectively by some organizations than by others (Armstrong & Shimizu, 2007; Srivastava et al., 2001). Within construction and project management research, recent reviews suggest that the value of a resource-based perspective lies in its ability to explain how accumulated experience, managerial routines, and project governance capabilities create performance advantages in uncertain environments (Goh & Loosemore, 2016; Mansour et al., 2022). That logic is particularly relevant in infrastructure delivery, where the same formal contract structure can yield very different results depending on how well the contractor recognizes signals, mobilizes knowledge, and coordinates action across project stages.

For the present study, a capability-based interpretation is more useful than a narrow inventory of cost overrun factors. BRI transportation projects are not only technically demanding; they are also institutionally varied and culturally diverse. Under such conditions, cost performance is shaped by whether contractors possess experience that is relevant to comparable projects, whether they can govern contracts effectively, whether they can absorb the pressures created by technological complexity, and whether they can make productive use of government support. These resources and conditions do not automatically improve performance. They are translated into cost outcomes through project-level routines, especially those related to risk identification, assessment, mitigation, and follow-up (Chenya et al., 2022; Iyer et al., 2019; Liu et al., 2016).

A project-governance perspective complements this capability logic. Infrastructure projects are delivered through temporary but highly structured systems that link owners, contractors, consultants, regulators, and local actors through contracts, reporting routines, escalation procedures, and control mechanisms. In such settings, the value of a capability depends not only on whether the focal contractor possesses it, but also on whether it can be embedded in workable project routines. This is why project risk management capability is treated as more than a technical control process. It is an organising mechanism through which capabilities are translated into action and through which project conditions are interpreted and governed (Andrić et al., 2019; Chenya et al., 2022).

Cross-cultural communication adds a second theoretical layer. In multinational project environments, communication is not merely a relational issue. It affects the speed and fidelity with which technical instructions, contractual interpretations, and risk responses travel across organisational and national boundaries (Brewer, 2008; Cao, 2021; Wawrosz & Jurásek, 2022). A risk response plan may be technically sound but operationally weak if team members do not interpret it consistently or if cultural misunderstandings slow execution. Cross-cultural communication effectiveness is therefore treated here as a contextual condition that strengthens or weakens the conversion of project risk management capability into cost performance.

Contractor experience and contract management capability

Contractor experience is a path-dependent asset. Repeated exposure to comparable projects generates knowledge about sequencing, supplier coordination, local operating conditions, stakeholder behavior, and likely points of failure. In transport infrastructure, that experience helps contractors anticipate disruptions, calibrate resource allocation, and avoid avoidable rework or escalation (Diab et al., 2020; Pakhale & Pal, 2020). Experience also reduces the time needed to interpret emerging problems because project teams can draw on analogies from prior work rather than beginning every response from first principles. This suggests a direct relationship between contractor experience and cost performance.

At the same time, contractor experience is likely to improve project risk management capability. Experienced contractors usually recognize patterns in geology, logistics, labour coordination, regulatory delay, and interface risk more quickly than less experienced firms. Their prior exposure to project shocks can strengthen both ex ante risk identification and ex post response routines (Iyer et al., 2019; Liu et al., 2016). Accordingly, the following hypotheses are proposed:

- **H9.** Contractor experience has a significant positive effect on project cost performance.
- **H5.** Contractor experience has a significant positive effect on project risk management capability.

Contract management capability is another core project resource. In large transport schemes, contractual arrangements do more than allocate legal obligations; they provide the operating architecture for variation control, claims handling, incentive alignment, documentation, and dispute containment. Strong contract management capability reduces ambiguity in responsibilities, improves visibility over change orders and payment issues, and shortens the cycle through which disputes are diagnosed and addressed (Choi et al., 2020; Elkomy, 2022; Gultom, 2019). These effects should improve cost performance directly.

Contract management capability should also strengthen project risk management capability. Contractual clarity supports the assignment of risk ownership, the monitoring of obligations, and the enforcement of response procedures. When risk-sharing arrangements are better specified and better administered, project teams are more likely to escalate risk promptly and to act within agreed boundaries (Srivastava & Teo, 2012). On that basis, the following hypotheses are advanced:

H2. Contract management capability has a significant positive effect on project cost performance.

H6. Contract management capability has a significant positive effect on project risk management capability.

Technological complexity and government support

Technological complexity occupies a more ambiguous position in the cost-performance literature. Complex transport projects often require advanced systems integration, specialised equipment, demanding tolerances, and coordination across technical domains. These characteristics can increase uncertainty, intensify interface risks, and create downstream rework if systems do not perform as expected (Mewes & Broekel, 2020; Woldemariam, 2021). From that perspective, technological complexity can weaken cost performance.

Yet complexity does not always produce deterioration. Advanced technologies may also improve productivity, shorten construction duration, reduce lifecycle maintenance demands, or enable better monitoring and coordination. The net effect is therefore an empirical rather than an a priori question (Demetracopoulou et al., 2025; Lee & Kim, 2021). This study retains the non-directional form used in the thesis and tests whether technological complexity has a significant direct effect on cost performance.

Technological complexity is also expected to affect project risk management capability. Greater complexity increases the need for more systematic risk identification, more frequent monitoring, and more specialized mitigation. Whether the direction is positive or negative in practice depends on how effectively contractors respond, but a significant relationship is expected. Accordingly:

H3. Technological complexity has a significant effect on project cost performance.

H7. Technological complexity has a significant effect on project risk management capability.

Government support is similarly more complex than a generic "external factor". Support may be developmental, regulatory, logistical, or financial in form, and these forms need not operate through the same project mechanisms. Some kinds of support may reduce cost directly by easing permits or mobilizing land and utilities. Others may indirectly improve internal management by reducing uncertainty and allowing project teams to invest in more systematic control routines. The model therefore treats government support as an empirically open question rather than assuming that all benefits pass through the same internal pathway.

Government support introduces an external, institutional dimension into the model. In transport infrastructure, governments shape project conditions through approvals, financing arrangements, access to land or utilities, regulatory coordination, and policy stability. Such support can reduce transaction costs, smooth access to key resources, and ease the administrative frictions that often undermine cost performance in cross-border projects (Kayembe et al., 2021; Moon et al., 2022; Zou et al., 2021). A direct positive association with cost performance is therefore expected.

Government support can also improve project risk management capability. Supportive regulatory coordination, financial backing, and policy stability create room for more systematic risk tracking, contingency planning, and response execution. They may not eliminate project risk, but they can reduce the pressure under which risk responses are designed and implemented. Therefore:

H4. Government support has a significant positive effect on project cost performance.

H8. Government support has a significant positive effect on project risk management capability.

Project risk management capability as mediator

Project risk management capability sits at the centre of the proposed model because it links project resources and conditions to observable cost outcomes. In infrastructure delivery, risk management capability is not simply the existence of a register or a formal plan; it is the practical ability to detect threats early, evaluate their consequences, trigger the right response, and close the loop through monitoring and learning (Andrić et al., 2019; Chenya et al., 2022; Iyer et al., 2019). When this capability is strong, projects are better able to prevent disruption, contain loss severity, and avoid the cumulative cost effects of delay, rework, or coordination failure.

