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J G T S S

Research article

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

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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

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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 back-

ground 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:

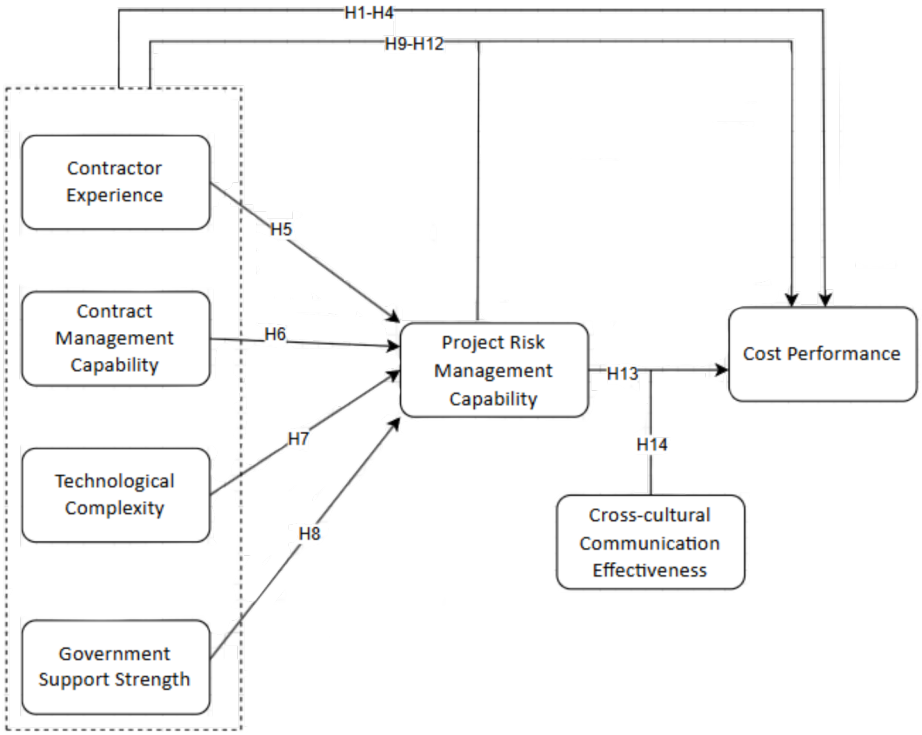

Figure 1 | Proposed research framework

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-

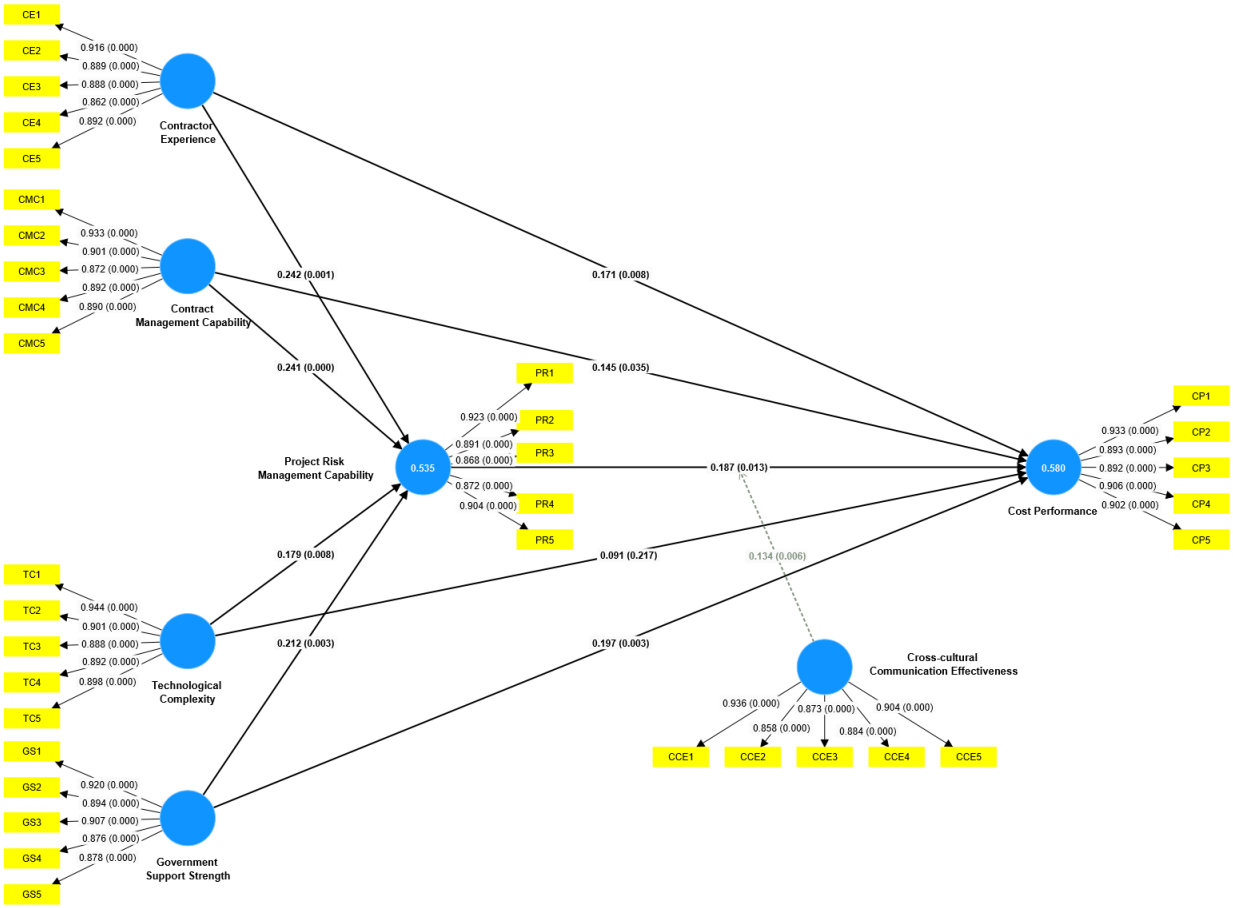

Figure 2 | Final structural model

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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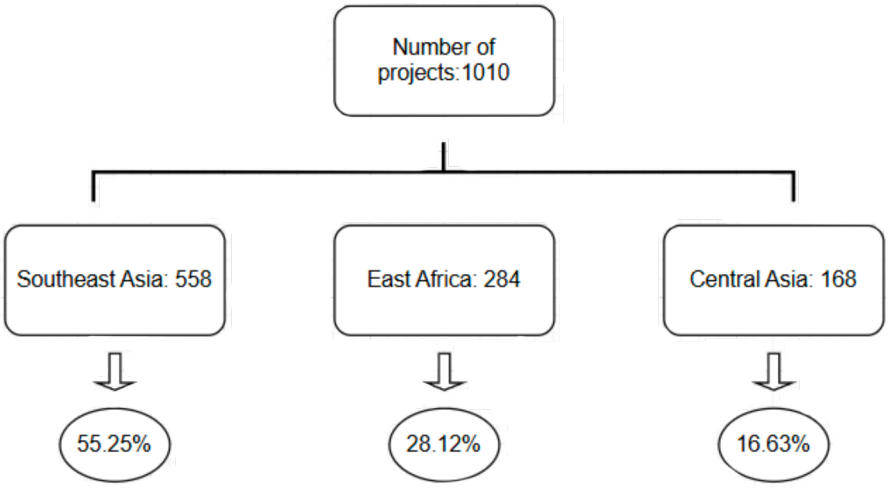
Appendix



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 α=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

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J G T S S

Research article

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Inter-City Cinematic Networks in Cold War Global History: A Reinterpretation of Chinese-Language Film Circulation Between Hong Kong and Phnom Penh, 1950s–1970s

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Abstract: This article examines the circulation of Chinese-language films between Hong Kong and Phnom Penh from the 1950s to the 1970s, situating it within the dual analytical frameworks of Cold War global history and inter-city cinematic networks to reassess the cultural circulation mechanisms generated by these two cities through the interweaving of diaspora communities, markets, and ideological forces. First, the article demonstrates how Hong Kong films entered Phnom Penh's Chinese communities through diasporic networks, exhibition circuits, and Cold War political contexts. Cantonese opera films and leftist productions were reinterpreted locally, becoming key media through which emotional bonds were sustained and political imaginations were projected. Second, the article foregrounds Phnom Penh's agency, arguing that it was not merely a passive recipient of cultural imports but an active node that, through local production, cross-border collaboration, and market feedback, exerted reverse influence on Hong Kong and neighboring regional film industries. Based on this historical process, the article proposes an analytical model of cross-city image circulation, suggesting that cities constitute crucial units for understanding the circulation of Chinese-language films during the Cold War, and demonstrating how Hong Kong and Phnom Penh formed an interconnected system that transcends the conventional "center–periphery" paradigm. By moving beyond the nation-centered framework of film historiography, this study highlights the composite roles of urban actors, diasporic structures, and political forces in Cold War-era cinematic flows, offering new theoretical insights for the transnational history of Chinese-language cinema.

Keywords: Cold War global history; Cross-city image networks; Chinese-language film circulation; Diasporic networks

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In recent years, the convergence of international history and film studies has brought the analytical framework of Cold War global history increasingly to the fore. Representative works such as *The Cambridge History of the Cold War* and *The Oxford Handbook of the Cold War* have gradually moved away from traditional nation-centered narratives, conceptualizing the Cold War as a global structure of interactions whose driving forces were deeply rooted in transnational flows, cultural networks, and the agency of non-state actors (Chen, 2015). This paradigmatic shift has opened new pathways for reinterpreting the cultural histories of East and Southeast Asia—allowing previously marginalized entities, such as Chinese diasporic communities, urban film industries, and cross-regional audiences, to re-enter the center of historical analysis.

Meanwhile, film studies has undergone a parallel "global turn." Classical frameworks of "world film history" have been critically reexamined (Bordwell & Thompson, 2009), while renewed attention to Asian, African, and Latin American "non-Western film traditions" has pushed transnational image circulation, industrial networks, and diasporic cultural transmission to the forefront of global film historiogra-

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phy (Nowell-Smith, 1996). Within this intellectual trajectory, studies of Chinese-language cinema have increasingly moved beyond the conventional paradigm of "national cinema," shifting instead toward the cultural meanings and practical logics generated through cross-regional, cross-city, and cross-ethnic interactions (Li, 2014).

Situated at the intersection of these two scholarly currents, the present study positions its examination of Hong Kong–Phnom Penh Chinese-language film circulation. Although located within different political systems during the Cold War, Hong Kong and Phnom Penh formed a dynamic and sustained network of image circulation through diasporic connections, market linkages, and ideological entanglements. This article seeks to uncover the inner mechanisms of this interconnected system at the margins and to explore how cities, as cultural nodes, shaped film networks that transcended national borders within the broader global structure of the Cold War.

From Hong Kong to Phnom Penh: Intercity Ideological Flows and Reinterpretations

Most Chinese migrants in Cambodia trace their ancestral origins to Guangdong, Hainan, and Fujian, with Teochew migrants constituting the majority—approximately 80 percent of the overall Chinese Cambodian population—followed by Hakka migrants (State Council Overseas Chinese Affairs Cadre School, 2005). Concentrated in commercial districts such as O'Russei Market and New Market, these communities were further organized into associations based on dialect and place of origin, including the Teochew, Cantonese, Fujianese, and Hainanese. Owing to relatively recent settlement histories, control over commercial networks, restrictions embedded in Cambodian naturalization policies, and the persistence of native-place consciousness, Chinese in Phnom Penh generally maintained cultural practices tied to their homelands, making them a natural audience for Sinitic-language cinema.

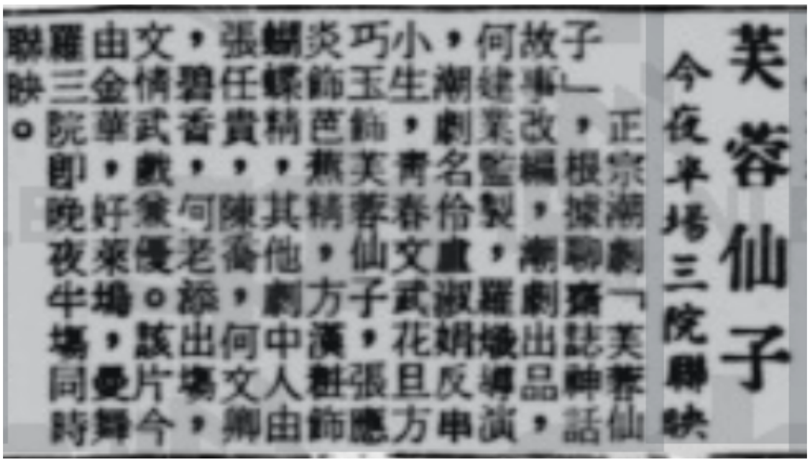
Lin (2018) mentions that Minbao Evening News (Shantou Edition) on February 10, 1939, reported that Teochew opera troupes, such as the "Old Yuchunxiang Troupe" and the "Zhongyizhixiang Troupe," had established regular performance circuits in the 1920s. In the late 1950s, the China Teochew Opera Troupe, led by Wang Kunlun and Qi Feng, embarked on a cultural exchange tour to Cambodia, generating significant excitement in Phnom Penh. Lai (1993) notes that over the course of forty-two days, the troupe attracted more than sixty thousand spectators, staging full-length operas such as *Chen San & Wu-Niang*（《陈三五娘》） and *Su Liu-Niang*（《苏六娘》）, as well as classic excerpts like *Lu-lin Hui*（《芦林会》） and *Sao-chuang Hui*（《扫窗会》）. The tour received extensive media coverage, with four major local Chinese-language newspapers—*Mianhua Daily*, *Kung Sheung Daily*, *Meijiang Daily*, and *Life Daily*—publishing more than fifty reports and commentaries, accompanied by over 240 production stills.The Voice of Cambodia radio highlighted the troupe's success, describing Teochew opera as "one of the oldest and finest traditional genres" (Lai, 1993, p. 237).

The tour began with a special performance at the Fuchani Palace for Queen Sisowath Kosamak and her royal family. Lai (1993) records that the Queen expressed her appreciation, saying, "This is the first time a visiting troupe has used Khmer subtitles. Thank you for your thoughtful preparation". Despite the theatre's limited capacity of just over eight hundred seats, to meet the overwhelming demand, five to six hundred standing-room tickets were sold each night, and thousands of spectators gathered outside to listen to live broadcasts. The final performance was held on a temporary stage at the Ministry of Foreign Affairs square, free to the public, where tens of thousands of residents gathered, filling both the stage and surrounding streets.

In May 1960, Troupe One of the Guangdong Teochew Opera Theatre performed publicly for the first time in Hong Kong, showcasing productions such as *Ci-lang Zhou*（《辞郎洲》）, *Li-jing Ji*（《荔镜记》）, and *Su Liu-niang*, which sparked the "Yao Xuanqiu phenomenon."According to Lai (2021), the troupe premiered *Dang-Ma*（《挡马》） and *Ci-lang Zhou* at the Ko Shing Theatre on June 10, captivating the audience with continuous applause (Huang, 2021, p. 149). After the performance, more than 1,000 people crowded outside the theatre, waiting to catch a glimpse of the performers, as reported by *Southern Daily* (1960). Xu (2005) describes that when the troupe performed at the Pou Hing Theatre in Kowloon, a typhoon struck Hong Kong, yet the ticket queue stretched from Nathan Road to Gascoigne Road. As the troupe moved to the Ko Shing Theatre, the crowd grew even larger, with overseas Chinese from Southeast Asia flying in, some paying 150 Hong Kong dollars for black-market tickets—twelve times the regular price—to see the performance.

During this period, Hong Kong—then the most important Chinese-language film production center outside mainland China—developed an export-oriented mechanism for cultural circulation within Southeast Asian migrant communities in the Cold War geopolitical context. According to Pu (2010), in the 1950s, many films circulating in Thailand as "Teochew films" were actually Hokkien-language films dubbed into Teochew. In contrast, locally produced "authentic Teochew films" in Hong Kong featured primarily spoken-drama performances with only a few Teochew arias, rather than full opera-style staging. However, by 1960, *Kung Sheung Evening Post* reported that audiences "increasingly long for fully theatricalized singing performances" (Pu, 2010). Even before the Guangdong troupe's 1960 visit, Hong Kong's film industry began experimenting with opera-style Teochew cinema. In February 1960, Donghai Film Company initiated the production of *A Pair of Carved Jade*（《刘明珠三审玉芝兰》）, marketed as a "Teochew opera stage film," marking a key step in the operatic transformation of Hong Kong's Teochew-language cinema.

The surge in Teochew opera films was sustained by a stable diasporic audience and low production costs. According



芙蓉仙子

今夜半場三院聯映

Figure 1 | Tonight's Joint Screening of Hibiscus Fairy at Three Theatres

Note. From "芙蓉仙子今夜半場三院聯映" 1964, Nanyang Siang Pau, November 28.

to Zhong (2007), Teochew films, as a dialect cinema, enjoyed a steady market within Teochew diasporic communities. With low production costs, the influx of overseas capital naturally pushed up distribution prices. Local opera troupes provided ready-made scripts, songs, performers, and musicians, making Teochew film production relatively risk-free for Hong Kong producers who managed their budgets carefully.

Key productions from 1960 to 1965, such as *Su Liu-niang* and *Chen San & Wu-Niang*, both starring Yao Xuanqiu, were known for their refined production values and vivid color cinematography. These films also exemplified a triangular geography of film history linking Guangzhou, Hong Kong, and Southeast Asia. *Su Liu-niang* was co-produced by Hong Kong's Hongtu Film Company and the First Troupe of Guangdong Teochew Opera Theatre, with filming at the Pearl River Film Studio in Guangzhou, while *Chen San & Wu-Niang* was produced by Dapeng Film Company in partnership with the same troupe and filmed in Guangzhou. The creative team included opera directors Zheng Yibiao（郑一标） and Wu Feng（吴峰）, and the renowned film director Zhu Shilin (朱石麟), who, having moved to Hong Kong in 1946, became a central figure in the Hong Kong film industry during the 1950s–60s; his daughter recalls, "As long as the film was directed by Zhu, Southeast Asia would purchase the demo reel in advance" (Li, 2010).

Ding (2015) observes that many opera films of the era claimed to be Hong Kong co-productions merely to secure distribution rights there, producing what she terms nominal co-productions during the Seventeen Years period. *Su Liu-niang* and *Chen San & Wu-Niang* were important exceptions—genuine cross-regional collaborations whose production practices linked disparate locations, reconfigured senses of belonging, and mobilized travelling troupes that traversed linguistic, political, regional, and ideological boundaries. These entangled histories demonstrate that mainland Chinese film history and Hong Kong film history during the Cold War can no longer be examined in isolation.

The Cold War ideological divide endowed such cultural circulation with even greater significance. Because these eight co-produced Teochew films surpassed independently produced Hong Kong Teochew films in sophistication and popularity, promoters frequently used the label "mainland standards" (大陆水准) as a marketing slogan. For example, a December advertisement for The Lotus Fairy highlighted: "Authentic Teochew opera The Lotus Fairy, adapted from a Strange Tales narrative…". Another headline announced, "芙蓉仙子今夜半場三院聯映" ("Tonight's joint screening of *Hibiscus Fairy* at three theatres"; see **Figure 1**). The Guangdong troupe's 1960 tour—marking the first post-1949 public performance of Teochew opera in Hong Kong—generated a cultural phenomenon described as "no conversation without Teochew opera, no sound without Teochew melody" (Lin, 2019). This successful cultural exchange not only showcased the aesthetic power of Teochew opera but also helped cultivate a crucial audience base and market atmosphere for the subsequent rise of Teochew-language cinema.

Teochew opera films were linguistically limited, with audiences primarily confined to Teochew-speaking communities. Due to political and historical constraints, these films struggled to circulate in the Chaoshan region of mainland China, and with Teochew residents making up only about 20 percent of Hong Kong's population, the domestic market was small. As a result, Teochew diaspora communities across Southeast Asia became the primary audience and profit base for Hong Kong's Teochew-language cinema. Zhong (2013) explains the commercial logic: "Teochew-language films enjoyed a stable market among overseas Teochew communities. With low production costs and overseas capital flowing into Hong Kong, demand easily drove up selling prices. Local opera troupes provided scripts, songs, performers, and musicians, making production effortless and risk-free for producers who managed costs carefully." This structure allowed Hong Kong's Teochew cinema to form a cross-regional cultural circuit, linking diaspora demand, box-office revenue, and capital feedback, which sus-

tained its economic foundation. It not only secured more screenings in Southeast Asia than in Hong Kong, but also shaped film themes, narratives, and star systems, producing a cinema that was diasporic, transnational, and ethnically marked within the broader Hong Kong film industry.

The Agency of Phnom Penh's Film Industry and Its Cross-Regional Participation

In contrast to Hong Kong, Phnom Penh between the 1950s and 1970s exhibited an urban cultural landscape deeply shaped by its Chinese communities, as noted by Li (2010). While Cambodia under Prince Sihanouk officially pursued a policy of neutral diplomacy, the capital's cultural ecology clearly reflected the long-standing presence of Chinese settlers. Historical records indicate that Chinese settlers were involved in agricultural production in Cambodia as early as the sixteenth century. The *Gazetteer of Jiading: Geography Section*（《嘉定通志·山川志》） describes the southeastern regions, where "farmlands were abundant, and Chinese settlers cultivated the land alongside local inhabitants" (Chen, 1990, p.541), highlighting the long history of shared settlement and development.

The formation of Cambodia's Chinese society was the result of a complex historical process. As Bussell (1958) observes, prior to World War II, Chinese migrants—including those of Fujianese origin—were primarily involved in agriculture, fishing, and commerce. In the fishing industry in particular, "Chinese occupied an important position; before Cambodia became a French protectorate, Cambodian kings often leased fishing rights to Chinese." Such deep economic participation enabled Chinese communities to establish a strong foothold in local society. In central Phnom Penh, especially around the Central Market area, Chinese-operated shops, schools, theaters, and temples formed a dense cultural ecosystem. These dialect-based cultural choices reflected the intricate territorial and linguistic identities within the diaspora. Collective film-viewing activities organized by clan associations and schools, along with the ubiquity of Chinese-language film posters across the city, constituted a distinctive cultural landscape. Phnom Penh's Chinese-language film market was thus not a passive recipient of external culture, but rather an outward manifestation of the diaspora's internal cultural logic. As Li(2010) argues, Chinese communities actively constructed an autonomous cultural sphere in Phnom Penh through sustained cultural practices.

From the 1950s to the 1990s, Phnom Penh maintained close ties with Hong Kong's film industry, with over a dozen major cinemas, most of which were Chinese-owned. Liang and Chen (1997) note that Cambodia accounted for 12.4% of Hong Kong's overseas film revenue during this period, underlining the city's reliance on Hong Kong for its film supply. According to Kang (2023), some theaters in Phnom Penh were even directly linked to Hong Kong companies through capital networks. This resulted in the development of a stable channel for the distribution of Hong Kong cinema. While the Cambodian government promoted Khmer nationalism, Chinese cultural expression was generally tolerated, with censorship mainly targeting political content. Consequently, Hong Kong films were able to cross geographical and cultural boundaries, building a strong distribution network throughout Southeast Asia. Phnom Penh thus emerged as a city that was culturally open yet politically vigilant, where Chinese-language cinema existed as a semi-autonomous sphere within the local sociopolitical framework, balancing relations with the royal government.

To understand the flow of images between Hong Kong and Phnom Penh, it is essential to view the diaspora community as a form of cross-regional cultural infrastructure. Under Cold War conditions, Hong Kong became a central hub for the circulation of Chinese-language films. For instance, Xu (2005) explains that a major business of Nanfang Film Company involved purchasing films or investing in productions for overseas Chinese theaters and distributors. Its distribution network spanned Laos, Myanmar, Cambodia, Malaya, Singapore, and Thailand, relying on shared ethnic ties, as well as on commercial collaboration, capital circulation, and information exchange.

Commercial capital and industrial-chain integration formed the basis of film circulation. As markets expanded, theaters operating only at the exhibition end could no longer meet demand, making it "urgent for them to intervene in the upstream stages of film production" (Zhang, 2017). Guangyi Film Company traveled to Hong Kong to produce Cantonese films precisely because "producing directly in Hong Kong was more cost-effective." According to the recollections of director Chu Yuan（楚原）, then employed by Guangyi, "a budget of only 160,000 Singapore dollars was sufficient to break local box-office records," and the 330,000 Singapore dollar gross of *Liu Sanjie* (1960;《刘三姐》) was a sensation, leading Malayan and Singaporean distributors to conclude that "investing in Hong Kong productions was more profitable; with production costs as low as 30,000–40,000 dollars, films could earn revenue both in Hong Kong and in Singapore/Malaya markets" (Xu, 2005).

Meanwhile, diaspora media and educational institutions provided cultural support for film circulation. Chinese-language newspapers regularly published advertisements, celebrity news, and serialized film narratives, while Chinese schools' group-viewing events enhanced film visibility. Shared linguistic repertoires—Mandarin, Cantonese, and Teochew—served not only symbolic but also functional communicative purposes, forming the basis for film consumption. Finally, cinema served as a medium through which diasporic subjects sustained cultural identities and emotional ties to their ancestral homes. The modern urban imaginaries portrayed in these films often functioned as affective symbols of "the homeland." As such, diaspora communities were not merely consumers of cinema but active agents whose investment, media activity, and cultural prac-

Figure 2 | An Inseparable Bond with Snakes: Dy Saveth Has a Secret

Note. From "與蛇結不解緣 李莎月有秘密" 1974, Kung Sheung Evening Post, November 28.

tices continually drove the emotional and structural forces underpinning cross-city image circulation.

It is important to emphasize that the Chinese diaspora was not a passive cultural receiver; rather, it actively reshaped the circulation and interpretation of Hong Kong films through processes of selective appropriation and cultural reproduction. Cinema functioned not only as a medium of identity formation but also as a catalyst for new cross-cultural affective structures. From the perspective of global cultural networks, interactions between dominant media cities and weaker cities often exhibit a "media capital siphoning effect," in which the former absorbs cultural resources from the latter and integrates them into its own popular cultural system (Curtin, 2003). This dynamic was particularly evident in the cinematic exchanges between Hong Kong and Phnom Penh.

By the 1970s, some Sino-Cambodian film practitioners began to experiment with film festivals, co-productions, and other strategies to project Cambodian cinema toward the Hong Kong-centered Sinitic film market. A representative figure is Kuang Hui(许强), whose cross-cultural background—his father was a Chinese Communist underground member active in Indochina's leftist press and education sectors, while his mother belonged to the Cambodian aristocracy—allowed him to cultivate extensive networks within local political and commercial circles and to build close ties with the Hong Kong and Taiwan film industries. In 1970, under his initiative, *The Snake King's Wife*(1970; 《人蛇恋》), starring Cambodian megastar Dy Saveth（李莎月）, won six awards at the Singapore International Film Festival (**Figure 4**). The film became a landmark of Cambodia's cinematic "golden age," and Dy Saveth emerged as "one of the most beloved actresses of Cambodian cinema in the 1960s" (Bangkok Post, 2012).

This process of cultural re-inscription was far from a purely commercial phenomenon; rather, it was deeply embedded in the geopolitical configuration of Cold War Southeast Asia. Under the physical and informational barriers produced by ideological confrontation, Hong Kong and Singapore viewed Cambodia—whose political orientation diverged sharply from their own—with both caution and fascination. The media's construction of Dy Saveth's persona can be seen as a projection of these ambivalent sentiments. Hong Kong newspapers portrayed the actress as a "wild" woman capable of communicating with snakes or even forming emotional bonds with them—an image amplified in sensationalist reportage. As *Kung Sheung Evening Post* wrote on 5 February 1974, Dy Saveth had "formed an inseparable bond with snakes," and rumors surrounding the film *Snake Girl* (1974) "broke box-office records across Singapore and Malaysia," with speculation that she might visit Hong Kong. The report further suggested that "the secret she keeps can only be understood by herself; but unfortunately, paper cannot contain fire, and the truth has now been exposed." (**Figure 2**)

This "othering" narrative mechanism, co-constructed by media and cinema, profoundly reflects the asymmetric operation of cultural power under the Cold War configuration. Examining this process from the perspective of cultural production reveals dual structural characteristics: First, when local cultural symbols enter transnational commercial systems, they inevitably undergo processes of extraction, reconfiguration, and recoding. Cambodian cultural practices—such as religious beliefs and folk rituals that possess profound historical accumulation and social functions—are reduced to visual spectacles readily identifiable and consumable. *Kung Sheung Daily* (January 29, 1974) reported: "To demonstrate her fondness for snakes, she is developing a

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李莎月對蛇極好感
闢園飼養各地名蛇

因一部「人蛇戀」在東南亞各地，包括香港均收百多萬元，而使一個高棉的女演員，紅透半邊天，馬上又被邀請拍了一部「蛇魔女」，另外還有兩部正在籌拍中。有關「蛇」的故事的影片，兩部都由高棉女演員李莎月為主角，其中一部，仍與「人」片的小女孩合作。

也因為這個緣故，李莎月在東南亞各地，就被冠了一個「蛇后」美譽。

事實上，李莎月自從拍過「人蛇戀」之後，對於蛇，不但已不感到害怕，而且對蛇，開始有好感。

李莎月說，蛇在普通人心目中，是一種冷血可怕的毒蟲，但如果你有辦法，或對牠們友善，那麼，這冷血爬蟲，也是通曉人性的東西。

為了表示她對蛇的好感，她正開始闢一個廣闊的花園，作為養蛇之用，刻下她正搜集世界各種稀有的蛇類。

高棉一帶是盛產毒蛇的地方，故此，那些地方的人民，很多都信奉蛇神，與馬來亞一帶，都有蛇廟建立，讓人膜拜。李莎月雖然不是信奉蛇神，現在她寓所後的一個花園，卻豢養了不少蛇類，其中有些是在「蛇魔女」片中，擔任重要角色的。

在「人」片，那[illegible]是戴上一個蛇髻，在「蛇魔女」一片中，李莎月也一樣要戴出那使人驚駭欲絕的蛇髮，而且還在蛇洞中，[illegible]着幾條巨蟒玩耍。也虧得李莎月有此膽量，換上別人，嚇都嚇死才怪呢。

香港也有人以蛇為中心拍了一部影片，由此可以知道，香港甚至世界各地的觀眾，看電影的興趣，已經大大的改變了。換句話說，除了那些色情片，永遠都是吸引觀眾的影片之外，一般的心理，大都趨向新奇刺激，越恐怖越對胃口。好像不久前有過一部以「鼠」為中心的西片，當日賣座得很使人滿意。「蛇魔女」也是噱頭十足的一部傳奇片，受到歡迎是肯定的。

不過，話又說回來，拍「蛇魔女」這種影片，可不容易，單以虛耗菲林，就比普通的影片多花三倍以上，因為蛇不是人，比較難於控制，也因為這樣，成本就相應的大了。所以拍的人也不會很多。

Figure 3 | Dy Saveth's Great Fondness for Snakes: Establishing a Garden to Raise Famous Snakes from Various Locations

Note. From "李莎月對蛇極好感 闢園飼養各地名蛇" 1974, Kung Sheung Daily, February 5.

beautiful garden for snake breeding. She is currently collecting rare snake species from around the world. The Khmer region is abundant in venomous snakes; consequently, many people there worship snake deities. Similar to the Malaya region, snake temples have been established there for public veneration." (**Figure 3**: Li Shayue's Great Fondness for Snakes: Establishing a Garden to Raise Famous Snakes from Various Places) This report sutures Khmer cultural beliefs into a broader "Southeast Asian witchcraft" imaginary familiar to Chinese-speaking audiences, diminishing its distinctiveness. It represents a dimensional reduction of complex cultural systems into symbolic exotic labels, thereby adapting them to the narrative conventions and market expectations of Chinese-language commercial genre films.