The mediating logic differs across antecedents. Contractor experience may generate better cost performance directly, but part of its value may still pass through risk management routines. Contract management capability should support cost performance partly because it creates stronger risk allocation and response discipline. Technological complexity may have little direct effect on cost performance if its impact is absorbed or amplified entirely through risk management capability. Government support may also shape cost outcomes through the enabling conditions it creates for risk control. These possibilities lead to four indirect-effect hypotheses, alongside a direct hypothesis for project risk management capability:

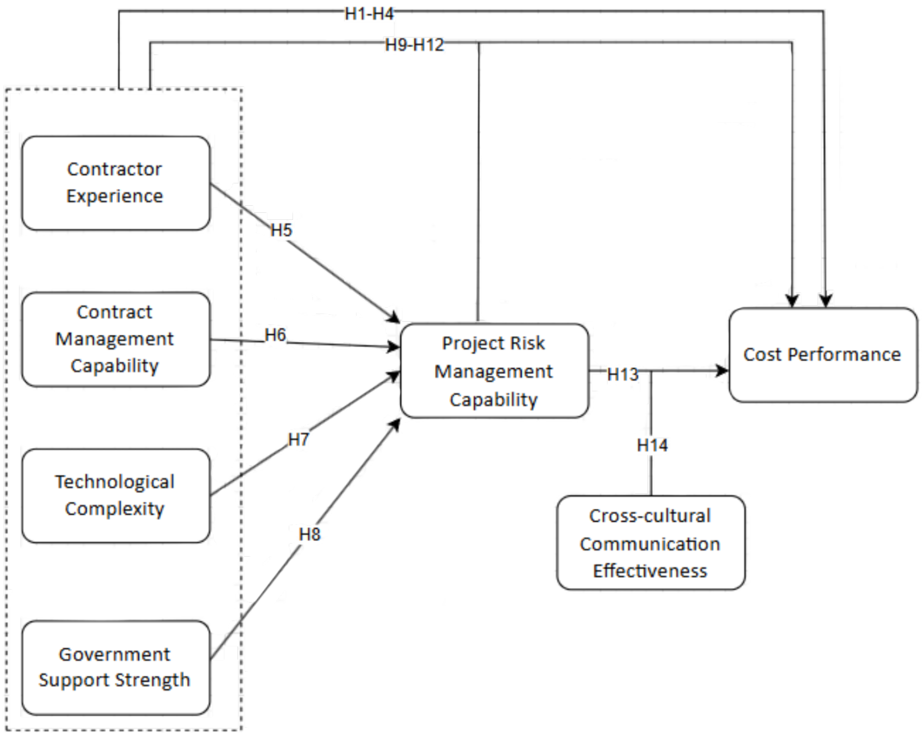

Figure 1 | Proposed research framework

H9. Contractor experience has a significant indirect effect on project cost performance through project risk management capability.

H10. Contract management capability has a significant indirect effect on project cost performance through project risk management capability.

H11. Technological complexity has a significant indirect effect on project cost performance through project risk management capability.

H12. Government support has a significant indirect effect on project cost performance through project risk management capability.

H13. Project risk management capability has a significant positive effect on project cost performance.

Cross-cultural communication effectiveness as moderator

The final element of the framework is cross-cultural communication effectiveness. Multinational transport projects require communication across languages, professional subcultures, contracting organizations, and national institutional settings. Misalignment in communication can slow risk escalation, distort the interpretation of instructions, and weaken the implementation of otherwise sound management routines (Brewer, 2008; Cao, 2021). By contrast, effective cross-cultural communication improves mutual understanding, reduces the friction associated with coordination, and enables project actors to translate formal risk management procedures into timely operational action.

This moderating argument is particularly relevant in BRI projects because communication problems often emerge at interfaces rather than within single organizations. Risk mitigation plans may originate with one party, require approval from another, and be executed by a third whose first language, reporting conventions, and assumptions about hierarchy differ from those of the initiating team. In that environment, the practical force of risk management depends on communicative translation as much as on technical analysis. This is why communication effectiveness is expected to strengthen, rather than substitute for, formal project risk management capability.

The implication is not that communication replaces technical capability. Rather, it conditions whether project risk management capability can be converted into cost performance in a multicultural delivery environment. When communication is strong, the cost benefits of risk management should be more pronounced. Hence:

H14. Cross-cultural communication effectiveness positively moderates the relationship between project risk management capability and project cost performance.

Table 1 | Respondent profile (N = 391)

Characteristic	n	%	Characteristic	n	%
Gender: Male	286	73.1	Nationality: Chinese	265	67.8
Gender: Female	105	26.9	Nationality: Southeast Asian	62	15.9
Age: 25–30	92	23.5	Nationality: East African	38	9.7
Age: 31–35	128	32.7	Nationality: Central Asian	26	6.6
Age: 36–40	95	24.3	Experience: 1–3 years	88	22.5
Age: >40	76	19.4	Experience: 4–6 years	128	32.7
Education: Below bachelor's	35	9.0	Experience: 7–10 years	97	24.8
Education: Bachelor's	215	55.0	Experience: >10 years	78	19.9
Education: Master's	132	33.8	Role: Project manager	115	29.4
Education: Doctoral or above	9	2.3	Role: Cost/contract controller	118	30.2
Project type: Railway	211	54.0	Role: Engineer	119	30.4
Project type: Highway	180	46.0	Role: Supervisor & others	39	10.0

Table 2 | Construct operationalisation

Construct	Operational emphasis in this study	References
Contractor experience (CE)	Accumulated experience with comparable transport projects, local conditions, standards, and prior technical challenges	Diab et al. (2020) Iyer et al. (2019)
Contract management capability (CMC)	Ability to identify contractual risk points, manage change, monitor obligations, quantify breaches, and resolve disputes	Choi et al. (2020) Elkomy (2022)
Technological complexity (TC)	Extent of technical integration, precision requirements, external dependence, and unresolved implementation challenges	Mewes and Broekel (2020) Woldemariam (2021)
Government support (GS)	Approvals, policy stability, financial support, resource coordination, and regulatory facilitation	Kayembe et al. (2021) Moon et al. (2022)
Project risk management capability (PRMC)	Breadth and discipline of risk identification, assessment, response, reserve use, and audit closure	Chenya et al. (2022) Iyer et al. (2019)
Cross-cultural communication effectiveness (CCE)	Information clarity, conflict-resolution speed, inclusion, cultural training, and team cohesion in multicultural collaboration	Brewer (2008) Cao (2021)
Cost performance (CP)	Budget control, change-order cost containment, resource efficiency, forecast accuracy, and preservation of quality and schedule	Islam et al. (2019) Love et al. (2017)

The proposed research framework, which summarises the hypothesised direct, mediating, and moderating relationships, is presented in **Figure 1**.

Research Methodology

Research design and sample

The study used a cross-sectional quantitative design and a structured questionnaire survey. This design was appropriate because the model includes multiple latent constructs, mediation effects, and a moderation effect, all of which are well suited to partial least squares structural equation modeling (PLS-SEM) (Hair et al., 2021). The empirical focus was on contractor-side project management personnel directly involved in BRI transportation projects. The target respondents included project managers, cost and contract controllers, engineers, supervisors, and risk-related personnel working on railway and highway projects across Southeast Asia, East Africa, and Central Asia.

Sampling followed the regional project logic established in the thesis. These three regions were selected because they capture a large share of BRI transportation activity while also displaying meaningful variation in cultural environment, institutional conditions, and technical demands. A total of 440 questionnaires were distributed through a mixed online and offline process involving industry channels, project networks, and direct project contacts. After data screening, 391 usable responses were retained, yielding an effective response rate of 88.9%.

Data collection combined online distribution with project-network circulation and targeted follow-up. This mixed approach was necessary because the respondent population was geographically dispersed and occupied demanding project roles. The survey instrument was available in Chinese and English, and the wording was refined after expert review to reduce ambiguity in the multinational project context. Respondents were informed of the study purpose and assured that participation was voluntary and that all responses would be treated confidentially. These procedures were important not only for ethical reasons but also for data quality, as the questionnaire asked respondents to evaluate organizational capabilities and project-control practices that could easily be interpreted as sensitive if anonymity were not credible.