Meanwhile, this symbolic strategy is further reinforced in film marketing. The poster for *The Snake King's Wife* (1971) (**Figure 4**) employs snakes entwined around a female body as its central visual element, accompanied by the tagline "The First Spectacular Film to Shake Asian Cinema," explicitly translating Cambodian religious beliefs into genre spectacles of horror and suspense. The poster's inscription "Asian Folk Tale" further generalizes the culturally specific Khmer naga worship into a vague Southeast Asian legend. This dimensional reduction enables its seamless integration into the genre conventions and market expectations of Chinese-language commercial cinema. *Wah Kiu Yat Po,* or *Overseas Chinese Daily News* (October 29, 1974) emphasized the contrast generated by her mixed heritage: "Dy Saveth is a Khmer actress with Chinese ancestry... This petite, gentle, and charming star possesses a healthy physique and beautiful features. Many find it puzzling how such a gentle and lovely actress would associate with fear-inducing snakes and even engage in intimate scenes with them during filming." (**Figure 5**: The Petite and Charming Snake Enchantress: Dy Saveth's Mastery of Snake Handling) This narrative reveals the complex mentality of the Cold War-era overseas Chinese community: on one hand, her Chinese ancestry provides cultural proximity, making her an acceptable "us"; on the other hand, her exotic behaviors from turbulent Cambodia (dancing with snakes) satisfy the Free World's Orientalist imagination of the primitive, mysterious, and even dangerous aspects behind the Iron Curtain. This narrative maintains cultural identity boundaries while providing audiences with an othering gaze from a safe distance: they can glimpse the mysteries beyond the Iron Curtain without genuinely understanding its cultural connotations or assuming political risks.

The collaborative construction of Dy Saveth's public image by the three newspapers—ranging from the generalization of her cultural background (*The Kung Sheung Daily*

Figure 4 | The Snake King's Wife(1970;《人蛇恋》)

Note. Movie posters, 1970. Left: Chinese poster; right: Thai promotional poster.

Figure 5 | The Petite and Charming Snake Enchantress: Dy Saveth's Mastery of Snake Handling

Note. From "玲瓏嫵媚蛇魔女 李莎月最擅玩蛇" 1974, Wah Kiu Yat Po, February 5.

News), to the romanticization of her mystique (*The Kung Sheung Evening Post*), and finally to the emphasis on her mixed heritage (*Wah Kiu Yat Po*)—constituted a complete mechanism of discourse production. The influx of Cambodian cultural elements seemingly enriched the thematic repertoire of Chinese-language cinema, yet in fact underwent a systematic process of "decontextualization" and "recontextualization": indigenous cultural forms were stripped of their social foundations and historical contexts, only to be reassembled into a set of genre conventions and aesthetic standards predetermined by dominant cultural centers. This unidirectional process of cultural incorporation made it difficult for cultural producers in disadvantaged regions to maintain subjectivity; instead, their cultural resources were reduced to a repository of materials and objects of imagination for stronger markets.

Ultimately, under the dual forces of commercial integration and geopolitics, the original Cambodian cultural characteristics embedded in "snake films" were rapidly diluted and replaced. This uprooting of culture occurred simultaneously with the collapse of Cambodia's domestic film industry, together constituting a cultural tragedy severed by the Cold War. Commercial logic requires that cultural products adapt to the reception habits and consumer psychology of their

target markets; thus, cultural differences are strategically amplified or diminished to maximize market returns. In this process, Cambodian filmmakers actively participated in the commodified transformation of their own culture in order to enter Chinese-language markets; media outlets collaborated to construct exotic imaginaries in pursuit of sensationalism; and audiences continuously reinforced stereotypical perceptions of the "Other" through consumption. Together, these three actors formed a self-perpetuating closed loop of cultural production and consumption. This seemingly spontaneous market behavior in fact profoundly embodied the covert operational logic of the cultural Cold War: through the production and circulation of cultural commodities, particular geopolitical imaginations and cultural hierarchies were continually reproduced and solidified.

Against this backdrop, the personal fate of Dy Saveth—the leading actress of The Snake King and the inspirational source of snake films—became a cruel microcosm of the era. Once "one of the most recognizable faces of Cambodian cinema's golden age" (Jackson, 2014), her artistic life ended abruptly with the upheavals of her nation. After the Khmer Rouge came to power, she was forced into exile, first to France and later to Hong Kong, ultimately abandoning her acting career. Her displacement was not merely an individual tragedy but symbolized the rupture of talent and historical continuity within Cambodia's entire film industry. As domestic film production in Cambodia fell completely silent after 1975, the snake film—a genre that originated from Khmer soil—saw its production center wholly transferred to and rooted in Hong Kong and Taiwan, completing its cultural migration and final settlement under the Cold War structure. The snake film phenomenon was by no means an isolated commercial case; rather, it represented a typical cross-section of cultural power operations under the geopolitical configuration of the Cold War. While Cambodia's domestic film industry perished amid political turmoil, a genre born from its cultural soil survived and continued in Hong Kong and Taiwan—an inherently paradoxical outcome of cultural migration that poignantly illustrates the profound imprint of power relations within cultural flows.

The Mechanism of Hong Kong–Phnom Penh Filmic Connectivity: Inter-city Image Circulation

From the perspective of global urban history, cities during the Cold War frequently served as hubs of transnational cultural circulation (Xiao, 1989). Hong Kong and Phnom Penh shared several characteristics, including highly commercialized media industries and multilingual, multiethnic cultural compositions. Therefore, film circulation should not be understood merely as an interaction between nation-states; rather, cities should be viewed as cultural nodes that generate inter-regional cinematic linkages through population movements, diasporic networks, and the operations of film industries.

Hong Kong's emergence as the "media capital" of the Chinese-speaking world under the Cold War was not only the result of its relatively open cultural environment but also its unique geopolitical position. Borrowing Zhang Yingjin's distinction, "translocality," rather than "transnationalism," more accurately captures the production and exhibition patterns of Teochew-language cinema. This was not a project that could be fully subsumed under the state-driven rubric of "national cinema," but a cultural channel connecting Guangdong, Hong Kong, Thailand, Singapore, Malaysia, Indonesia, Cambodia, and Vietnam. As Curtin (2003) notes, "media capitals are sites of mediation, the locations where complex forces and flows interact; they are neither bounded entities nor autonomous formations… These new patterns of circulation should not be interpreted as multilateral in the traditional sense, because they do not involve exchanges between sovereign states." By facilitating interconnections between transnational cultural flows and peripheral spaces, Hong Kong established its position as a nodal center. In doing so, it constructed a cultural network that operated independently of state structures—a network that gave rise to linguistic, regional, and emotional communities transcending the borders of nation-states.

Communities such as Teochew, Fujianese, and Hakka not only share languages and belief systems but also maintain transregional commercial networks, educational systems, and newspaper infrastructures. These diasporic networks performed multiple roles as cultural consumers and providers of circulation channels. In the postwar period, Southeast Asian states generally adopted accelerated policies of sinicizing or naturalizing the overseas Chinese. Although Cambodia did not implement such policies as aggressively as some neighboring countries, many Chinese in Phnom Penh nevertheless remained non-citizens due to "their relatively short settlement history, their control over commercial networks, the restrictions of the Cambodian naturalization policy, and their persistent attachment to native-place consciousness" (Xiao, 1989). This politically marginal status heightened the cultural identification with the ancestral homeland. Consequently, compared with entertainment films produced by purely commercial Hong Kong studios, the works of leftist film companies—despite operating under commercial logic—maintained a distinct sense of balance in their production principles. As Shi (2006) pointed out, "The guiding principle of leftist filmmaking was not primarily to indoctrinate audiences with certain ideological or political messages, but to maintain a balanced foothold in this place through normal commercial means."

This production philosophy resulted in a realist attention to urban phenomena and the destinies of ordinary people, resonating strongly with the social conditions of diasporic audiences. Zhu Shilin candidly admitted in a letter to his daughter, "We make films in Hong Kong mainly for overseas Chinese audiences, and we must improve both artistic quality and entertainment value" (Zhu Feng & Zhu Yan, 1999). Although leftist Teochew opera films were limited in number, they benefited from financial support from the mainland

and technical assistance from the Pearl River Film Studio, as well as from the availability of professional performers from Guangdong Teochew Opera Troupe. As a result, audiences praised them as exhibiting unmistakable mainland-level quality.

In early 1960s Phnom Penh, the first domestically screened Teochew opera film *Huo Shao Lin Jiang Lo*u(《火烧临江楼》) attracted overwhelming crowds at the Kim Hong Theater. Yao Xuanqiu's starring performances in *Su Liu-niang* and *Chen San & Wu-Niang* were grandly launched at the Kim Ta Theater, where "many uncles and aunties watched repeatedly and simply could not stop" (Wu, 2015). Through film consumption, the Phnom Penh Chinese community built a complex social network in which collective film viewing became an important platform for community gathering and social interaction. These public cultural spaces facilitated interethnic communication while strengthening cohesion within the Chinese diaspora. During the screenings of leftist Teochew opera films, local leftist Chinese organizations such as the "Sports Association" formed amateur troupes to stage the same opera works. This innovative practice linked them to Hong Kong's leftist cultural workers and simultaneously shifted the leadership in Teochew opera performances from commercial troupes to leftist cultural organizations—"With the influence of these Teochew opera films… Teochew opera moved from professional troupes into progressive community organizations and was endowed with new vitality" (Wu, 2015).

According to Su Zhangxi's research, *Su Liu-niang* premiered in Singapore on October 2, 1960 and ran for 72 consecutive days, breaking local box-office records. Numerous Teochew opera troupes in Singapore staged adaptations of the film, and large quantities of *Su Liu-niang*-themed New Year cards, calendars, albums, and songbooks were published. Ten days after its premiere, the opera's famous aria "Peach Blossoms Crossing the River" appeared at the Oriental Garden song stage. Amid the Teochew-language film boom, Singapore Teochew troupes' adaptations of *Su Liu-niang* demonstrated the bidirectional flow between film and opera.

The concept of vernacular, proposed by Miriam Hansen as a modern theoretical category, provides an important analytical framework for understanding transnational film circulation (Hansen, 1993). Influenced by Hansen's theory, Zhang Zhen introduced the concept of vernacular into the Chinese historical and cultural context, attempting to "liberate the term from the exclusive domain of linguists and literary historians" and extend it into the realm of everyday sensibility and material experience (Zhang, 2005). Drawing upon this perspective, the concept of the vernacular helps explain the seemingly paradoxical relationship between the use of Teochew as a localizing marker and the commercial ambition embodied in multilingual subtitles that aimed at outward circulation. While the practice of adding Mandarin subtitles to dialect films suggests a centripetal homogenizing tendency of the nation-state, the appearance of multiple subtitle versions (including Malay) for films like *Su Liu-niang* in Southeast Asia counteracted such homogenization and illustrated the coexistence of commercial forces and state power. As Zhang Zhen's analysis of Shanghai's pidgin speech reveals, hybridity and fluidity constitute the core characteristics of translocal cultural formation.

Some Teochew opera films that achieved commercial success in Southeast Asia were never screened in Hong Kong, a phenomenon that further underscores their nature as translocal cultural commodities. Beyond Teochew-language films, other genres produced by Hong Kong leftist institutions also entered the Phnom Penh market in large numbers. These films adhered to Zhou Enlai's directive for Hong Kong—"long-term planning, full utilization"—and thus muted overt communist propaganda. After the establishment of diplomatic relations between China and Cambodia, Hong Kong's Nanfang Film Company even directly distributed mainland films into Phnom Penh. Zhou Degao, a Chinese Cambodian intelligence operative, later recalled, "I once felt deep affection for the Party. Watching the public security officers arrest spies in films filled me with boundless admiration" (Wu, 2015).

During this period, the political ecology of Phnom Penh's Chinese community underwent significant changes, as leftist forces gradually took control of Chinese associations, Chinese-language schools, and newspaper media. Against this backdrop, cultural exchange became a crucial vehicle for sustaining emotional bonds between overseas Chinese and their ancestral homeland. In 1960, after watching *Chen San & Wu-Niang* in Phnom Penh, Wang Kunlun, head of the China Teochew Opera Troupe, composed a poem to the tune of *Shui Diao Ge Tou,* expressing the excitement it generated among local audiences: "Sino-Cambodian relations flourish; new sounds are sent overseas. All compete to witness Wu Niang's story; grief and joy stir the Golden City."

Leftist organizations raised funds to build the Kim Ta Theater specifically for screening leftist films; meanwhile, *Mianhua Daily*, an important leftist-controlled newspaper, actively created columns for film criticism and systematically introduced mainland and Hong Kong leftist cinema. This cultural dissemination mechanism was fully demonstrated during the Teochew Opera Troupe's visit to Cambodia. Wang Kunlun's 98-line poem The Lament of San Niang was transcribed and published in Mianhua Daily with his permission, becoming a representative case of leftist cultural transmission (Lin, 2019). This cultural dissemination system—encompassing theater construction, newspaper publicity, and educational outreach—though ideologically uniform, effectively opened a channel for the spread of leftist ideas within Phnom Penh's Chinese community.

Thus, film circulation between Hong Kong and Phnom Penh during the Cold War was not driven purely by economic logic but was deeply embedded in ethnic structures, linguistic ecologies, and emotional affiliations. Hong Kong was not only a production base for Chinese cinema but also a crucial hub for the export of ideology. In the case of Phnom Penh, this transregional circulation constituted a complex cultural network: it carried the identity and native-place

sentiments of the diaspora, facilitated the cross-border circulation of audiovisual products under commercial imperatives, and was profoundly shaped by political conditions and ideological influences. Hong Kong's film presence in Southeast Asia thus reflected both cultural affinity and the tensions of global and regional politics under the Cold War. In other words, Hong Kong–Phnom Penh film circulation was not merely the movement of audiovisual commodities but a multidimensional practice where ethnic identity, cultural memory, and political context intersected.

Conclusion

Film circulation during the Cold War was neither a simple one-way dissemination nor a straightforward cultural exchange between nation-states. Instead, it constituted a multilayered, multidirectional transregional cultural system formed through the interplay of diasporic networks, commercial capital, ideological penetration, and local agency. Its formation relied on a relatively open cultural environment and Hong Kong's unique geopolitical position, as well as the mature commercial networks and highly organized cultural institutions of the overseas Chinese community.

On one hand, Phnom Penh's Chinese diaspora constructed complex social networks and cultural identities through film consumption, with internal distinctions based on dialect and native-place shaping differentiated viewing habits and cultural preferences. On the other hand, Phnom Penh's film industry—through local production, cross-border collaboration, and market feedback—exerted reverse influence on Hong Kong and the broader Chinese-language film network. The diaspora were not merely consumers of cinema; they were providers of cultural circulation channels, investors of commercial capital, and producers of emotional identification.

The political marginality experienced by overseas Chinese in postwar Southeast Asia strengthened their cultural ties to the ancestral homeland, making cinema a vital medium for sustaining emotional connections between diaspora communities and their place of origin. By treating cities as analytical units and viewing diaspora networks as structural forces, a more complex and diversified Cold War cultural landscape emerges. The case of Hong Kong and Phnom Penh demonstrates that Cold War-era cultural flows were deeply embedded in ethnic structures, linguistic ecologies, and modes of emotional attachment, shaped simultaneously by ideological confrontation, commercial logic, and local cultural agency.