The regional composition of the sample reflects the practical structure of BRI transport delivery. Southeast Asia contributed the largest share of responses, followed by East Africa and Central Asia. This distribution mirrors the concentration of transport projects in those regions while still allowing the model to capture meaningful contextual variation. The intention was not to compare countries one by one, but to construct a dataset broad enough to test the model

Table 3 | Reliability and convergent validity

Construct	Code	Loadings range	Cronbach's alpha	CR	AVE
Contractor Experience	CE	0.862–0.916	0.934	0.939	0.791
Contract Management Capability	CMC	0.872–0.933	0.940	0.941	0.806
Technological Complexity	TC	0.888–0.944	0.945	0.946	0.819
Government Support Strength	GS	0.876–0.920	0.938	0.941	0.801
Project Risk Management Capability	PRMC	0.868–0.923	0.936	0.939	0.795
Cross-cultural Communication Effectiveness	CCE	0.858–0.936	0.935	0.937	0.795
Cost Performance	CP	0.892–0.933	0.945	0.947	0.819

across varied project settings without reducing the analysis to isolated case descriptions.

The final sample is broadly consistent with the organizational profile of large cross-border transport projects. Male respondents accounted for 73.1% of the sample, and the largest age cluster was 31–35 years (32.7%). More than half of the respondents held a bachelor's degree, while a further 33.8% held a master's degree. Chinese personnel formed the largest nationality group (67.8%), reflecting the central role of Chinese contractors in BRI delivery, but local and regional respondents from Southeast Asia, East Africa, and Central Asia were also represented. In terms of experience, 77.4% had at least four years of work experience, and the sample was balanced across project managers, cost or contract controllers, and engineers. Railway projects accounted for 54.0% of the sample and highway projects for 46.0%. **Table 1** summarizes the respondent profile.

Measurement of variables

All constructs were measured with five indicators using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The instrument was built from the measurement logic developed in the thesis and adapted from project management and cross-cultural research already cited in the dissertation. Contractor experience drew on work emphasizing accumulated project knowledge and contextual familiarity (Diab et al., 2020; Iyer et al., 2019). Contract management capability reflected competence in identifying contractual risk points, monitoring performance, evaluating breach costs, and handling dispute mechanisms (Choi et al., 2020; Elkomy, 2022). Technological complexity captured cross-domain integration, dependence on specialized solutions, unresolved technical challenges, precision requirements, and speed of technological change (Mewes & Broekel, 2020; Woldemariam, 2021). Government support reflected approvals, financial backing, policy stability, coordination over key resources, and regulatory flexibility (Kayembe et al., 2021; Moon et al., 2022). Project risk management capability assessed the breadth, frequency, and closure quality of risk identification and response routines (Chenya et al., 2022; Iyer et al., 2019). Cross-cultural communication effectiveness captured communication loss, conflict-resolution speed, inclusion of non-native speakers, cultural training, and team cohesion (Brewer, 2008; Cao, 2021). Cost performance reflected budget control, change-order cost containment, resource efficiency, forecasting accuracy, and the ability to control cost without damaging quality or progress (Islam et al., 2019; Love et al., 2017). **Table 2** summarizes the construct operationalization.

Before the main survey, the questionnaire underwent two stages of refinement. First, eight experts, including five practitioners with extensive BRI project experience and three academic specialists, reviewed the instrument for content relevance, clarity, and redundancy. Second, a pilot test with 30 eligible respondents was used to verify reliability and improve wording. This sequence helped ensure that the final survey was both contextually appropriate and statistically workable.

Data screening and analytical procedure

The data were screened prior to model estimation. Cases with excessive missingness, obvious response-pattern problems, and logically inconsistent answers were removed during the cleaning stage. Remaining isolated missing values were treated conservatively. Descriptive checks suggested mild departures from normality at item level, but this did not create a methodological problem because the study used PLS-SEM, which is appropriate for complex predictive models involving non-normal data and latent constructs (Hair et al., 2021).

The analysis proceeded in two stages. First, the measurement model was assessed through indicator loadings, Cronbach's alpha, composite reliability, average variance extracted (AVE), the Fornell-Larcker criterion, and the heterotrait-monotrait ratio (HTMT). Second, the structural model was examined through variance inflation factors (VIF), path coefficients, effect sizes, coefficients of determination (R^2), predictive relevance (Q^2), and bootstrap tests of mediation and moderation. This sequence followed standard practice in PLS-SEM and ensured that the structural results were interpreted only after the adequacy of the measurement model had been established.

Empirical Analysis Results

Measurement model

The measurement model performed well across all major criteria. Indicator loadings were consistently strong, ranging from 0.858 to 0.944. This indicates that the items captured their intended latent constructs with substantial reliability. Internal consistency reliability was also high. Cronbach's alpha values ranged from 0.934 to 0.945, while composite reli-

Table 4 | Fornell-Larcker discriminant validity matrix

	CMC	CE	CP	CCE	GS	PRMC	TC
CMC	0.898						
CE	0.553	0.890					
CP	0.61	0.626	0.905				
CCE	0.621	0.647	0.624	0.891			
GS	0.588	0.605	0.637	0.611	0.895		
PRMC	0.616	0.611	0.598	0.645	0.609	0.892	
TC	0.646	0.599	0.606	0.624	0.610	0.609	0.905

Table 5 | Direct effects

Hypothesis	Path	β	SD	t	p	Decision
H1	Contractor Experience → Cost Performance	0.171	0.064	2.664	0.008	supported
H2	Contract Management Capability → Cost Performance	0.145	0.069	2.114	0.035	supported
H3	Technological Complexity → Cost Performance	0.091	0.074	1.234	0.217	not supported
H4	Government Support Strength → Cost Performance	0.197	0.065	3.021	0.003	supported
H5	Contractor Experience → Project Risk Management Capability	0.242	0.07	3.482	0.001	supported
H6	Contract Management Capability → Project Risk Management Capability	0.241	0.061	3.94	0.000	supported
H7	Technological Complexity → Project Risk Management Capability	0.179	0.068	2.643	0.008	supported
H8	Government Support Strength → Project Risk Management Capability	0.212	0.071	3.004	0.003	supported
H13	Project Risk Management Capability → Cost Performance	0.187	0.075	2.486	0.013	supported

Table 6 | Mediation and moderation results

Effect	β	95% CI	p	Inference
CE → PRMC → CP	0.045	0.005 to 0.097	0.053	No mediation (H9 not supported)
CMC → PRMC → CP	0.045	0.006 to 0.094	0.043	Partial mediation (H10 supported)
TC → PRMC → CP	0.034	0.003 to 0.069	0.049	Full mediation (H11 supported)
GS → PRMC → CP	0.040	0.004 to 0.087	0.070	No mediation (H12 not supported)
CCE × PRMC → CP	0.134	—	0.006	Positive moderation (H14 supported)

ability values ranged from 0.937 to 0.947. All of these values exceed conventional thresholds. Convergent validity was likewise supported: AVE values ranged from 0.791 to 0.819, indicating that each construct explained a large share of the variance in its indicators. Table 3 reports the main reliability and convergent validity statistics.

Discriminant validity was established in two ways. First, the square root of the AVE for each construct exceeded its correlations with other constructs, satisfying the Fornell-Larcker criterion. Second, HTMT values ranged from 0.578 to 0.683, remaining comfortably below the conservative threshold of 0.90. Together, these results suggest that the model's constructs were empirically distinct rather than artefacts of overlapping measurement. Table 4 reports the Fornell-Larcker matrix, while the HTMT matrix is reproduced in the supplementary material.

Structural model

The structural model also met standard diagnostic expectations. Multicollinearity was not a concern: VIF values for all predictor relationships ranged from 1.874 to 3.216, below critical thresholds. Explanatory power was moderate to strong. The model accounted for 53.5% of the variance in project risk management capability and 58.0% of the variance in project cost performance. Predictive relevance was also satisfactory, with Q^2 values of 0.412 for project risk management capability and 0.456 for cost performance. Taken together, these statistics indicate that the model possesses useful explanatory and predictive capacity rather than merely statistical fit.

The direct-effect results provide a differentiated picture. Contractor experience had a significant positive effect on cost performance (beta = 0.171, t = 2.664, p = 0.008), supporting H1. Contract management capability also had a significant positive effect on cost performance (beta = 0.145, t = 2.114, p = 0.035), supporting H2. Government support likewise improved cost performance directly (beta = 0.197, t = 3.021, p = 0.003), supporting H4. By contrast, technological complexity did not have a statistically significant direct ef-

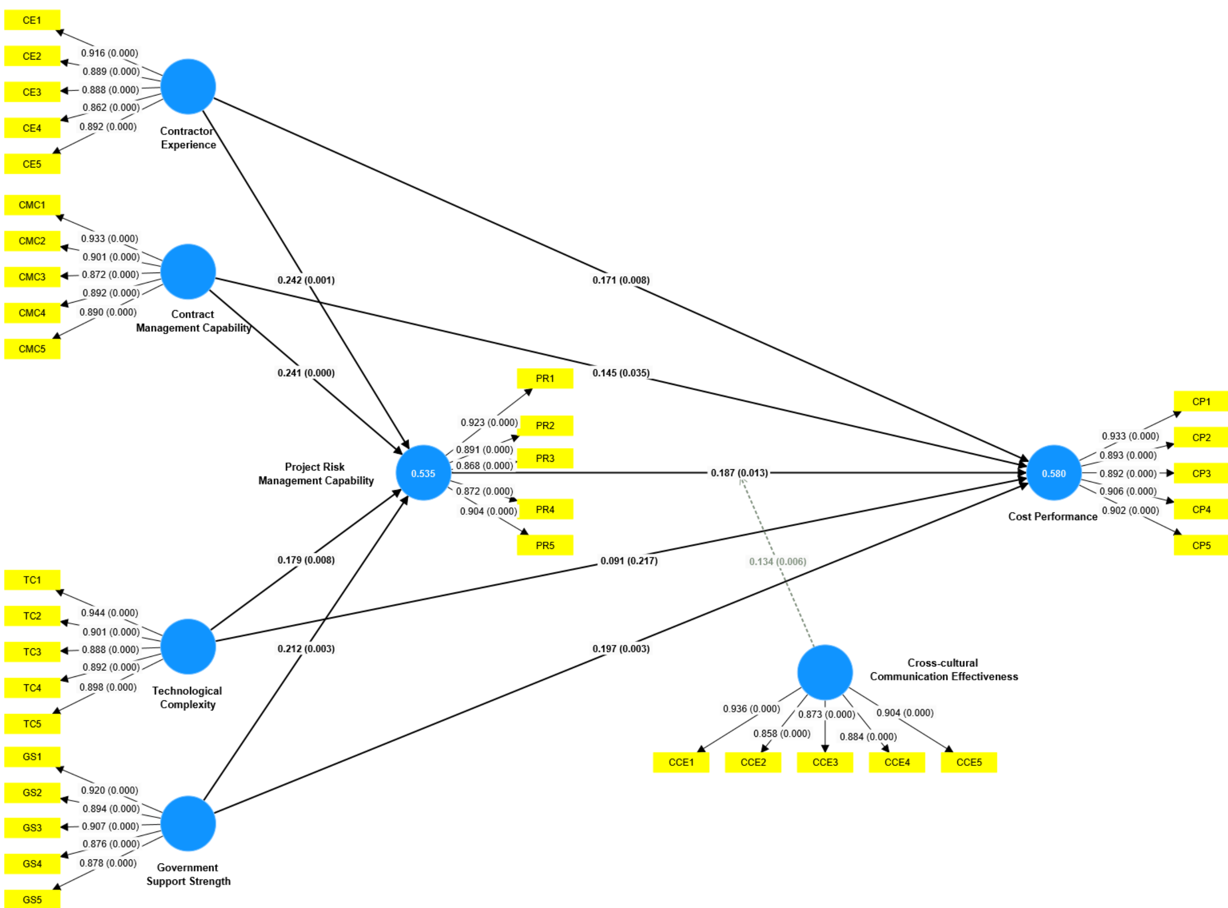

Figure 2 | Final structural model

fect on cost performance (beta = 0.091, t = 1.234, p = 0.217); H3 was therefore not supported.

All four antecedents significantly affected project risk management capability. Contractor experience had a positive effect (beta = 0.242, t = 3.482, p = 0.001), supporting H5. Contract management capability also had a positive effect (beta = 0.241, t = 3.940, p < 0.001), supporting H6. Technological complexity significantly affected project risk management capability (beta = 0.179, t = 2.643, p = 0.008), supporting H7. Government support also showed a positive effect (beta = 0.212, t = 3.004, p = 0.003), supporting H8. Finally, project risk management capability had a significant positive effect on cost performance (beta = 0.187, t = 2.486, p = 0.013), supporting H13. Table 5 summarizes the direct paths.

Mediation and moderation

Bootstrap mediation tests revealed that project risk management capability does not play the same role for every antecedent. The indirect effect from contractor experience to cost performance through project risk management capability was not statistically significant (beta = 0.045, p = 0.053). H9 was therefore not supported. In practical terms, contractor experience appears to improve cost performance mainly through a direct route rather than through formal risk management capability.

The results were different for contract management capability. Its indirect effect through project risk management capability was significant (beta = 0.045, p = 0.043), while the direct path to cost performance remained significant. This pattern indicates partial mediation and supports H10. Contract management capability therefore improves cost performance both directly and indirectly through stronger risk management capability.

Technological complexity displayed a full mediation pattern. Its direct effect on cost performance was not significant, but its indirect effect through project risk management capability was significant (beta = 0.034, p = 0.049). H11 was supported. This suggests that technological complexity affects cost performance only to the extent that it changes the quality of project risk management. Government support, however, did not show a significant indirect effect through project risk management capability (beta = 0.040, p = 0.070), and H12 was not supported.

The moderation analysis confirms the conditional role of cross-cultural communication effectiveness. The interaction between cross-cultural communication effectiveness and project risk management capability had a significant positive effect on cost performance (beta = 0.134, t = 2.733, p =

0.006), supporting H14. This means that project risk management capability contributes more strongly to cost performance when communication across cultural boundaries is more effective. **Table 6** reports the mediation and moderation results, and **Figure 2** presents the final structural model.

The effect-size results reinforce this interpretation. Most f^2 values fell in the small-to-moderate range, which is typical for organizational and project-management models where multiple related drivers jointly shape an outcome rather than one dominant predictor explaining most of the variance on its own. Contractor experience and contract management capability had relatively stronger contributions to project risk management capability, while government support and cross-cultural communication effectiveness made notable contributions to cost performance. This pattern supports the argument that cost performance in cross-border transport projects is cumulative in origin: different capabilities and contextual supports each add part of the explanatory picture.