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The Impact of the Stratified Teaching Model in Physical Education on Middle School Students' Physical and Mental Health from a Gender Perspective

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Abstract: With the deepening understanding of students' individualized needs in the field of education, particularly in physical education (PE) teaching, the conventional unified teaching model can no longer adequately address the differentiated learning requirements among students. Middle school students are in a critical period of physical and mental growth and development, during which the value orientation of teaching plays a pivotal role in cultivating students' correct gender concepts and awareness. Moreover, significant differences exist in individual physical conditions during this period, rendering the adoption of more personalized and flexible teaching strategies essential. This study employs an elastic stratified teaching method, utilizing research methodologies such as literature review, questionnaire survey, teaching experiment, statistical analysis, and logical analysis to explore its application and effectiveness in middle school PE teaching. The objective is to provide each student with personalized instruction tailored to their abilities and needs, thereby maximizing the promotion of students' physical and psychological development. The findings indicate that the elastic stratified teaching model, when examined through a gender lens, demonstrates significant advantages over conventional teaching approaches in enhancing both physical fitness indicators and psychological well-being among middle school students, while simultaneously contributing to the dismantling of traditional gender stereotypes in physical education settings.

Keywords: Stratified teaching; Middle school students; Physical health; Mental health; Gender perspective; Educational equity

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Introduction

Conceptual framework of physical and mental health in educational contexts

Defining physical and mental health

Physical and mental health refers to a state of comprehensive well-being encompassing physical, psychological, and social adaptability dimensions. Specifically, an individual can only be recognized as a truly healthy person when they demonstrate soundness across the three interconnected domains of physical health, psychological stability, and social interaction. This holistic conceptualization, grounded in the biopsychosocial model initially proposed by Engel in 1977, has gained increasing traction in educational research and policy formulation. Within the specific context of physical education, this multidimensional understanding of health necessitates pedagogical approaches that transcend mere physical skill acquisition to encompass psychological resilience, social competence, and emotional regulation.

Developmental characteristics of middle school students

The developmental trajectory of students during middle school (typically ages 12–15) represents a particularly sensitive period characterized by accelerated physical growth, cognitive maturation, and psychosocial identity formation. During this critical juncture, the physical and mental devel-

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opment status of students manifests significant individual disparities, influenced by a complex interplay of genetic predisposition, environmental factors, nutritional status, and sociocultural contexts. These variations not only constrain the implementation effectiveness of PE teaching activities but also profoundly influence the formation of gender role cognition and self-concept. Tanner's pioneering research on pubertal development stages has documented substantial variability in the timing and tempo of physical maturation among adolescents, with implications for motor skill acquisition, physical performance, and psychological adjustment.

Theoretical foundations of stratified teaching

Pedagogical rationale for differentiated instruction

Stratified teaching, also conceptualized as differentiated instruction or ability grouping, represents a pedagogical approach that systematically addresses individual student differences through targeted instructional strategies. This educational philosophy, rooted in Vygotsky's zone of proximal development theory and Bloom's mastery learning model, posits that optimal learning outcomes are achieved when instruction is calibrated to students' current developmental levels and learning capacities. In the domain of physical education, stratified teaching assumes particular significance given the pronounced variability in students' physical attributes, motor skill proficiency, and psychological readiness for various forms of physical activity.

Theoretical underpinnings in physical education contexts

The theoretical underpinnings of stratified teaching in PE contexts draw upon multiple complementary frameworks. Gardner's theory of multiple intelligences suggests that individuals possess diverse cognitive profiles that influence their preferred modes of learning and skill acquisition. In physical education, this translates to recognition that students may excel in different movement domains—some demonstrating exceptional kinesthetic intelligence in complex motor sequences, while others may struggle with basic coordination patterns. Similarly, social cognitive theory, as articulated by Bandura, emphasizes the reciprocal interactions between personal factors, environmental conditions and behavioral outcomes, highlighting the importance of creating learning environments that accommodate individual differences while fostering self-efficacy and motivation.

Policy context and educational imperatives

National policy framework for physical education reform

In recent years, the Chinese government has vigorously promoted the construction of school physical education curricula, progressively refining PE teaching strategies through systematic top-level design. In 2019, the Central Committee of the Communist Party of China and the State Council promulgated "China's Education Modernization 2035," which articulated eight core educational concepts, prominently featuring the principle of teaching students in accordance with their aptitude—a pedagogical philosophy with deep roots in Confucian educational thought dating back to Confucius' teachings in the Analects. This policy document signals a fundamental shift from uniform, one-size-fits-all instructional approaches toward more nuanced, individualized pedagogical frameworks.

Recent policy developments and their implications

The subsequent issuance of the "Opinions on Comprehensively Strengthening and Improving School Physical Education Work in the New Era" by the General Office of the CPC Central Committee and the General Office of the State Council further accentuated the urgency of teaching reform and innovation in physical education. This policy directive explicitly calls for the development of PE programs that accommodate student diversity, promote inclusive participation, and foster lifelong physical activity habits. Most recently, in 2021, the "Guiding Outline for the Teaching Reform of 'Physical Education and Health'" issued by the Ministry of Education emphasized that PE courses need to achieve the multifaceted goals of "enjoying fun, enhancing physique, improving personality, and tempering will." This comprehensive objective framework acknowledges the integral role of physical education in holistic student development, encompassing not only physical outcomes but also psychological growth and character formation.

Research problem and significance

Identifying gaps in current stratified teaching approaches

Despite the clear policy mandate for individualized instruction and the theoretical rationale supporting stratified approaches, existing stratified teaching models have encountered significant challenges in successfully resolving the issue of differentiated progress in the teaching process. These challenges arise from differences in students' skill mastery levels, physical fitness profiles, learning pace preferences, and motivational orientations. Furthermore, the intersection of these individual differences with gender-based variations in physical development, socialization experiences, and educational expectations creates complex pedagogical dynamics that conventional stratified models inadequately address.

The gender dimension in physical education research

The gender dimension of physical education merits particular scholarly attention given the persistent disparities in participation rates, performance outcomes, and psychological experiences between male and female students. Research by Eccles and colleagues on expectancy-value theory demonstrates that students' achievement-related choices and performances are shaped by their expectations for success and the subjective value they attach to different activities, both of which are significantly influenced by gender socialization processes. In physical education contexts, these gendered expectations manifest in differential participation

patterns, with boys typically engaging more vigorously in competitive, contact-oriented sports, while girls often exhibit lower levels of engagement, particularly in activities perceived as masculine or physically demanding.

Research objectives and contributions

Based on this identified research gap, the present study adopts a multifaceted methodological approach, incorporating literature review, questionnaire survey, teaching experiment, statistical analysis, and logical analysis to investigate the intervention effects of the elastic stratified teaching model on the physical and mental health outcomes of middle school students. By explicitly incorporating a gender perspective throughout the research design, implementation, and analysis phases, this study aims to implement the pedagogical principle of individualized instruction while providing novel theoretical insights and practical solutions for existing pedagogical dilemmas. The findings are expected to contribute to the growing body of literature on differentiated instruction in physical education and inform evidence-based policy and practice in school settings.

Theoretical Framework: Elastic Stratification

Conceptualization and operational definition

Defining elastic stratified teaching

The elastic stratified teaching method represents a pedagogical approach wherein teachers systematically categorize students into differentiated learning levels based on comprehensive assessments of their learning abilities, prior knowledge, and developmental readiness. Following this initial stratification, educators provide differentiated instructional content and methodological approaches calibrated to students' individual characteristics and learning needs. This pedagogical framework operationalizes the ancient educational principle of teaching according to aptitude within contemporary educational contexts, translating philosophical ideals into practical instructional strategies.

Distinguishing features of elastic stratification

A distinguishing feature of the elastic stratified approach, in contrast to static or fixed stratification models, lies in its dynamic and responsive character. Throughout the instructional process, teachers must continuously monitor and evaluate students' ongoing progress, developmental changes, and emerging needs, making timely adjustments to stratification assignments and instructional provisions accordingly. This dynamic quality necessitates that teachers maintain vigilant observational awareness of students' learning trajectories, regularly administer formative assessments to gauge progress, and possess the pedagogical flexibility to modify grouping arrangements when evidence suggests such changes would benefit student learning outcomes.

Multidimensional elasticity in practice

The elasticity inherent in this model manifests in multiple dimensions. First, stratification criteria themselves are subject to ongoing refinement based on accumulating evidence regarding which student characteristics most strongly predict learning outcomes in specific instructional contexts. Second, individual students' stratification assignments may change over time as they demonstrate growth in particular skill domains or encounter challenges requiring additional support. Third, instructional strategies within each stratum may be adapted in response to emerging patterns of student engagement, comprehension difficulties, or exceptional progress. This multidimensional flexibility distinguishes elastic stratification from more rigid tracking systems that have been criticized for perpetuating educational inequalities and limiting student mobility.

Historical origins and developmental trajectory

International origins of stratified teaching

The conceptual origins of stratified teaching can be traced to 1868, when American educator Harris first articulated the concept and implemented the activity grouping system in St. Louis schools. This pioneering approach involved teachers categorizing students into differentiated learning levels through evaluative assessments, subsequently adjusting instructional objectives for each level, and periodically reallocating students across classes to enable level adjustments based on demonstrated progress. Harris's system represented a significant departure from the age-graded classroom organization that had become dominant in American education, introducing the possibility of instructional differentiation based on demonstrated achievement rather than chronological age alone.

Progressive era developments

The early twentieth century witnessed further elaborations of stratified approaches in progressive education movements. The "Winnetka Plan," proposed by American educator Carleton Washburne in 1919, emphasized individualized instruction and self-paced learning, allowing students to progress through curriculum materials at rates commensurate with their abilities. Similarly, the "Dalton Plan," implemented by Parkhurst in 1920, introduced laboratory-style classrooms where students could work independently on assigned tasks, with teachers serving as facilitators and guides rather than lecturers. Both approaches emphasized adjusting learning progress according to student abilities and are historically regarded as early instantiations of stratified teaching practices.

Introduction and development in China

The introduction and development of stratified teaching in China occurred primarily in the 1990s, coinciding with broader educational reforms and increasing attention to individual differences in learning. In the initial stage, experiments were primarily conducted in high school settings to address variations in subject-specific abilities, particularly

in mathematics and science domains where achievement disparities were most pronounced. The earliest systematic articulation can be traced to Professor Hu Xinghong's 1992 publication "Conception on 'Layered Progressive Teaching'," which proposed establishing five core frameworks: student stratification, goal stratification, teaching stratification, evaluation stratification, and timely adjustment for layered improvement. This comprehensive framework provided theoretical grounding and practical guidance for implementing stratified approaches in Chinese educational contexts.

It is particularly noteworthy that Liu Ruixue subsequently introduced the concept of elasticity to stratified teaching discourse, proposing that teachers must make timely and flexible hierarchical adjustments based on evaluation feedback from a developmental perspective. This theoretical refinement addressed a significant limitation of earlier stratified models, which risked creating rigid tracking systems that could constrain student opportunities and reinforce initial achievement differences. By emphasizing the dynamic, responsive character of stratification decisions, Liu's formulation aligned stratified teaching more closely with contemporary understandings of learning as a developmental process characterized by variable trajectories and potential for growth.

Following the 2001 new curriculum reform in China, elastic stratified teaching was progressively promoted in compulsory education stages, with implementation experiments in Shanghai, Beijing, and other major urban centers. These initiatives emphasized the synthesis of the traditional principle of "teaching students in accordance with their aptitude" with modern educational concepts, gradually consolidating into a classic teaching model characterized by stable teaching effects and ongoing adaptation to evolving educational contexts.

Comparative analysis with alternative instructional models

Limitations of conventional unified teaching

To fully appreciate the distinctive features of elastic stratified teaching, it is instructive to compare this approach with alternative instructional models commonly employed in physical education contexts. The conventional unified teaching model, which remains prevalent in many school settings, presumes that all students in a given class can appropriately engage with identical instructional content delivered at a uniform pace. While administratively convenient, this approach fails to accommodate the substantial individual differences documented in empirical research on student learning and development. Consequently, students whose abilities or learning rates deviate from the class average may experience either frustration from content that exceeds their readiness or boredom from instruction that fails to challenge them appropriately.

Fixed stratified models, wherein students are assigned to relatively stable ability groups based on initial assessments, represent an improvement over unified instruction in acknowledging individual differences. However, such approaches risk creating self-fulfilling prophecies wherein students in lower groups receive diminished expectations, reduced learning opportunities, and consequently limited growth. Research by Oakes and colleagues on tracking in American schools has documented the deleterious effects of rigid ability grouping on educational equity and student outcomes, particularly for students from historically marginalized backgrounds.

Advantages of elastic stratification

In contrast, elastic stratified teaching incorporates mechanisms for ongoing assessment and regrouping that mitigate the risks associated with fixed tracking. By maintaining flexibility in grouping assignments and instructional provisions, this approach supports student mobility across strata as their competencies develop, thereby communicating the expectation that all students are capable of growth and advancement. Furthermore, by calibrating instruction to students' current developmental levels while simultaneously challenging them toward higher levels of performance, elastic stratification operationalizes Vygotsky's concept of the zone of proximal development within authentic classroom settings.

Empirical Evidence: Impact on Physical Health Outcomes

Physiological foundations of physical fitness development

Adolescent growth and developmental processes

The development of physical fitness during middle school years is underpinned by complex physiological processes that exhibit substantial inter-individual and gender-based variation. During this developmental period, students experience accelerated growth in height and weight, changes in body composition, improvements in neuromuscular coordination, and enhancements in cardiorespiratory function. Research by Malina and colleagues on adolescent growth and development has documented that the timing and tempo of these changes vary considerably both within and between genders, with girls typically entering the pubertal growth spurt approximately two years earlier than boys, while boys ultimately achieve greater gains in lean body mass, muscular strength, and aerobic capacity.

The physiological mechanisms underlying fitness development include improvements in neuromuscular efficiency, characterized by enhanced motor unit recruitment, synchronization, and rate coding. Skeletal muscle adaptations encompass hypertrophy of existing fibers, particularly Type II fibers responsible for high-force, high-velocity contractions. Cardiorespiratory adaptations include increases in stroke volume, cardiac output, and oxygen extraction by working muscles. These physiological changes interact with skill acquisition processes, wherein repeated practice of specific movement patterns leads to the development of motor pro-

grams and improved coordination through mechanisms of neuroplasticity.

Understanding these physiological foundations is essential for designing effective stratified instruction in physical education. Students at different developmental stages may require appropriately calibrated training stimuli to optimize adaptation while avoiding injury or excessive fatigue. For example, students in early stages of pubertal development may benefit from emphasis on motor skill development and foundational movement patterns, while those in later stages may be ready for more intensive conditioning activities that capitalize on their enhanced physiological capacity.

Research evidence on stratified teaching and physical fitness outcomes

Overview of Empirical Findings

The selection and implementation of appropriate teaching methods during the instructional process constitutes a critical determinant of physical fitness improvement through specific sports skill development. According to existing domestic research findings, the application of elastic stratified teaching models to experimental classes comprising male and female students with significant variations in age, baseline physical fitness, and learning capabilities yields demonstrable improvements in student physical fitness outcomes.

Empirical investigations have documented that students in experimental classes employing dynamic stratified teaching demonstrate significantly enhanced performance on standardized physical fitness measures, including standing long jump, 50-meter sprint, 800-meter run, and throwing events. These improvements are observed across both male and female students, suggesting that the stratified approach effectively addresses the diverse needs of all learners regardless of gender. Notably, the magnitude of improvement is often greatest among students who initially demonstrated lower fitness levels, indicating that stratified instruction may be particularly effective in supporting struggling learners and reducing achievement gaps.

Mechanisms underlying effectiveness

The mechanisms through which dynamic stratified teaching enhances physical fitness outcomes merit careful consideration. First, by calibrating instructional demands to students' current fitness levels, this approach ensures that all students experience an appropriate balance between challenge and success. Students are neither overwhelmed by tasks exceeding their current capabilities nor under-challenged by activities that fail to stimulate adaptation. This optimal challenge level promotes continued engagement and effort, which are essential for physiological adaptation and skill development.

Second, the dynamic stratified approach enables teachers to progressively increase task demands as students demonstrate readiness for more challenging activities. This progressive overload principle, fundamental to exercise physiology, ensures that students receive training stimuli sufficient to stimulate ongoing adaptation while avoiding the plateaus that occur when demands remain static. By systematically advancing expectations in response to demonstrated progress, teachers maximize the likelihood of continued fitness gains throughout the instructional period.

Third, by accommodating individual differences in learning pace and readiness, stratified instruction reduces the likelihood that students will become discouraged by repeated failure or disengaged by insufficient challenge. Both experiences undermine motivation and reduce the quality and quantity of practice, thereby limiting fitness development. By maintaining students in an optimal challenge zone, stratified instruction supports the sustained effort and engagement necessary for meaningful physiological adaptation.

Implications for gender-sensitive physical education

Challenging essentialist assumptions

The observed effectiveness of dynamic stratified teaching in improving physical fitness outcomes across both male and female students carries important implications for gender-sensitive physical education practice. Traditional physical education approaches have often operated on implicit assumptions about gender differences in physical capabilities and interests, leading to differential treatment, expectations, and opportunities for male and female students. Such practices may inadvertently reinforce gender stereotypes and limit students' opportunities to develop their full physical potential.

Individualized rather than gender-based instruction

The dynamic stratified teaching model offers an alternative framework that acknowledges individual differences while avoiding essentialist assumptions about gender-based capabilities. By basing instructional decisions on systematic assessment of each student's current performance level rather than on gender-based expectations, this approach creates conditions in which all students can develop their physical capacities to the fullest extent possible. Female students who might otherwise be presumed to have limited interest or capability in certain physical activities receive instruction calibrated to their individual needs and responsive to their demonstrated progress, rather than being channeled toward activities considered gender-appropriate.

Creating opportunities for gender-integrated learning

Furthermore, by creating flexible grouping arrangements that may bring together students of different genders who share similar current ability levels, stratified instruction provides opportunities for collaborative learning that transcend gender boundaries. Such arrangements challenge the implicit assumption that boys and girls should be separated for physical activities and create opportunities for students to recognize commonalities in their learning experiences that cut across gender lines.

Empirical Evidence: Impact on Mental Health Outcomes

Mental health dimensions in adolescent development

The mental health of middle school students encompasses multiple interconnected dimensions, including emotional well-being, psychological resilience, self-concept, social competence, and the capacity to cope with developmental challenges. During adolescence, students navigate significant transitions in their cognitive abilities, social relationships, and identity formation, all of which have implications for mental health outcomes. Research by Steinberg and colleagues on adolescent development has documented that this period is characterized by heightened emotional reactivity, increased sensitivity to social evaluation, and ongoing development of self-regulatory capacities.

Physical education settings represent potentially significant contexts for mental health promotion, offering opportunities for physical activity engagement that can reduce symptoms of anxiety and depression, enhance self-esteem, and foster social connections. The structured nature of PE classes, combined with opportunities for skill mastery, social interaction, and physical challenge, creates conditions conducive to positive mental health outcomes. However, these benefits are not automatically realized; rather, they depend on the quality of instructional practices and the nature of students' experiences within PE settings.

The primary objective of stratified teaching evaluation is to ensure that the individualized learning needs of each student are adequately addressed. During the middle school years, students' physical development is particularly pronounced, with boys typically demonstrating superior performance in physical qualities such as muscular strength and speed. These objective differences in physical capability intersect with socially constructed gender norms and expectations, creating complex dynamics that influence students' psychological experiences in physical education.

Gender dynamics in middle school physical education

Observational research on gender dynamics in middle school physical education reveals complex patterns of differential treatment and experience. Boys generally demonstrate preferences for competitive, contact-oriented sports such as football, basketball, and wrestling—activities characterized by direct opposition, physical challenge, and opportunities for dominance displays. In contrast, the majority of girls, influenced by both objective physical differences and socially transmitted gender perceptions, do not actively participate in sports involving high physical exertion and tend to prefer physical activities such as aerobics, dance, and gymnastics that align more closely with conventional gender norms emphasizing grace, flexibility, and aesthetic expression rather than strength and aggression.

These differential preferences and participation patterns cannot be adequately understood without considering the broader sociocultural context in which physical education occurs. Gender socialization processes, operating through family, media, peer interactions, and educational institutions, transmit powerful messages about appropriate activities, behaviors, and identities for males and females. Physical education settings may either challenge or reinforce these messages, depending on the pedagogical approaches employed and the explicit or implicit values communicated through instructional practices.

To systematically investigate these dynamics, comparative studies have been conducted examining differences between natural classes employing conventional instruction and experimental classes implementing dynamic stratified teaching. These investigations have explored the impact of various instructional arrangements, including within-class gender-based grouping and combined-class gender-integrated grouping, on outcomes including girls' participation rates, engagement levels, and psychological experiences in physical activity contexts.

Cultivation of sportsmanship and psychological resilience

Building self-efficacy through mastery experiences

The elastic stratified teaching model, through its systematic attention to individual student differences, facilitates more targeted skill development, which in turn contributes to building students' self-confidence and supporting their psychological development. As students experience success in mastering progressively challenging skills calibrated to their current abilities, they develop enhanced self-efficacy beliefs—the confidence in their capacity to execute actions necessary to produce desired outcomes. These positive mastery experiences are particularly significant during adolescence, a period when many students experience declining academic self-concept and increasing self-doubt.

Enhancing psychological resilience

Research has demonstrated that psychological course interventions can effectively enhance individual psychological resilience across multiple dimensions, including goal focus, emotional control, and positive cognition. By incorporating explicit attention to psychological skills alongside physical skill development, physical education programs can contribute to the cultivation of resilience competencies that benefit students across multiple life domains. The critical stage of adolescence, characterized by heightened sensitivity to social evaluation and increased vulnerability to psychological distress, represents an opportune moment for such interventions.

The structured challenges inherent in physical education settings provide natural opportunities for students to develop perseverance and character. Learning to persist in the face of difficulty, manage disappointment following failure, and maintain effort toward long-term goals are competencies cultivated through appropriately designed physical activities. The elastic stratified model, by calibrating challenges to students' current capacities while progressively in-

creasing demands, ensures that students experience an optimal balance between success and struggle—sufficient success to maintain motivation and confidence, combined with sufficient challenge to develop resilience and coping skills.

Fostering social competence

Furthermore, the social context of physical education provides opportunities for developing interpersonal competencies essential for psychological well-being. Cooperative learning activities, team sports, and group problem-solving tasks require students to communicate effectively, coordinate actions with others, manage conflicts constructively, and provide and receive social support. These experiences contribute to the development of social competence, which research has consistently linked to positive mental health outcomes throughout the lifespan.

Shaping gender cognition through pedagogical practice

Implicit gender bias in teacher-student interactions

Within the process of teacher-student interaction in physical education classes, gender stereotypes may unconsciously influence expectations, opportunities, and evaluations. Observational studies of classroom interaction patterns have documented systematic differences in teachers' treatment of male and female students. Boys are frequently preferentially selected by teachers for skill demonstrations, thereby receiving additional opportunities for public recognition and practice. They also receive more opportunities during classroom questioning sessions and are more frequently called upon to respond to teacher inquiries.

Furthermore, attributions for student performance and behavior often differ systematically by gender. The trait of maintaining psychological stability when receiving criticism is generally attributed more readily to male students by teachers, reflecting implicit assumptions about gender differences in emotional resilience. Simultaneously, teachers may demonstrate significantly greater tolerance in their instructional attitudes toward girls, holding preconceptions about their limited physical capabilities, reduced tolerance for environmental conditions such as sun exposure, or diminished enthusiasm for vigorous physical activity.

The social construction of ability differences

The perception of ability differences formed within the physical education teaching context essentially reflects the implicit regulatory influence of traditional gender roles. When teachers consistently attribute girls' lower performance or engagement to internal, stable factors such as lack of ability or motivation, while attributing boys' difficulties to external, variable factors such as insufficient effort or challenging circumstances, they communicate differential expectations that students internalize. These implicit messages shape students' developing beliefs about their own capabilities and the activities appropriate for their gender.

Consequences of differentiated treatment

Thus, a significant phenomenon of gender-differentiated treatment persists in physical education teaching practice. This differential treatment is manifested not only at the level of observable teaching behaviors but also, more profoundly, affects students' cognitive construction of their own athletic abilities. The differentiated evaluation standards that teachers unconsciously apply to male and female students inadvertently reinforce the social stereotype of male athletic superiority, with potentially lasting consequences for students' physical activity participation and self-concept.

Empirical findings on gender-sensitive stratified instruction

Enhanced psychological outcomes in experimental classes

Empirical investigations comparing conventional and stratified instructional approaches have yielded valuable insights regarding gender dynamics in physical education. Students in experimental classes employing dynamic stratified teaching demonstrated more positive outcomes across multiple psychological dimensions compared to their peers in conventional classes. Specifically, experimental class students exhibited enhanced personal value identification and stronger team cooperation abilities, suggesting that the stratified approach created conditions more conducive to positive psychological development.

Differential benefits for female students

Particularly noteworthy are the findings regarding female students' experiences and outcomes. Girls in experimental groups receiving stratified instruction demonstrated significantly more positive sportspersonship and engagement compared to girls in control groups receiving conventional instruction. This finding suggests that the stratified approach, by calibrating instructional demands to individual readiness levels and providing appropriately challenging experiences, may be particularly beneficial in addressing the motivational and engagement challenges that disproportionately affect female students in conventional physical education settings.

Mechanisms underlying positive outcomes

These positive outcomes likely result from multiple features of the stratified approach. By ensuring that all students experience an appropriate level of challenge and success, stratified instruction supports the development of positive ability beliefs and task values among female students who may have previously experienced physical education as frustrating or alienating. The flexible grouping arrangements characteristic of elastic stratification may also create opportunities for female students to experience success and recognition in contexts less dominated by the most physically capable students, thereby supporting positive social comparisons and self-evaluations.

Design and Implementation of the Elastic Stratified Teaching Model

Targeted learning objectives

The role of objectives in elastic stratified learning

The establishment of appropriate learning objectives constitutes the foundational element of effective elastic stratified instruction. In the context of elastic stratified learning, the core function of goal-setting lies in measuring the changes in the knowledge and skill systems acquired by learners following phased instruction and dynamically adjusting subsequent stratification decisions based on documented progress. This recursive process ensures that instructional objectives remain appropriately calibrated to students' evolving capabilities throughout the learning sequence.

Principles for objective setting

Teachers implementing elastic stratified instruction must operationalize the principle of teaching according to aptitude by establishing targeted learning objectives and process evaluations informed by comprehensive understanding of students' learning situations. This requires systematic initial assessment to establish baseline profiles of each student's current knowledge, skills, and readiness, followed by ongoing formative assessment to track progress and identify emerging needs. The resulting objectives should be sufficiently challenging to stimulate growth while remaining attainable with appropriate effort and support, thereby optimizing the balance between challenge and success that supports motivation and learning.

The establishment of appropriately calibrated objectives prompts each student to develop accurate understanding of their current capabilities and progress toward desired outcomes. When students clearly understand what they are expected to learn and receive regular feedback regarding their progress, they are better positioned to regulate their own learning efforts effectively. This metacognitive awareness supports the development of autonomous learning competencies that extend beyond the immediate instructional context.

By ensuring that objectives are adapted to individual readiness levels, elastic stratification enables students to achieve incremental improvement within ranges commensurate with their current ability thresholds. This gradual progression ensures that students experience the satisfaction of mastery while continuously extending their capabilities. The resulting pattern of successful challenge and growth stimulates individual learning interest, enhances learning confidence, and contributes to significant improvements in teaching quality.

Diversified teaching content

The design of instructional content within elastic stratified frameworks should implement the principle of diversification in addressing foundational knowledge and skills within curriculum design. This diversification promotes positive transfer effects, wherein knowledge and skills acquired in one context facilitate learning and performance in related contexts. By providing varied opportunities to apply and extend learning, diversified content supports the development of flexible, transferable competencies rather than context-bound skills.

Cultivating problem-solving abilities

The cultivation of students' practical abilities to discover and solve problems through independent inquiry represents an important objective of diversified content design. When students encounter varied learning tasks requiring active problem-solving, they develop the cognitive flexibility and strategic thinking essential for adapting to novel challenges. These competencies are particularly valuable in physical education contexts, where authentic movement situations rarely replicate exactly the conditions of practice and require adaptive responses to changing circumstances.

Implementing gradual progression

The principle of gradual progression must be systematically implemented throughout the entire teaching process, emphasizing the decomposition and integration of movement skills. Complex motor skills are typically acquired through initial development of component elements, followed by progressive integration into coordinated sequences. This decomposition-integration cycle should be explicitly addressed in instructional design, with attention to the readiness of individual learners to progress from simpler to more complex combinations.

Ensuring accessibility for all learners

Effective implementation of gradual progression achieves a pedagogical approach that explains profound theories in simple terms, enabling students at all learning levels to comprehend and master skills. By carefully sequencing learning experiences and providing appropriate scaffolding, teachers ensure that all students can access challenging content regardless of their starting points. This universal design for learning approach recognizes that difficulty is not inherent in content but rather emerges from the interaction between learner characteristics and instructional conditions.

Gender-informed elastic stratified evaluation

Limitations of conventional evaluation approaches

The asymmetric distribution of explicit manifestations and implicit characteristics between male and female groups presents significant challenges for evaluation design in physical education. Conventional quantitative evaluation methods, which assess performance on standardized measures without consideration of individual starting points or developmental trajectories, demonstrate significant limitations in addressing these complexities. Such approaches may systematically disadvantage students whose capabilities or developmental patterns deviate from normative expectations, including many female students in traditionally masculine activity domains.

Principles of differentiated evaluation

A layered, elastic evaluation system responsive to gender differences requires the construction of differentiated evaluation frameworks wherein learners at different ability levels are assessed according to appropriately calibrated criteria. This approach effectively enhances learners' intrinsic drive by ensuring that evaluation provides meaningful feedback regarding progress relative to appropriate standards rather than invidious comparisons with peers whose developmental trajectories may differ substantially.

In terms of evaluation methods, teachers should not limit their assessment to students' demonstrated athletic abilities but should also incorporate implicit elements such as emotional states, motivational orientations, and value concepts manifested during the sports process into the evaluation framework. This comprehensive approach recognizes that physical education outcomes encompass not only physical competencies but also psychological and social dimensions essential for holistic development.

The developmental sensitivity of middle school students necessitates careful attention to evaluation practices. During this formative period, students are particularly vulnerable to the motivational consequences of evaluation experiences. Negative evaluations may undermine developing self-concept and motivation, while positive, constructive feedback can support continued engagement and effort. Teachers should prioritize encouraging students to participate actively in physical exercise, using the sports context as a vehicle for helping them establish correct gender concepts and develop healthy personalities.

Teacher preparation and professional development

Successful implementation of elastic stratified teaching with attention to gender dynamics requires teachers to possess specialized knowledge, skills, and dispositions that may not be adequately addressed in conventional teacher preparation programs. Teachers must develop proficiency in conducting comprehensive initial assessments, designing differentiated instruction responsive to individual student profiles, monitoring ongoing progress, and making timely adjustments to stratification assignments and instructional provisions.

Addressing implicit bias in teaching practice

Furthermore, teachers must cultivate awareness of their own implicit biases and assumptions regarding gender and physical ability. Research on implicit bias demonstrates that even individuals who explicitly endorse egalitarian values may unconsciously hold associations that influence their perceptions, judgments, and behaviors. Without explicit attention to these implicit processes, teachers may inadvertently perpetuate the very gender stereotypes they intend to challenge.