The structure of the findings is also more informative than a simple count of supported hypotheses. Four direct effects were tested, of which three were supported; four antecedent-to-mediator paths were tested, and all four were supported; three of the four indirect effects were not equally strong; and the moderation hypothesis was supported. The resulting pattern shows that the model is neither universally direct nor universally mediated. Instead, it contains multiple causal routes of unequal strength. For theory building, that is more valuable than a model in which every path is significant in the same way, because it helps distinguish which relationships are structurally central and which are more contingent.

Discussion

The results show that cost performance in BRI transportation projects cannot be explained satisfactorily by project conditions alone. It is produced through an interaction between contractor-side capabilities, project-level control routines, institutional support, and communication quality. Five findings deserve particular attention.

First, contractor experience improves cost performance directly, but not through a statistically significant indirect route via project risk management capability. This is an important result because it suggests that experienced contractors do not depend exclusively on formalized risk-management routines to achieve cost control. Experience may work through tacit judgement, faster problem recognition, more realistic planning assumptions, better supplier coordination, and more credible anticipation of local constraints. In other words, a contractor that has repeatedly delivered comparable transport projects is likely to make fewer avoidable errors before formal risk processes are even activated. This interpretation is consistent with capability-based thinking in project management, where accumulated experience functions as a non-transferable operational asset rather than as a generic background variable (Diab et al., 2020; Goh & Loosemore, 2016; Mansour et al., 2022). It also helps explain why experienced project personnel remain so highly valued in infrastructure delivery despite growing investment in formal control systems.

Second, contract management capability improves cost performance both directly and indirectly through project risk management capability. This is arguably the most managerially actionable finding in the model. Contract management capability matters directly because it reduces ambiguity, improves documentation and procedural discipline, and prevents disputes or unplanned change from escalating into cost instability. At the same time, the significant indirect path indicates that contract governance also helps to structure risk ownership and response behavior. When contractual obligations, escalation procedures, and claims mechanisms are clearer, project actors have a stronger foundation for identifying and handling emerging threats. This result echoes work showing that contract type and governance mechanisms shape time-cost-change performance by influencing how parties respond to uncertainty rather than simply by allocating legal responsibility on paper (Choi et al., 2020; Elkomy, 2022; Srivastava & Teo, 2012). For BRI projects, where contractual misunderstandings can be amplified by jurisdictional and cultural distance, this dual role is especially important.

Third, technological complexity has no significant direct effect on cost performance but does exert a significant indirect effect through project risk management capability. This full mediation result is theoretically and practically revealing. It suggests that complexity is not inherently cost-damaging. What matters is whether the project possesses the capability to identify, interpret, and control the uncertainties associated with complexity. Under weak risk-management conditions, complexity is likely to destabilize the project. Under stronger risk-management conditions, the same complexity may be absorbed without causing cost deterioration. This result refines a common assumption in the cost-overrun literature, namely that more complex technology automatically worsens cost outcomes. In cross-border transport infrastructure, the picture is more conditional. Complexity becomes economically meaningful only through the quality of project control routines that surround it (Demetracopoulou et al., 2025; Mewes & Broekel, 2020; Woldemariam, 2021). The implication is that technologically ambitious projects should not be evaluated solely in terms of technical difficulty; they should also be evaluated in terms of the organizational capability available to manage the risks that difficulty generates.

Fourth, government support improves cost performance directly, but its indirect effect through project risk management capability is not significant. This finding implies that external support works through a different logic from internal capabilities. Government support appears to reduce cost pressure more immediately, perhaps by accelerating approvals, stabilizing access to critical resources, smoothing regulatory processes, or improving financing conditions.

These benefits can improve cost performance without necessarily being translated into stronger internal risk-management routines. Put differently, supportive institutions help projects, but they do not automatically produce better project management. This distinction matters because it cautions against assuming that external facilitation can substitute for organizational capability. It also suggests that policymakers should not treat support as a purely distributive matter. If the aim is to strengthen project resilience rather than only to reduce short-term cost pressure, support measures may need to be tied more explicitly to capability development and management-system improvement (Kayembe et al., 2021; Moon et al., 2022; Zou et al., 2021).

Fifth, cross-cultural communication effectiveness strengthens the positive relationship between project risk management capability and cost performance. This result confirms that communication in multicultural projects is not a peripheral soft variable but a practical condition of control. Risk registers, thresholds, mitigation plans, and escalation protocols produce value only when they are interpreted consistently and acted upon promptly across the project network. In projects involving multinational teams, language differences, divergent reporting norms, and differing assumptions about authority can weaken that chain. Strong cross-cultural communication, by contrast, improves mutual understanding and speeds coordinated response. This helps explain why technically competent project teams can still perform unevenly in cross-border environments: the operational value of their routines depends partly on the communication system through which those routines are enacted (Brewer, 2008; Cao, 2021; Wawrosz & Jurásek, 2022).

Overall, the findings reveal that project cost performance in BRI transportation projects is structured by layered mechanisms. Experience and government support work largely through direct channels. Contract management capability operates through both direct governance effects and an indirect risk-management channel. Technological complexity matters only through risk management. Communication effectiveness does not replace risk-management capability, but it changes how powerfully that capability translates into cost outcomes. This pattern is more nuanced than a simple list of cost overrun factors, and it helps to explain why similar projects may diverge sharply in financial performance even when they appear comparable on paper.

The non-significant indirect effect of contractor experience is especially instructive. It suggests that some of the most valuable consequences of experience may be pre-emptive rather than procedural. Experienced teams often frame problems more accurately at the outset, select more realistic sequences, and make fewer judgement errors in procurement, logistics, and stakeholder handling. Those advantages reduce the need for later corrective action. From this perspective, experience does not merely feed into risk management; it partly reduces the volume of risk that must be formally managed. That is a different mechanism from the one associated with contract management capability and helps explain why the mediation result is absent even though the path from experience to project risk management capability is significant.

The non-significant indirect effect of government support also deserves careful interpretation. It would be misleading to conclude that government support is unimportant to risk management simply because the mediation test was not significant. The direct path from government support to project risk management capability was significant, and the direct path to cost performance was strong. What the mediation result indicates is that the financial value of government support appears to reach cost outcomes through channels that are not fully captured by the formal risk-management construct used in the model. Administrative convenience, improved liquidity, easier access to inputs, and clearer regulatory positioning may all improve cost performance without necessarily altering the measured routines of risk identification and mitigation. Future research could profitably disentangle these channels more explicitly.

Another noteworthy feature of the results is the positive effect of technological complexity on project risk management capability. This does not mean that complexity is beneficial in itself. Rather, it suggests that more complex projects tend to activate more intensive risk-management effort, which then shapes cost outcomes. In practice, technologically demanding projects may attract stronger oversight, more detailed planning, or more specialized expertise precisely because they are recognized as difficult. The full mediation result implies that this intensified management response is the decisive mechanism. Complexity only becomes financially consequential through the adequacy or inadequacy of the control architecture built around it.

The moderation result further indicates that the value of project routines depends on the social system through which they are enacted. In cross-border projects, communication challenges are often treated as irritants or soft issues that sit alongside the "real" technical work. The findings suggest otherwise. Communication quality changes the performance yield of a technical control capability. This is a subtle but important distinction. Better communication does not simply make teams more harmonious; it makes risk management more financially productive by reducing misinterpretation, response delay, and implementation slippage in multicultural project environments.

Implications

Theoretical implications

The study makes three theoretical contributions. First, it advances a contractor-centred explanation of cost performance in BRI transportation projects. Much of the existing discussion is structured around macro-level conditions, procurement arrangements, or project type. Those factors remain important, but the present model shows that micro-level contractor capabilities have their own explanatory power. Contractor experience and contract management capability are not merely background characteristics; they are substantive predictors of cost performance and of the project's ability to manage risk.