Designing effective professional development

Professional development initiatives supporting elastic stratified teaching should address both technical competencies and reflective awareness. Technical training should encompass assessment strategies, instructional design principles, grouping practices, and evaluation methods appropriate for differentiated instruction. Reflective components should engage teachers in examining their own beliefs and practices, considering how gender influences their expectations and interactions, and developing strategies for creating more equitable learning environments.

The role of collegial support and collaborative inquiry

Ongoing collegial support and collaborative inquiry represent valuable resources for teachers implementing complex instructional innovations. Through shared reflection on implementation challenges and successes, teachers can develop practical knowledge and adaptive expertise that extends beyond what any individual could develop alone. School-based professional learning communities focused on differentiated instruction and gender equity can provide sustained support for teacher development.

Discussion

Synthesis of findings

This study, from a gender perspective, has comprehensively explored the impact of the elastic stratified teaching model on the physical and mental health outcomes of middle school students. Through systematic examination of the theoretical foundations of elastic stratified teaching, including its historical origins and developmental trajectory, as well as the specific model design and practical application in middle school physical education contexts, several significant conclusions emerge.

The findings of this investigation contribute to the growing body of evidence supporting differentiated instructional approaches in physical education while extending this literature through explicit attention to gender dynamics. By demonstrating that elastic stratified teaching yields superior outcomes compared to conventional instruction across multiple physical and psychological dimensions, this study provides empirical support for policy initiatives promoting individualized instruction and teaching according to aptitude.

Physical health implications

Superiority of stratified instruction for fitness outcomes

In terms of physical fitness outcomes, following 18 weeks of experimental intervention, both the elastic stratified teaching method and conventional teaching methods positively influenced students' physical fitness development. However, the elastic stratified teaching method demonstrated superior effectiveness in improving specific physical fitness indicators, including standing long jump performance and 50-meter sprint times. These findings indicate that the stratified teaching model can more effectively tailor

instruction and training based on individual student differences, including variations attributable to gender, thereby promoting enhanced physical fitness development.

The differential effectiveness observed across fitness measures merits consideration. Some fitness components may be more responsive to instructional differentiation than others, depending on their sensitivity to training variables and the extent to which conventional instruction adequately addresses individual differences. Future research should explore whether the advantages of stratified instruction generalize across diverse fitness domains and identify mechanisms underlying differential effects.

Implications for gender equity in physical development

The finding that stratified instruction benefits both male and female students challenges essentialist assumptions about gender differences in physical capabilities and responses to instruction. Rather than presuming that boys and girls require fundamentally different instructional approaches based on inherent gender characteristics, the stratified model responds to demonstrated individual differences regardless of their origins. This approach aligns with contemporary understandings of gender as socially constructed and individually variable rather than biologically determined and categorically fixed.

Mental health implications

Enhancing psychological resilience and sportsmanship

At the level of mental health outcomes, the elastic stratified teaching model demonstrates significant positive effects across multiple dimensions. On one hand, this approach contributes to cultivating middle school students' sportsmanship, enabling students to acquire mental health knowledge and psychological skills that enhance their capacity to face difficulties and setbacks while improving overall psychological resilience. The structured challenges and mastery experiences inherent in appropriately calibrated physical activities provide natural opportunities for developing these competencies.

Moderating traditional gender stereotypes

On the other hand, in shaping gender cognition, this model effectively moderates traditional gender stereotypes that have historically limited students' opportunities and self-conceptions in physical activity contexts. Students in experimental classes demonstrated enhanced personal value identification and stronger team cooperation abilities, suggesting that the stratified approach created conditions more conducive to positive identity development and social integration.

Particularly noteworthy are the differential outcomes for female students across experimental and control conditions. Girls receiving stratified instruction demonstrated significantly more positive sportspersonship and engagement compared to their peers in conventional classes, suggesting that the stratified approach may be especially beneficial in addressing the motivational challenges that disproportionately affect female students in traditional physical education settings. This finding carries important implications for efforts to promote gender equity and inclusive participation in physical education.

Pedagogical design implications

The value of targeted learning objectives

In terms of teaching model design, the elastic stratified approach incorporates multiple features that support positive student outcomes. The targeted learning objectives characteristic of this model enable instruction calibrated to students' starting points, thereby stimulating learning interest and confidence while maintaining necessary flexibility. By ensuring that all students experience appropriate challenge and success, this approach supports the development of positive ability beliefs and task values essential for sustained engagement.

Benefits of diversified content design

The diversified teaching content characteristic of elastic stratified models facilitates the construction of motor skill units grounded in principle-based knowledge while adhering to the principle of gradual progression. This design simultaneously accommodates the comprehension and practice needs of students at different developmental levels, ensuring that all learners can access and benefit from instruction regardless of their starting points.

Advantages of comprehensive evaluation frameworks

The gender-informed elastic stratified evaluation system developed in this study comprehensively considers students' athletic abilities alongside emotional motivation, value concepts, and other implicit characteristics. By improving the evaluation mechanism to encompass multiple dimensions of student development, this approach enhances students' learning drive while supporting the establishment of correct gender concepts and healthy personality development.

Limitations and future research directions

Methodological limitations

Several limitations of the present study should be acknowledged when interpreting findings and considering implications for future research. The relatively brief intervention period (18 weeks) limits conclusions regarding long-term effects and sustainability of observed outcomes. Extended longitudinal investigations are needed to determine whether the advantages of elastic stratified instruction persist over time and whether early benefits translate into lasting differences in physical activity participation and psychological development.

Generalizability considerations

The sample characteristics of this study, drawn from specific educational contexts in China, may limit generalizability to other populations and settings. Cross-cultural comparative research examining elastic stratified teaching in diverse

educational systems would illuminate the extent to which findings depend on specific cultural and institutional contexts. Such investigations would also reveal how gender dynamics in physical education vary across cultural settings and how stratified approaches might be adapted to address context-specific challenges.

Intersectionality and multiple dimensions of diversity

The intersection of gender with other dimensions of diversity, including socioeconomic status, ethnicity, disability status, and body composition, merits systematic investigation in future research. Students occupying multiple marginalized positions may experience compounded disadvantages in physical education settings, requiring intersectional approaches to instructional design and evaluation. Research examining how elastic stratified teaching can address these intersecting inequities would contribute to more inclusive educational practice.

Future research should also investigate more thoroughly the mechanisms through which elastic stratified teaching produces its effects. While this study has documented outcome differences between experimental and control conditions, the mediating processes responsible for these differences remain incompletely understood. Identifying specific features of stratified instruction that most strongly predict positive outcomes would inform more precise and efficient intervention design.

Conclusion

The elastic stratified teaching model from a gender perspective demonstrates significant value and positive implications for middle school physical education practice. This pedagogical approach effectively promotes the physical and mental health development of middle school students, providing useful reference and guidance for middle school physical education reform efforts. By advancing physical education teaching toward more individualized, scientific, and comprehensive directions, this model better accommodates the diverse developmental needs of middle school students, contributing to the cultivation of a new generation characterized by healthy physiques and sound personalities.

Theoretical contributions

The contributions of this research extend beyond immediate practical implications to theoretical understanding of teaching and learning in physical education contexts. By integrating attention to gender dynamics with differentiated instructional approaches, this study advances understanding of how pedagogical practices can simultaneously support individual development and challenge limiting social stereotypes. The findings suggest that attention to individual differences need not entail neglect of social categories; rather, thoughtfully designed instruction can address both individual and social dimensions of student experience.

Practical implications

For educational practice, this study offers concrete guidance regarding the design and implementation of elastic stratified teaching in middle school physical education. The principles and practices articulated herein provide a foundation for curriculum development, instructional planning, and teacher preparation that can support more equitable and effective physical education for all students regardless of gender or initial ability level.

For educational policy, these findings support continued investment in professional development and curriculum resources that enable teachers to implement differentiated instruction effectively. Policy initiatives promoting smaller class sizes, adequate planning time, and ongoing professional learning opportunities create conditions conducive to the thoughtful implementation of complex instructional approaches such as elastic stratified teaching.

In conclusion, this investigation demonstrates that elastic stratified teaching informed by gender awareness represents a promising approach to addressing the diverse needs of middle school students in physical education contexts. By systematically accommodating individual differences while challenging limiting gender stereotypes, this pedagogical model contributes to the dual goals of educational excellence and equity that characterize contemporary educational reform efforts worldwide.

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J G T S S

Case study

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A Study on the Development of Community Worker Teams in Modern Grassroots Governance

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Abstract: Modern grassroots governance is grounded in problem-oriented approaches, responsive to needs, rich in contextual scenarios, and characterized by diverse participation. Among these elements, the development of the community worker workforce has become a key factor in enhancing community governance capabilities and service quality. This paper focuses on the community worker workforce, analyzing the current status and existing issues in talent development. It proposes the following policy recommendations: strengthening Party leadership to establish a model-based training mechanism for grassroots workers; constructing a talent development system that fully integrates Chinese theoretical frameworks with local practices; prioritizing talent cultivation by establishing an evaluation system for community workers; and enhancing guidance and incentives by leveraging performance-based training mechanisms. These measures aim to provide a solid foundation for the modernization of community governance.

Keywords: Modern grassroots governance; Community workers; Workforce development

Introduction

Grassroots governance serves as the "nerve endings" of national governance, and the advancement of modern grassroots governance is inseparable from a high-quality workforce of community workers [1]. The report of the 20th National Congress of the Communist Party of China explicitly proposed "building a community of social governance where everyone shares responsibility, fulfills their duties, and benefits from the outcomes," highlighting the foundational role of grassroots governance within the national governance system [2]. General Secretary Xi Jinping emphasized: "The focus of social governance must be placed on urban and rural communities; when community service and management capabilities are strengthened, the foundation of social governance becomes solid," thereby charting the course for the development of the community worker force. The "Opinions of the General Office of the CPC Central Committee and the General Office of the State Council on Strengthening the Development of the Community Worker Force" further clarified that strengthening the community worker force is crucial to ensuring the people's peace of mind and livelihood, social stability and order, and the foundation of the Party's long-term governance; it is a key measure for advancing the modernization of the grassroots governance system and governance capabilities [3]. The "Decision of the Central Committee of the Communist Party of China on Further Comprehensively Deepening Reform and Advancing Chinese-Style Modernization," issued at the Third Plenary Session of the 20th CPC Central Committee, also calls for "improving the institutional mechanisms for social work, strengthening Party leadership in grassroots governance, and strengthening the development of the social worker workforce" [4].

These policy guidelines constitute the institutional framework for the development of the community worker force, with an underlying logic manifested in a progressive relationship of "Party leadership—institutional safeguards—capacity building—enhanced governance effectiveness": Party leadership clarifies the political direction of force development, institutional safeguards solidify the foundational environment for the force's growth, capacity building is the core objective of force development, and the ultimate goal is the comprehensive enhancement of grassroots governance effectiveness. Against this backdrop, the Zhejiang Provincial

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Party Committee, at its "First Meeting of the New Year," proposed strengthening the development of the "three teams" and advocated for building a vast army of builders for Chinese-style modernization through a "broad talent perspective," thereby providing local practical guidance for the development of the community worker workforce.

At the same time, the author's field research revealed that the community worker force in District S of Hangzhou lacks a clear system for cultivating professional competence. Communities lack practical and systematic standards for developing the professional competence of community workers; the training that community workers encounter in their daily work is merely intended to fulfill the requirements of relevant policy documents, and has not played a substantive role in enhancing their own capabilities or job satisfaction. How to enhance the professional competence of community workers and ensure that the advancement of the modernization of the national governance system is effectively implemented at the smallest unit of grassroots governance has become an urgent issue in improving the effectiveness of grassroots governance.

Based on this, this study adopts modern grassroots governance as its core perspective. Drawing on survey data collected in November 2023 from 51 communities across 6 subdistricts in District S of Hangzhou, it systematically analyzes the structural characteristics and development challenges of the community worker workforce. By integrating human resource management theory, the study constructs targeted optimization pathways, aiming to provide practical models and theoretical support for the development of community worker teams nationwide.

Literature Review and Theoretical Foundation

Literature review

The modernization of grassroots governance is a core issue in the improvement of the national governance system in the new era, and academic circles have explored it from multiple dimensions. Wang Sibin traces the evolution of grassroots social governance models over the 70 years since the founding of the People's Republic of China, highlighting the foundational role of social governance within the national governance system and emphasizing that grassroots governance models must adapt to shifts in social structure [5]. He Degui defines the theoretical essence of modernizing grassroots governance in the new era, arguing that it represents the organic unity of the ruling party's active governance and grassroots social self-governance, characterized by the people-centered nature of governance concepts and the stability of governance structures [6].

As a key lever for the modernization of grassroots governance, the development of the community worker workforce has been the focus of research on diagnosing current conditions and optimizing pathways. Liu Lijuan analyzed existing issues in workforce development, such as a lack of professionalization and imperfect incentive mechanisms, and proposed the need to establish a workforce development system tailored to the demands of governance modernization [7]. Li Qundi, drawing on the threefold logic of Chinese-style grassroots governance modernization, emphasized the systematic and forward-looking nature of community worker workforce development [8]. Xu Yamin addressed the challenges faced by certified community workers, such as being overwhelmed by administrative tasks and the disconnect between training and practical work, and proposed countermeasures including reducing the administrative burden on communities and strengthening professional development [9]. At the case study level, Guo Gen et al. examined Z Subdistrict in P District, Shanghai, to explore the professional challenges faced by community workers in megacities [10]; Jia Zhike et al., based on a survey of 54 communities in Nanjing, analyzed structural issues within the workforce and proposed optimization recommendations [11]. These studies provide practical references for this paper.

In research on optimization pathways for the modernization of grassroots governance, He Degui proposes resolving governance dilemmas through two-way interactive governance and the coordinated transformation of state will and public will; Chen Youhua et al. emphasize a multi-stakeholder collaborative approach featuring Party leadership, market-driven initiatives, and support from social organizations [12]; Zhang Wenxian et al. regard the "integration of self-governance, rule of law, and moral governance" as the ideal model for the modernization of grassroots governance [13]; Sun Bo et al. focus on the professionalization of the community worker workforce, proposing measures such as institutionalizing full-time positions and providing specialized training for current staff [14].

In summary, while existing research has established a certain theoretical foundation and accumulated practical experience, significant shortcomings remain: From a research perspective, there is a scarcity of studies that systematically explore the development of the community worker workforce from the core perspective of modernized grassroots governance; most studies have failed to adequately align the substantive requirements of governance modernization with the practical logic of workforce development; In terms of theoretical support, existing research often piecemeal applies fragments of theories such as human resource management and public administration, lacking a systematic theoretical framework centered on career development. Consequently, it fails to fully reveal the intrinsic connection between the patterns of professional growth among community workers and workforce development, making it difficult to provide precise theoretical guidance for the long-term development of the workforce. Based on this, this study adopts the perspective of modernized grassroots governance, with career development theory as its core foundation. Drawing on survey data from District S in Hangzhou, it constructs a workforce development pathway that combines theoretical depth with practical feasibility through a logical chain of "current status—problems—causes—countermeasures."

Theoretical foundation

Career development theory focuses on the full-cycle patterns of individual career development. Its core premise is that an individual's career development is a continuously evolving dynamic process that progresses through distinct stages, each characterized by unique developmental tasks, needs, and growth bottlenecks. Furthermore, career development is influenced by the interaction of multiple factors, including individual traits, organizational environments, and social contexts [15]. The core framework of this theory includes key branches such as career development stage theory and career anchor theory, providing a systematic analytical perspective and practical guidance for the development of the community worker workforce: From the perspective of career development stages, the professional growth of community workers can be divided into key phases such as the exploration phase (1–3 years after joining), the establishment phase (4–9 years), and the maintenance phase (10 years or more). Workers in different stages exhibit significant differences in terms of competency requirements, career perceptions, and developmental aspirations; From the perspective of career anchor theory, the career anchors of community workers typically manifest as service-oriented, security-oriented, and autonomy-oriented. Their career choices and development are deeply influenced by their value alignment with community service, their need for job stability, and their expectations regarding work autonomy.