Second, the findings refine the use of a capability-based or resource-based perspective in project research. The results do not support a one-size-fits-all transmission logic in which every antecedent works through the same mediating mechanism. Instead, the model shows differentiated causal patterns. Experience and government support affect cost performance mainly through direct routes, whereas contract management capability partly works through risk management and technological complexity works entirely through it. This differentiation matters because it moves the discussion away from generic statements about "important factors" and towards a more precise account of how specific resources or conditions operate in project environments.

Third, the article integrates cross-cultural communication more tightly into infrastructure project theory. Communication is often acknowledged as a challenge in multinational projects, but it is frequently treated descriptively rather than analytically. By modeling cross-cultural communication effectiveness as a moderator, the study shows that communication affects project performance not only through general coordination quality but specifically by conditioning the effectiveness of risk management. This helps connect project-management theory with cross-cultural management research in a way that is particularly relevant for transnational infrastructure delivery.

Managerial implications

For contractors, the findings suggest that cost control should be approached as a capability portfolio rather than as a narrow budgeting exercise. Experience still matters greatly, which means that staffing, project assignment, and knowledge-retention systems should be designed to preserve contextual learning from earlier cross-border projects. Contractors should also invest in contract management systems that do more than ensure compliance. Stronger variation control, documentation routines, and dispute-handling procedures can improve cost performance directly and can also raise the quality of project risk management.

For technologically demanding projects, the managerial lesson is clear: complexity should trigger stronger risk-management architecture, not merely more technical supervision. High-complexity projects need earlier interface mapping, more frequent risk review, and clearer escalation protocols if their cost performance is to remain stable. Where government support is available, firms should make strategic use of it, but without assuming that external facilitation can compensate for weak internal control systems.

For project sponsors and host governments, the results underline the practical value of stable approvals, coordinated resource access, and policy support. Yet the non-significant indirect effect through risk management suggests that support mechanisms could be designed more intelligently. Instead of focusing only on administrative facilitation or funding, governments might link support to stronger reporting, risk-review discipline, or capability-development standards within project organizations.

Finally, the moderation result points to an issue often underestimated in project delivery: cross-cultural communication capability should be treated as a cost-control instrument. Training, multilingual reporting protocols, culturally aware meeting structures, and inclusive decision routines can strengthen the financial value of project risk management. In multinational project environments, better communication is not cosmetic. It is part of how effective control is achieved.

These implications extend to organizational design. Firms involved repeatedly in multinational transport projects should consider institutionalizing post-project learning rather than relying on individual memory. Lessons from claims, interface failures, and successful mitigation episodes need to be codified and recirculated so that contractor experience becomes an organizational rather than purely personal asset. The same applies to communication capability. Rather than treating cross-cultural communication as an occasional training topic, firms may need standing multilingual reporting templates, translation protocols for critical instructions, and meeting structures that give non-native speakers a workable route to clarification and dissent.

For public authorities and project sponsors, the findings point to a governance agenda that goes beyond basic facilitation. Where governments wish to improve the cost performance of strategically important transport projects, the most effective support may combine administrative efficiency with incentives for stronger project-control practices. For example, support packages could be linked to clearer milestone reporting, joint risk-review mechanisms, or dispute-prevention procedures. In that sense, the study implies that external support and internal capability should be designed to reinforce one another rather than treated as separate policy and management domains.

Conclusion

This article examined cost performance in BRI transportation projects through a model that combines contractor capabilities, project conditions, institutional support, project risk management capability, and cross-cultural communication effectiveness. Using survey data from 391 contractor project personnel and PLS-SEM analysis, it shows that contractor experience, contract management capability, and government support all improve cost performance directly, while technological complexity has no direct effect. Project risk management capability plays a central but differentiated mediating role: it partially mediates the effect of contract management capability and fully mediates the effect of technological complexity, but it does not significantly mediate the effects of contractor experience or government support. Cross-cultural communication effectiveness further strengthens the positive influence of project risk management capability on cost performance.

The article therefore offers a more fine-grained explanation of why cost performance varies across cross-border transport projects. It suggests that financial outcomes depend not only on whether projects are difficult or well supported, but on how contractor resources are organized, how risk is managed, and how effectively diverse teams communicate when responding to uncertainty.

The study is not without limitations. Its cross-sectional design limits causal inference; the evidence comes from self-reported perceptions rather than purely archival cost records; and the geographic focus, though appropriate for BRI transportation research, does not represent all infrastructure contexts. Future work could use longitudinal project data, compare contractor and client perceptions, or examine whether the model behaves differently across delivery systems, ownership structures, or stages of the project lifecycle. Even so, the findings provide a coherent empirical basis for understanding cost performance as a capability-driven and communication-conditioned outcome in multinational transport infrastructure delivery.

The article also points to a methodological implication. Research on infrastructure cost performance often oscillates between richly descriptive case studies and highly aggregated factor lists. The present approach shows the value of modeling the intervening mechanisms that connect antecedents to performance. Doing so makes it possible to see why superficially similar predictors do not necessarily work in the same way, and why management attention should be directed not only to "what matters" but also to "how it matters".

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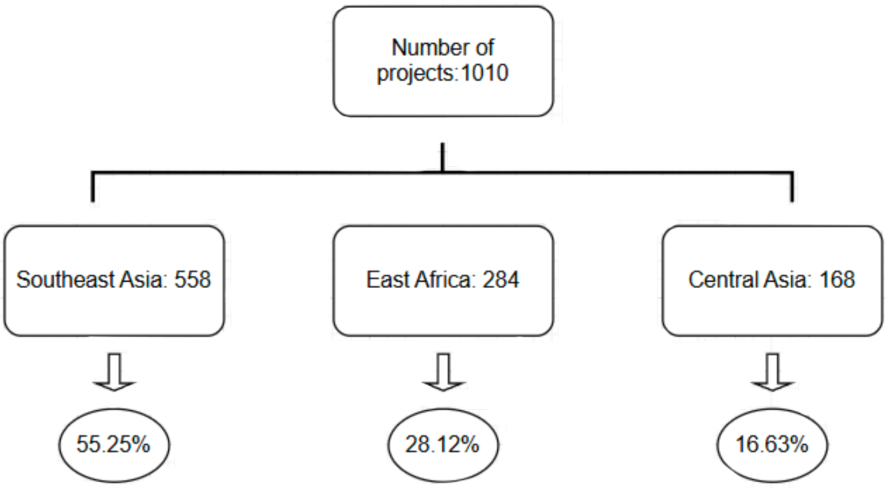
https://doi.org/10.70731/c6wgxz82

Appendix



Supplementary Figure S1 | Regional sample distribution from the original thesis

Supplementary Table S1 | Statistical power analysis

Area	Sample size
Southeast Asia	265
East Africa	135
Central Asia	80

Note: Using G*Power 3.1 software (Faul et al., 2009) with parameters set to medium effect size ($f^2=0.15$), significance level $\alpha=0.05$, and statistical power=0.80 (the minimum acceptable power for detecting significant effects), the required minimum sample size for testing the structural paths in the model is 225.