Applying career development theory to the development of the community worker workforce requires localization tailored to the practical context of modern grassroots governance. The core lies in establishing a workforce development system aligned with the laws of career progression: First, implement targeted training based on the characteristics of career development stages. For workers in the exploration phase, prioritize strengthening foundational professional skills and career awareness training to help them quickly adapt to job requirements; for workers in the establishment phase, the focus should be on enhancing professional capabilities and clarifying career positioning to support the development of core professional expertise; for workers in the maintenance phase, emphasis should be placed on knowledge transfer and fostering innovation to leverage their leadership role within the workforce. Second, incentive and support mechanisms are optimized to align with career anchor types. For service-oriented workers, emphasis is placed on providing psychological incentives related to social recognition and self-actualization; for security-oriented workers, compensation, benefits, and job stability are enhanced; and for autonomy-oriented workers, appropriate autonomy is granted to encourage personalized service innovation in community governance. Third, align organizational and individual career development goals by integrating the developmental needs of modernized community governance with the professional growth aspirations of community workers. By establishing clear career advancement pathways and optimizing the organizational support environment, we can achieve the synergistic enhancement of individual professional value and organizational governance effectiveness. This theoretical framework provides the core theoretical foundation for this paper to accurately identify issues in workforce development and design phased, differentiated optimization pathways.

Current Status and Developmental Characteristics of the Community Social Work Workforce: A Case Study of a Sampling Survey in District S, Hangzhou

This study focuses on the current training status and development needs of community workers. It is based on a survey of 1,939 questionnaires conducted across all sub-districts under the jurisdiction of District S in Hangzhou, supplemented by 63 in-depth interviews with frontline community workers from more than ten sub-districts, including KX Sub-district in District S. Guided by the principles of full coverage, highlighting key areas, and implementing tiered and categorized approaches, this study aims to establish a standardized, professional, forward-looking, and exemplary system for the development and cultivation of community worker teams nationwide.

Using SPSS statistical methods combined with case studies, the research analyzes the career development pathways of community workers, including their gender, age, years of service, job titles, tenure, educational background, professional qualifications, and job competency requirements.

Descriptive analysis of the community worker population

As shown in **Table 1**, a total of 1,939 community workers were selected as the survey sample for this study. Statistical analysis of their basic personal information reveals the following group characteristics.

In terms of gender composition, there were 1,161 female practitioners, accounting for 59.88%; and 778 male practitioners, accounting for 40.10%. The sample group exhibits a gender distribution where women constitute the majority.In terms of age distribution, young and middle-aged individuals form the core of the workforce. The 36–45 age group had the highest proportion at 48.43%, while the 22–35 age group accounted for 37.75%, together comprising 86.18% of the total. The 46–55 and 56+ age groups accounted for 13.00% and 0.83%, respectively, indicating an overall youthful age structure dominated by young and middle-aged individuals.

In terms of years of service and tenure, the distribution of total years in community work is relatively balanced, with practitioners having 1–15 years of experience accounting for over 70% of the total. Specifically, those with 1–3 years, 4–6 years, 10–12 years, and 13–15 years of experience account for 21.14%, 16.61%, 16.19%, and 14.34%, respectively;The proportions of newcomers with less than one year of experience and senior practitioners with 20 or more years of experience are relatively low, at 5.67% and 5.05% respectively,

Table 1 | Descriptive Statistics of Sample Structure (N=1939)

Variable Name	Category	Frequency/Number	Percentage (%)
Gender	Male	778	40.10
	Female	1161	59.88
Age	22–35	732	37.75
	36–45	939	48.43
	46–55	252	13.00
	56 and older	16	0.83
Years of community service	Less than 1 year	110	5.67
	1–3 years	410	21.14
	4–6 years	322	16.61
	7–9 years	244	12.58
	10 years or more	853	43.99
Current Position	Community Worker	1,131	58.33
	Member of the Two Committees	335	17.28
	Community Deputy Director	329	16.97
	Community Director	144	7.43
Years of service in this role/position	Less than 1 year	225	11.60
	1–3 years	772	39.81
	4–6 years	431	22.23
	7–9 years	191	9.85
	10–12 years	152	7.84
	13–15 years	90	4.64
	16–19 years	44	2.27
	20 years and older	34	1.75
Educational Attainment	Associate degree or below	252	12.99
	Bachelor's degree	1,639	84.53
	Master's Degree	48	2.48
Academic Background	Philosophy	10	0.52
	Economics	253	13.05
	Law	126	6.50
	Political Science	18	0.93
	Sociology	153	7.89
	Management	605	31.20
	Literature	114	5.88
	History	6	0.31
	Science	78	4.02
	Engineering	174	8.97
	Agricultural Sciences	14	0.72
	Education	41	2.11
	Other	347	17.90
Professional Qualifications	Assistant Social Worker	845	43.58
	Intermediate Social Worker	579	29.86
	Senior Social Worker	1	0.05
	Other	514	26.51

forming a tiered structure of service tenure within the workforce.In terms of tenure in current positions, there is a concentration in the short-to-medium term: 39.81% have held their positions for 1–3 years, 11.60% for less than 1 year, and 22.23% for 4–6 years; the proportion of those in their positions for 7 years or more decreases gradually with increasing tenure, with those in their positions for 20 years or more accounting for only 1.75%.

In terms of position composition, frontline staff constitute the overwhelming majority, with community workers accounting for 58.33%; members of the two committees and deputy community directors account for 17.28% and 16.97%, respectively; community directors have the lowest proportion at 7.43%, reflecting a distribution pattern where frontline staff form the core and managerial positions account for a smaller proportion.

In terms of educational attainment and academic background, the sample group's overall educational level is relatively high, with 87.01% holding a bachelor's degree or higher—of which 84.53% hold a bachelor's degree and 2.48% hold a master's degree; those with an associate degree or lower account for only 12.99%. The professional backgrounds were diverse, with management studies having the highest proportion at 31.20%; economics (13.05%), engineering (8.97%), and sociology (7.89%) followed; disciplines such as philosophy and history accounted for less than 1%,

while 17.90% of practitioners had other professional backgrounds, reflecting a professional distribution characterized by the strong suitability of management-related disciplines and the integration of multidisciplinary backgrounds.

Regarding professional qualifications, the coverage of specialized certifications is high: practitioners holding social work-related certifications accounted for 73.49% of the total, with Assistant Social Workers comprising 43.58%, Intermediate Social Workers 29.86%, and Senior Social Workers only 1 person, representing 0.05%; Practitioners holding other professional qualifications accounted for 26.51%. This indicates that the sample group possesses a high degree of professional specialization, but there is a shortage of senior-level professionals.

Descriptive analysis of the current state of competency perception among community workers

As shown in **Table 2**, the competency perceptions of community workers in different positions can be clearly illustrated from three dimensions: perception of core job competencies, urgent needs for competency enhancement, and expectations regarding training content. The specifics are as follows:

Perceptions of core job competencies exhibit distinct hierarchical and categorical characteristics. Management positions (deputy directors and directors) place greater emphasis on coordination and planning competencies, with organizational coordination (85.4%), problem-solving (83.3%), and team-building (63.0%) ranking as the top three in terms of recognition. In contrast, recognition of specialized competencies such as platform management (23.0%) and project administration (28.8%) is relatively low.Frontline positions (community workers, members of the two committees) place greater emphasis on practical application skills. The highest recognition rates were for problem-solving skills (75.0%), team collaboration skills (67.5%), and conflict analysis and mediation skills (46.9%), while recognition of theoretical learning and application skills was the lowest, at only 29.1%.

The urgent need for skill enhancement aligns closely with the perceived core competencies of each position, while skill gaps are also evident. For management positions, the top three most urgently needed competencies are problem-solving skills (64.3%), organizational and coordination skills (60.3%), and strategic planning skills (49.9%), which align closely with the perceived core competencies for these roles; however, the demand for improving competencies such as platform management (16.5%), project administration (16.9%), and policy implementation (22.8%) is relatively low, highlighting these as key competency gaps for management positions. For frontline positions, the most urgent need is to improve problem-solving skills, accounting for 61.7%, followed by conflict analysis and mediation skills (43.4%) and project management skills (40.5%). The demand for improving theoretical learning and application skills remains the lowest, at only 22.2%.

Regarding training content expectations, all survey respondents demonstrated a preference for a balanced focus on both theory and practical application. Among these, expectations for community governance theory (54.7%), professional social work theory and methods (48.6%), and crisis management principles and methods (37.9%) ranked in the top three; while expectations for knowledge in digital technology and software applications (24.8%), project management principles and methods (22.9%), and applied writing (18.3%) were relatively lower. This reflects that community workers are more eager to use training to solidify their theoretical foundation in governance and enhance their practical response capabilities.

In summary, community workers in different positions exhibit differences in their perceptions of core competencies and their needs for improvement, and their expectations regarding training content demonstrate a balanced emphasis on both theoretical knowledge and practical methods. These findings provide valuable reference for the design of community worker training systems, career development planning, and the optimization of community work. By designing training content, career advancement pathways, and adjusting work assignments in a targeted manner based on these needs, the overall quality of community workers and the quality and efficiency of community work can be enhanced.

Overall, establishing a systematic and professionalized team development and training system is of significant importance to community workers. First, systematic training can enhance the professional competence and skill levels of grassroots community personnel, improve their work capabilities, and better meet the needs of community residents. Second, professional training helps strengthen the professional ethics and qualities of grassroots community staff, improve their service attitude and professionalism, and elevate the level of community governance. Systematic training can also promote the career development of grassroots community personnel, provide opportunities for promotion and advancement, and motivate them in their work. Strengthening the development of the grassroots community workforce requires a comprehensive consideration of various factors. For instance, training content should encompass knowledge and skills in policy and regulations, community service techniques, communication skills, and crisis management; training formats can include in-person classroom sessions, online learning, and practical activities to meet the needs of diverse groups; and training should emphasize the integration of theory and practice, providing opportunities for hands-on exercises and scenario simulations to ensure that the training content is closely aligned with actual work and meets the needs of community workers.

Table 2 | Descriptive Statistics of Sample Perceptions of Competencies

Variable Name	Category	Frequency/Number of Respondents	Percentage (%)
Perception of Core Competencies (Deputy Directors, Directors)	Strategic Planning Competency	215	45.5
	Organizational and coordination skills	404	85.4
	Problem-Solving Skills	394	83.3
	Social Research Skills	148	31.3
	Policy Implementation Capabilities	208	44.0
	Ability to innovate models	180	38.1
	Platform Management Capabilities	109	23.0
	Team-building skills	298	63.0
	Project Administration Skills	136	28.8
	Perception of Core Competencies (Community Workers, Members of the Two Committees)Teamwork Skills	989	67.5
	Problem-Solving Skills	1100	75.0
	Project Management Skills	563	38.4
	Social Research and Needs Analysis Skills	494	33.7
	Policy Learning and Application Skills	509	34.7
	Theoretical Learning and Application Skills	426	29.1
	Resource Exploration and Linking Skills	537	36.6
	Conflict Analysis and Resolution Skills	687	46.9
	Emergency Management Skills	561	38.3
Capacity Development Needs (Deputy Directors, Directors)	Strategic Planning Capabilities	236	49.9
	Organizational and Coordination Skills	285	60.3
	Problem-solving skills	304	64.3
	Social Research Skills	109	23.0
	Policy Implementation Skills	108	22.8
	Ability to Innovate Models	206	43.6
	Platform Management Capabilities	78	16.5
	Team-building skills	228	48.2
	Project Administration Skills	80	16.9
Capacity Building Needs (Community Workers, Members of the Two Committees)	Teamwork Skills	610	41.6
	Problem-Solving Skills	904	61.7
	Project Management Skills	593	40.5
	Social Research and Needs Analysis Skills	455	31.0
	Policy Learning and Application Skills	444	30.3
	Theoretical Learning and Application Skills	326	22.2
	Resource Exploration and Linking Skills	541	36.9
	Conflict Analysis and Resolution Skills	636	43.4
	Emergency Management Skills	448	30.6
Training Knowledge Needs	Theories Related to Community Governance	1,060	54.7
	Theories and Methods in Social Work	943	48.6
	Principles and Methods of Social Research	683	35.2
	Principles and Methods of Policy Practice	629	32.4
	Digital Technology and Software Applications	480	24.8
	Principles and Methods of Project Management	445	22.9
	Principles and Methods of Crisis Management	735	37.9
	Principles and Methods of Team Building	542	28.0
	Principles and Techniques of Stress Management	656	33.8
	Applied Writing	354	18.3
	Other	32	1.7

Note: Core competencies and most urgently needed competencies: N=473, 1466; Knowledge most anticipated to be learned in training: N=1939

Core Issues in Community Worker Workforce Development and Analysis of Their Causes

Through field research and a review of the literature, it has been found that the development of the community worker workforce currently faces numerous challenges, which severely hinder the advancement of modern grassroots governance. Specifically, these challenges primarily fall into the following two categories.

Core issues

The development of the community worker workforce is out of sync with the modernization of grassroots governance

First, there is a gap between the professional skills of community workers and the pace of development in grassroots governance. The modernization of grassroots governance is a comprehensive and systematic process aimed at improving the efficiency and quality of social governance to better meet the needs and expectations of the people. In this process, the adaptability of community workers' professional capabilities is a key factor that directly impacts the speed and effectiveness of grassroots governance. Community workers must keep pace with the times and quickly adjust to and adapt to new governance concepts and methods. For example, the shift from a "task-oriented" to a "mission-oriented" approach, and from an "isolated" to an "integrated" model, requires community workers to possess not only solid professional skills but also keen insight and rapid learning abilities to promptly understand and implement innovative strategies. However, during the actual research process, it was found that the professional backgrounds and educational levels of most community workers vary significantly, with relatively few holding degrees directly related to community work. In a sample survey of District S in Hangzhou, it was found that community workers with a bachelor's degree accounted for the highest proportion of total participants at 84.53%, followed by those with an associate degree at 12.53%. Among community workers, 73.49% hold a Certified Social Worker professional qualification certificate. Those with a background in management accounted for the highest proportion of the total participants, at 31.2%. The professional backgrounds of most respondents were in the humanities. Upon analyzing the data under the "Other" category, it was found that the vast majority had backgrounds in finance or the arts, while a small number could be classified under other disciplines such as sociology; however, the sample size was too small to be significant. Clearly, nearly 90% of community workers lack systematic education and training in fields such as community governance and social work, and there is a severe shortage of community social work professionals with backgrounds in science and engineering. Second, there is a mismatch between the professional competencies of community workers and the content of grassroots social governance. The scope of grassroots social governance is gradually expanding and deepening to the micro-level. For example, the scope of governance has expanded from traditional areas such as public security and public health to broader domains including environmental protection, community services, and resident self-governance. At the same time, governance methods are evolving, placing greater emphasis on the rule of law, smart governance, and precision management, while highlighting the use of modern information technology—such as big data and cloud computing—to enhance governance efficiency and standards. This places higher demands on the professional competence of community workers. The current workforce may face certain capability gaps in areas such as strategic planning, team collaboration, and conflict resolution. Among the 473 deputy and principal community officials in District S, the most urgently needed capabilities identified were "problem-solving skills," "organizational and coordination skills," and "strategic planning skills." Meanwhile, among the 1,466 ordinary community workers and members of the two committees, the most urgently needed capabilities were deemed to be "problem-solving skills," "conflict analysis and mediation skills," and "team collaboration skills." Third, there is still room for improvement in the professional competence and capacity of community workers to address grassroots governance issues. Modern governance emphasizes the organic integration of rule of law and moral governance, which is a key manifestation of building a grassroots social governance system. In this process, disparities in the professional competence of community workers are particularly significant, as they are the specific implementers and promoters of the concepts of rule of law and moral governance at the grassroots level. Regarding the rule of law, modern governance requires community workers not only to possess basic legal knowledge but also to be able to apply legal reasoning and methods to resolve community issues. Regarding moral governance, modern governance emphasizes guiding residents to consciously adhere to social ethics, professional ethics, and family virtues through the cultivation of moral norms and core socialist values. During my research, I found that some community workers may have a deep understanding of legal knowledge but lack competence in moral education and cultural event planning; others may be skilled at planning and organizing activities but lack knowledge in legal practice and legal risk prevention and control.