Supplementary Table S2 | Scale design

No.	Items	Response				
1	This contractor has completed ≥3 similar projects in the past 5 years	1	2	3	4	5
2	Contractor team members have more than 5 years of industry experience	1	2	3	4	5
3	Contractor has successfully handled projects with similar Technological Complexity	1	2	3	4	5
4	Contractor has a good historical performance record in the local market	1	2	3	4	5
5	Contractor is very familiar with the standards of the industry in which this project is located	1	2	3	4	5
6	We can accurately identify potential risk points in the contract terms	1	2	3	4	5
7	The project change management process has a clear approval hierarchy	1	2	3	4	5
8	Contract performance progress monitoring is highly synchronized with actual progress	1	2	3	4	5
9	We have the ability to quantitatively evaluate the cost of contract breach	1	2	3	4	5
10	Dispute resolution mechanism has been effectively implemented in past projects	1	2	3	4	5
11	The project involves more than 3 cross-domain technology integrations (such as AI + IoT + BIM)	1	2	3	4	5
12	Key technical solutions need to rely on external patent authorization	1	2	3	4	5
13	Technical implementation has industry-recognized unresolved problems	1	2	3	4	5
14	System debugging must meet the accuracy requirement of ±0.5%	1	2	3	4	5
15	Technical iteration speed requires quarterly updates	1	2	3	4	5
16	Government departments provide special approval green channels	1	2	3	4	5
17	Financial subsidies cover more than 15% of the total project investment	1	2	3	4	5
18	Policy stability commitment period ≥5 years	1	2	3	4	5
19	Government coordinates to solve key resources such as land/water use	1	2	3	4	5
20	Regulatory authorities adopt flexible law enforcement mechanisms	1	2	3	4	5
21	The actual cost of the project is controlled within ±3% of the budget Within	1	2	3	4	5
22	The proportion of additional costs caused by changing orders is less than 5%	1	2	3	4	5
23	The idle resource rate is lower than the industry benchmark for a long time	1	2	3	4	5
24	The accuracy of the cost forecast model is more than 90%	1	2	3	4	5
25	Cost control measures do not affect quality/progress targets	1	2	3	4	5
26	The risk register covers all risk categories agreed in the contract	1	2	3	4	5
27	The risk probability impact matrix is updated weekly and guides decision-making	1	2	3	4	5
28	The trigger conditions of the emergency plan strictly correspond to the risk threshold	1	2	3	4	5
29	The utilization rate of the risk reserve fund matches the risk exposure level	1	2	3	4	5
30	The closed-loop rate of risk audit findings is 100%	1	2	3	4	5
31	The information decay rate caused by multilingual communication is less than 10%	1	2	3	4	5
32	The conflict resolution cycle caused by cultural differences is ≤3 working days	1	2	3	4	5
33	The participation of non-native speakers in decision-making meetings is balanced	1	2	3	4	5
34	Cultural training covers all key stakeholders	1	2	3	4	5
35	The cross-cultural team cohesion index is higher than the organizational average	1	2	3	4	5

Supplementary Table S3 | In the pilot analysis of this study, 30 questionnaires were collected and evaluated by Cronbach's α coefficient.

Variable dimensions	Cronbach's α	Number of items
Contractor experience (IV1)	0.98	5
Contract management capabilities (IV2)	0.82	5
Technological Complexity (IV3)	0.78	5
Government support (IV4)	0.81	5
Cost performance (DV)	0.83	5
Project risk management capabilities (MEV)	0.89	5
Cross-cultural communication effectiveness (MOV)	0.86	5

Supplementary Table S4 | Sample descriptive statistics

Variables	Mean	SD	MIN	MAX
Contractor experience (IV1)	3.72	0.89	1.20	5.00
Contract management capability (IV2)	3.58	0.91	1.40	5.00
Technological Complexity (IV3)	3.35	1.03	1.00	5.00
Government support (IV4)	3.69	0.85	1.60	5.00
Cost performance (DV)	3.47	0.94	1.20	5.00
Risk management capability (MEV)	3.81	0.82	1.80	5.00
Cross-cultural communication effectiveness (MOV)	3.55	0.97	1.00	5.00

Supplementary Table S5 | Table Normality result

Construct	Item	Mean	SD.	Skew.	Kurt.
ContractorExperience	CE1	4.1	1.046	-1.562	2.192
ContractorExperience	CE2	3.81	0.932	-1.349	1.912
ContractorExperience	CE3	3.82	0.967	-1.129	1.155
ContractorExperience	CE4	3.83	0.883	-1.397	2.335
ContractorExperience	CE5	3.81	0.936	-1.215	1.531
Contract Management Capability	CMC1	4.07	1.078	-1.385	1.451
Contract Management Capability	CMC2	3.81	0.99	-1.215	1.253
Contract Management Capability	CMC3	3.83	0.928	-1.203	1.481
Contract Management Capability	CMC4	3.83	0.92	-1.236	1.764
Contract Management Capability	CMC5	3.79	0.946	-1.206	1.282
TechnologicalComplexity	TC1	4.02	1.141	-1.435	1.389
TechnologicalComplexity	TC2	3.8	0.995	-1.269	1.447
TechnologicalComplexity	TC3	3.82	0.954	-1.155	1.248
TechnologicalComplexity	TC4	3.83	0.989	-1.105	1.039
TechnologicalComplexity	TC5	3.81	0.964	-1.264	1.48
GovernmentTechnological	GS1	4.07	1.036	-1.455	1.839
GovernmentTechnological	GS2	3.78	0.926	-1.21	1.454
GovernmentTechnological	GS3	3.84	0.911	-1.246	1.723
GovernmentTechnological	GS4	3.81	0.922	-1.319	1.91
GovernmentTechnological	GS5	3.8	0.908	-1.216	1.584
Project RiskManagement Capability	PR1	4.08	1.072	-1.437	1.615
Project RiskManagement Capability	PR2	3.81	0.935	-1.134	1.174
Project RiskManagement Capability	PR3	3.85	0.93	-1.104	1.113
Project RiskManagement Capability	PR4	3.79	0.925	-1.229	1.595
Project RiskManagement Capability	PR5	3.83	0.934	-1.09	1.092
Cross-culturalCommunicationEffectiveness	CCE1	4.08	1.057	-1.501	1.936
Cross-culturalCommunicationEffectiveness	CCE2	3.85	0.887	-1.218	1.775
Cross-culturalCommunicationEffectiveness	CCE3	3.82	0.943	-1.267	1.633
Cross-culturalCommunicationEffectiveness	CCE4	3.82	0.928	-1.12	1.246
Cross-culturalCommunicationEffectiveness	CCE5	3.81	0.966	-1.208	1.399
Cost Performance	CP1	4.02	1.143	-1.437	1.413
Cost Performance	CP2	3.82	0.914	-1.129	1.292
Cost Performance	CP3	3.82	0.948	-1.127	1.024
Cost Performance	CP4	3.75	0.986	-1.317	1.553
Cost Performance	CP5	3.81	0.975	-1.143	1.023

Supplementary Table S6 | Table Demographic Profile of Respondents by Gender

	N	Percentage (%)
Male	286	73.1
Female	105	26.9
Total	391	100

Supplementary Table S7 | Demographic Profile of Respondents by Age

	N	Percentage（%）
25-30years old	92	23.5
31-35years old	128	32.7
36-40years old	95	24.3
>40years old	76	19.4
Total	391	100

Supplementary Table S8 | Demographic Profile of Respondents by Education

	N	Percentage（%）
Below Bachelor's Degree	35	9
Bachelor's degree	215	55
Master's degree	132	33.8
Doctoral degree/above	9	2.3
Total	391	100

Supplementary Table S9 | Demographic Profile of Respondents by Nationality

	N	Percentage（%）
Chinese	265	67.8
Southeast Asian	62	15.9
East African	38	9.7
Central Asian	26	6.6
Total	391	100

Supplementary Table S10 | Demographic Profile of Respondents by Job Experience Year

	N	Percentage (%)
1-3 years	88	22.5
4-6 years	128	32.7
7-10 years	97	24.8
>10 years	78	19.9
Total	391	100

Supplementary Table S11 | Demographic Profile of Respondents by Job Position

	N	Percentage（%）
Project Manager	115	29.4
Cost/Contract Controller	118	30.2
Engineer (Technical)	119	30.4
Supervisor & Others	39	10
Total	391	100

Supplementary Table S12 | Demographic Profile of Respondents by Project Type

	N	Percentage (%)
Railway project	211	54
Highway project	180	46
Total	391	100

Supplementary Table S13 | Factor loadings

	Cross-cultural Communication Effectiveness	Contractor Experience	Contract Management Capability	Cost Performance	Government Support Strength	Project Risk Management Capability	Technological Complexity
CCE1	0.936						
CCE2	0.858						
CCE3	0.873						
CCE4	0.884						
CCE5	0.904						
CE1		0.916					
CE2		0.889					
CE3		0.888					
CE4		0.862					
CE5		0.892					
CMC1			0.933				
CMC2			0.901				
CMC3			0.872				
CMC4			0.892				
CMC5			0.890				
CP1				0.933			
CP2				0.893			
CP3				0.892			
CP4				0.906			
CP5				0.902			
GS1					0.920		
GS2					0.894		
GS3					0.907		
GS4					0.876		
GS5					0.878		
PR1						0.923	
PR2						0.891	
PR3						0.868	
PR4						0.872	
PR5						0.904	
TC1							0.944
TC2							0.901
TC3							0.888
TC4							0.892
TC5							0.898

Supplementary Table S14 | Reliability and Convergent Validity

	Cronbach's alpha	Composite reliability (CR)	Average variance extracted (AVE)
Contractor Experience	0.934	0.939	0.791
Contract Management Capability	0.940	0.941	0.806
Technological Complexity	0.945	0.946	0.819
Government Support Strength	0.938	0.941	0.801
Project Risk Management Capability	0.936	0.939	0.795
Cross-cultural Communication Effectiveness	0.935	0.937	0.795
Cost Performance	0.945	0.947	0.819

Supplementary Table S15 | Table Discriminant Validity - HTMT(0.9)

	CMC	CE	CP	CCE	GSS	PRMC	TC
CMC							
CE	0.578						
CP	0.642	0.655					
CCE	0.656	0.683	0.656				
GSS	0.615	0.635	0.665	0.645			
PRMC	0.647	0.641	0.626	0.682	0.64		
TC	0.681	0.625	0.633	0.658	0.64	0.639	

Supplementary Table S16 | Discriminant Validity -Fornell-Larcker Criterion

	Contract Management Capability	Contractor Experience	Cost Performance	Cross-cultural Communication Effectiveness	Government Support Strength	Project Risk Management Capability	Technological Complexity
Contract Management Capability	0.898						
Contractor Experience	0.553	0.890					
Cost Performance	0.61	0.626	0.905				
Cross-cultural Communication Effectiveness	0.621	0.647	0.624	0.891			
Government Support Strength	0.588	0.605	0.637	0.611	0.895		
Project Risk Management Capability	0.616	0.611	0.598	0.645	0.609	0.892	
Technological Complexity	0.646	0.599	0.606	0.624	0.610	0.609	0.905

Supplementary Table S17 | Variance Inflation Factor(VIF)

	VIF
Contract Management Capability → Cost Performance	2.194
Contract Management Capability → Project Risk Management Capability	1.972
Contractor_Experience → Cost Performance	2.183
Contractor_Experience → Project Risk Management Capability	1.874
Cross-cultural Communication Effectiveness → Cost Performance	3.216
Government Support Strength → Cost Performance	2.144
Government Support Strength → Project Risk Management Capability	1.973
Project Risk Management Capability → Cost Performance	2.884
Technological Complexity → Cost Performance	2.296
Technological Complexity → Project Risk Management Capability	2.147

Supplementary Table S18 | Effect Size (f^2)

	f-square
Contract Management Capability → Cost Performance	0.023
Contract _Management Capability → Project Risk Management Capability	0.063
Contractor Experience → Cost Performance	0.032
Contractor Experience → Project Risk Management Capability	0.067
Cross-cultural Communication Effectiveness → Cost Performance	0.044
Government Support Strength → Cost Performance	0.043
Government Support Strength → Project Risk Management Capability	0.049
Project Risk Management Capability → Cost Performance	0.029
Technological Complexity → Cost Performance	0.009
Technological Complexity → Project Risk Management Capability	0.032

Supplementary Table S19 | Coefficient of Determination (R^2)

	R-square	R-square adjusted
Cost Performance	0.58	0.573
Project Risk Management Capability	0.535	0.53

Supplementary Table S20 | Q^2

	SSO	SSE	Q^2 (=1-SSE/SSO)
Cost Performance	1955	1062.55	0.456
Project Risk Management Capability	1955	1149.301	0.412

Supplementary Table S21 | Direct path

	Original sample (O)	StandardDeviation(STDEV)	Tstatistics	P values
Contractor Experience → Cost Performance	0.171	0.064	2.664	0.008
Contract Management Capability →Cost Performance	0.145	0.069	2.114	0.035
Technological Complexity → Cost Performance	0.091	0.074	1.234	0.217
Government Support Strength → Cost Performance	0.197	0.065	3.021	0.003
Contractor Experience → Project Risk Management Capability	0.242	0.07	3.482	0.001
Contract Management Capability →Project Risk Management Capability	0.241	0.061	3.94	0.000
Technological Complexity → Project Risk Management Capability	0.179	0.068	2.643	0.008
Government Support Strength → Project Risk Management Capability	0.212	0.071	3.004	0.003
Project Risk Management Capability → Cost Performance	0.187	0.075	2.486	0.013

Supplementary Table S22 | Mediating effect analysis

Path	β	T statistics	95% CI Lower	95% CI Upper	P values	Mediating type
Contractor Experience → Project Risk Management Capability → Cost Performance	0.045	1.932	0.005	0.097	0.053	No mediation
Contract Management Capability → Project Risk Management Capability → Cost Performance	0.045	2.021	0.006	0.094	0.043	Partial mediation
Technological Complexity → Project Risk Management Capability → Cost Performance	0.034	1.970	0.003	0.069	0.049	Full mediation
Government Support Strength → Project Risk Management Capability → Cost Performance	0.040	1.812	0.004	0.087	0.070	No mediation

Supplementary Table S23 | Moderating effect analysis

Path	β	Standard deviation (STDEV)	T statistics	P values
Cross-cultural Communication Effectiveness × Project Risk Management Capability → Cost Performance	0.134	0.049	2.733	0.006

Supplementary Table S24 | Hypothesis Results

	Hypothesis	Results
H1	Contractor Experience → Cost Performance	Supported
H2	Contract Management Capability → Cost Performance	Supported
H3	Technological Complexity → Cost Performance	Not Supported
H4	Government Support Strength → Cost Performance	Supported
H5	Contractor Experience → Project Risk Management Capability	Supported
H6	Contract Management Capability → Project Risk Management Capability	Supported
H7	Technological Complexity → Project Risk Management Capability	Supported
H8	Government Support Strength → Project Risk _Management Capability	Supported
H9	Contractor Experience → Project Risk Management Capability → Cost Performance	Not Supported
H10	Contract Management Capability → Project Risk Management Capability → Cost Performance	Supported
H11	Technological Complexity → Project Risk Management Capability → Cost Performance	Supported
H12	Government Support Strength → Project Risk Management Capability → Cost Performance	Not Supported
H13	Project Risk _Management Capability → Cost Performance	Supported
H14	Cross-cultural Communication Effectiveness x Project Risk Management Capability → Cost Performance	Supported