Lack of a full-cycle immersive training system for community workers

First, the course structure is monotonous, and the content is outdated. Currently, training for community workers remains primarily lecture-based, with a focus on theoretical knowledge. There is a lack of diverse and engaging course formats such as online classes, interactive sessions, mentorship programs, and roundtable discussions. Additionally, the training content needs to be updated to include a variety of courses, such as professional social work knowledge and new media operations and promotion. In terms of course structure, there is only a rough classification based on different job levels, resulting in unclear and inconsistent categorization of participants. Furthermore, training content remains overly institutionalized and fragmented, preventing community workers from developing a deep and comprehensive understanding of their roles within the community. Second, training lacks precision. Research indicates that community workers with varying years of service and job levels have different expectations regarding the core competencies they wish to develop, and the core competencies they should possess also differ. Under the current training landscape, there is no clear, tiered training standard for community workers, which is an urgent issue that must be addressed for the development of the community worker workforce.Third, the practicality of train-

ing topics is weak. Current training courses lack overarching interpretations and summaries of the latest policies. Community workers are typically the implementers and enforcers of these policies. Social policies cover multiple areas such as social welfare, public safety, and employment security. Community workers should use the latest policies as guidance to integrate the implementation of social policies into their community work, making service delivery more scientific and effective. Fourth, performance evaluation standards are unclear. While community worker training generally focuses on the learning process, the evaluation and assessment of training outcomes remain inadequate, primarily due to the absence of a formal assessment system. This lack of an assessment system can lead to a situation where "training makes no difference, and whether one performs well or poorly in training makes no difference." Without proper evaluation and oversight of training outcomes, there is no guarantee that training planning, theoretical research, and the standardization, relevance, and practicality of training content will be ensured. Furthermore, the full implementation of incentive mechanisms cannot be guaranteed. As a result, full-time community workers lack clear objectives during the learning process, making it difficult for training to achieve its intended goals.

Analysis of causes

Lack of Theoretical Support and Cognitive Biases. Insufficient theoretical empowerment is the core bottleneck constraining the standardized development of the community worker workforce. Currently, the practice of building grassroots community worker teams generally lacks guidance from a systematic theoretical framework, and a suitable theoretical application system tailored to the characteristics of community workers' career development has yet to be established.In particular, there are significant shortcomings in the practical application of core theories such as career development theory. Key elements—such as the patterns of career development stages and the characteristics of career anchors—have not been integrated into critical aspects of workforce cultivation, evaluation, and incentives. This has resulted in training content that is disconnected from the competency needs of workers at different career stages, and performance evaluation metrics that fail to align precisely with career growth objectives. Consequently, overall workforce development efforts exhibit fragmented and haphazard characteristics, lacking internal logical consistency. At the same time, some regions exhibit a fundamental misunderstanding of workforce development, simplistically equating it with the fulfillment of administrative tasks. They have failed to grasp the core requirements of modern grassroots governance—namely, the need for a professional, refined, and sustainable community worker workforce—and have overlooked the intrinsic link between workforce development and the enhancement of governance effectiveness. Consequently, the direction of development has deviated from the practical needs of grassroots governance, making it difficult to establish a virtuous cycle of "theoretical guidance—practical optimization—effectiveness enhancement."

Inadequate institutional design and insufficient resource allocation. The systemic gaps in the institutional framework and structural deficiencies in resource support collectively constitute practical obstacles to workforce development. At the institutional design level, the top-level planning of training systems has significant shortcomings, and a full-chain closed-loop mechanism encompassing "needs assessment—curriculum design—implementation evaluation—outcome feedback" has yet to be established: the needs assessment phase lacks precise analysis of competency gaps among workers at different career stages and in different job roles; the curriculum design phase has failed to establish a dynamic adjustment mechanism, making it difficult to adapt to the evolving dynamics of grassroots governance scenarios; the implementation, assessment, and feedback stages are largely perfunctory, with no scientific evaluation metrics in place to effectively verify training outcomes or optimize content based on feedback. In terms of resource allocation, there is a significant gap between the level of support provided and the actual needs of workforce development: the development of digital training platforms lags behind, with a lack of interactive and targeted online learning resources, making it difficult to meet workers' needs for fragmented learning; there is an insufficient pool of high-quality instructors, with a shortage of versatile trainers who possess both theoretical depth and practical experience, making it difficult to ensure training quality; The development of localized practical training materials is lagging; failure to integrate regional governance characteristics into training content makes it difficult to support diverse and personalized training needs. Furthermore, there is insufficient linkage between incentive mechanisms and training outcomes; training achievements are not effectively tied to core benefits such as salary increases and career advancement, resulting in a lack of intrinsic motivation among practitioners to participate in training and hindering the creation of a positive atmosphere of proactive learning and continuous improvement.

Insufficient practical coordination and lack of collaborative mechanisms. The absence of a collaborative mechanism among diverse stakeholders has left workforce development stuck in a "go-it-alone" predicament, making it difficult to generate a collective effort for capacity building.On the one hand, the integration of theory and practice is insufficient. Training curricula are detached from real-world grassroots governance scenarios, focusing primarily on theoretical instruction. There is a lack of simulated exercises for practical scenarios such as community conflict resolution, services for vulnerable groups, and digital governance. This results in a disconnect between learning and application, making it difficult for practitioners to translate training knowledge into practical governance skills and effectively address complex issues in grassroots governance. On the

other hand, interdepartmental coordination mechanisms are underdeveloped. The division of responsibilities among relevant functional departments—such as civil affairs, organization, and human resources and social security—in workforce development remains unclear, resulting in overlapping authority and responsibilities as well as buck-passing. This failure to establish a coordinated framework for planning and collaboration has led to fragmented policy implementation and inefficient resource allocation. At the same time, a collaborative education mechanism between government and civil society has yet to be established. The professional strengths of third-party entities—such as universities, social organizations, and professional social work agencies—have not been fully leveraged. Cooperation in areas such as training curriculum development, practical skills guidance, and career development planning lacks sufficient depth and breadth. Consequently, it is difficult to utilize social resources to enhance the professional standards of the workforce, which constrains the comprehensive improvement of the workforce's overall competence.

The Path to Building a Community Worker Workforce in Modern Grassroots Governance

Based on the requirements of modern grassroots governance, and combining career development theory with practical experience from District S in Hangzhou, this paper constructs a path for workforce development across four dimensions—Party leadership, training systems, evaluation mechanisms, and incentive measures—to achieve a precise alignment between the workforce's professional growth and governance needs.

First, strengthen Party leadership and establish a model training mechanism for grassroots workers.Against the backdrop of a complex and ever-changing domestic and international environment, as well as the new landscape of urbanization driven by economic transformation—where opportunities and challenges coexist—we will construct a training system for grassroots community workers based on a Chinese-style autonomous knowledge system. This will strengthen the Party's comprehensive leadership over grassroots community work, promote the integrated development of Party building and professional operations, and coordinate cadre training. We will firmly establish community workers' collective consciousness, sense of the bigger picture, holistic perspective, and innovative spirit, continuously cultivating their ability to navigate the complexities of the market economy and oversee the overall situation.

Second, we must establish a workforce development and training system that fully integrates Chinese-style theory with local practices. Based on the career development stages outlined in career theory, we will construct a diversified training system that covers the entire career cycle, adapts to stage-specific needs, and integrates online and offline learning. First, we will optimize the design of the phased curriculum system by establishing a dynamic model of "core foundational courses + stage-specific courses": core foundational courses will focus on modern grassroots governance theory, policies and regulations, and the enhancement of professional competence, covering the entire career cycle; stage-specific courses precisely match the needs of different developmental stages: during the exploration phase, courses on practical job operations and career awareness are offered to facilitate rapid integration into the role; during the establishment phase, courses on advanced professional skills, project management, and problem-solving strategies are provided to help develop core competencies; during the maintenance phase, courses on experience distillation and succession, governance model innovation, and interpretation of cutting-edge policies are offered to foster leadership and drive progress. At the same time, drawing on practical experiences from Hangzhou's S District—such as the "Five-Community Collaboration" and "Community-Enterprise Synergy"—we have developed localized practical teaching materials to strengthen the integration of theory and practice. Second, we implement tiered and categorized training. In addition to differentiated training based on job types, we prioritize targeted development according to career stages: For new hires in the exploration phase, we conduct integrated pre-employment training combining "mentor-apprentice programs, centralized training, and on-the-job practice"; for staff in the establishment phase, we offer capability-enhancement programs combining "specialized training, project experience, and peer learning"; and for senior staff in the maintenance phase, we provide leadership-oriented programs featuring "experience-sharing workshops and innovative research projects," thereby establishing a "full-cycle, tiered" training framework. Third, we innovate training formats by establishing a multi-track model combining "online, offline, and field visits": online, we build a digital teaching platform to provide bite-sized, phased learning resources; offline, we conduct interactive training such as scenario simulations, case studies, and cross-stage experience-sharing sessions; and we organize field visits to advanced regions for community workers at different development stages to learn from exemplary governance practices and team development models.

Third, establish a scientific evaluation system for community work talent that considers both process and results. Based on performance evaluation theories in human resource management, construct an evaluation system that balances process and results, as well as quantitative and qualitative assessments. First, establish a "dual-track" evaluation standard that combines training credits with performance assessments: training credits cover course completion, examinations, and practical application; performance assessments include indicators such as task completion rates, resident satisfaction, and innovative achievements, with resident satisfaction accounting for no less than 30% of the total weight. Second, improve the evaluation implementation mechanism by adopting a combined approach of "daily assessments + annual evaluations + special assessments." Daily assessments are conducted by community Party organizations, focusing on tracking workers' daily performance; annual assessments are led by civil affairs departments, which organize third-party agencies to con-

duct resident satisfaction surveys; special assessments target key governance projects, emergency response, and other tasks to ensure comprehensive and objective evaluation. Third, strengthen the application of evaluation results by directly linking them to compensation, career development, and awards and honors; establish a feedback mechanism for evaluation results to develop personalized competency enhancement plans for workers, forming a closed-loop of "evaluation–feedback–improvement."

Fourth, improve incentive and support mechanisms to stimulate the team's intrinsic motivation. Guided by career development theory and centered on the core needs of different career stages, we will establish an incentive and support mechanism that balances material and non-material incentives and integrates security with development, thereby fostering the team's intrinsic motivation and sense of professional belonging.First, optimize the phased compensation system by establishing a dynamic salary growth mechanism linked to career development stages, job responsibilities, work performance, and professional qualifications: During the exploration phase, ensure a basic salary and establish a position adaptation bonus; during the establishment phase, increase the proportion of performance-based pay and provide special subsidies for those who obtain professional certifications or achieve outstanding results; during the maintenance phase, introduce experience-sharing allowances and innovation achievement rewards to enhance the sense of value among senior staff. At the same time, implement comprehensive welfare policies—including social insurance, housing provident funds, and paid leave—to solidify the foundation for career stability. Second, we will streamline the full-cycle career development pathway by establishing a dual-track promotion system comprising "management roles" and "professional roles," with the two tracks interconnected: management roles follow a step-by-step progression from "community worker" to "member of the Community Party Committee and Residents' Committee" to "community director" to relevant positions at the subdistrict level; while professional roles follow a technical grading progression of "Assistant-level Social Worker – Intermediate Social Worker – Senior Social Worker – Chief Social Worker," with clear eligibility criteria and salary standards defined for each stage and grade. We will promote two-way mobility between community workers and positions in public institutions and state-owned enterprises to broaden career development opportunities. Third, we will strengthen targeted motivational incentives tailored to the needs of different career stages: for workers in the exploration phase, we will prioritize recognition of growth and provide guidance and support; for those in the establishment phase, emphasize performance recognition and professional validation; and for those in the maintenance phase, focus on incentives related to industry reputation and social recognition. Regularly organize selection activities such as "Outstanding Community Workers," "Governance Pioneers," and "Heritage Vanguards," and publicize exemplary deeds through commendation ceremonies and media coverage; establish a mechanism for tolerating and correcting errors to encourage workers at all stages to boldly explore governance innovations, fostering a work environment that is proactive and conducive to continuous growth.

Conclusion

The advancement of modern grassroots governance cannot be separated from the support of a high-quality community worker force. Team building must precisely align with governance needs and the laws of workers' professional growth, guided by Party building, supported by career development theory, centered on diversified cultivation, and secured by evaluation and incentives, to achieve the synergistic enhancement of political literacy, professional competence, and career growth. Based on survey data from District S in Hangzhou and using career development theory as its core framework, this study reveals the current characteristics and development challenges of the community worker workforce. It constructs a four-pronged development pathway of "Party-building leadership—diversified cultivation—scientific evaluation—incentive guarantees," providing practical references and theoretical guidance for the long-term development of the community worker workforce in the context of modernizing grassroots governance.

The study still has certain limitations: the survey area covers only District S in Hangzhou, and the representativeness of the sample needs to be further expanded; the depth of empirical analysis on factors influencing workforce development is insufficient. In the future, the scope of the survey could be expanded, and methods such as regression analysis could be employed to thoroughly explore the mechanisms by which various factors influence workforce development; by integrating the context of the new era—including digital governance and common prosperity—further research into new pathways and methods for workforce development could be conducted to provide more targeted theoretical and practical support for advancing the modernization of grassroots governance.

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J G T S S

Review article

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AI-Powered Digital Human Live Streaming and Chinese Consumers' Purchase Intention: Influencing Factors, Mechanisms, and Future Research Directions

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Abstract: Against the backdrop of the digital economy, AI-powered digital human live streaming, a novel marketing format that integrates artificial intelligence with live-streaming e-commerce, is profoundly reshaping Chinese consumers' shopping experiences and purchasing decisions. This paper employs a systematic literature review methodology to collate recent research findings on the factors influencing Chinese consumers' purchase intentions in relation to AI-powered digital human live streaming. Through integrated analysis, this paper first defines the conceptual evolution and technical characteristics of AI-powered digital humans. Second, it systematically identifies three core categories of factors influencing consumer purchase intention: feature dimensions of AI-powered digital humans (anthropomorphism, intelligent interactivity, and personalized recommendation), psychological mechanisms (social presence and trust in AI), and boundary conditions (product type and consumer characteristics). Consequently, this paper proposes an integrated dual-path model of presence and trust, revealing the underlying mechanisms through which these influencing factors affect purchase intention via the presence and trust pathways. Finally, this paper reviews the methodological characteristics of existing research and identifies future research directions. This paper provides a systematic knowledge base for theoretical construction and empirical research in the field of AI-powered digital human live streaming.

Keywords: AI-powered digital humans; Live-streaming e-commerce; Chinese consumers; Purchase intention; Systematic review

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Introduction

In recent years, AI-powered digital human live streaming has emerged as one of the most prominent new marketing models in China's e-commerce sector, with major e-commerce platforms and merchants actively exploring related practices. However, this new business model did not emerge overnight; its evolutionary trajectory clearly reflects the iterative development of the underlying artificial intelligence technologies (see **Figure 1**). From the mechanical repetition phase of 2018 to 2020 (merely looping pre-set videos with zero interaction), through the templated interaction phase of 2021 to 2023 (keyword-triggered pre-set scripts with stiff interactions), to the Intelligent AI phase from 2023 to the present (driven by generative AI, enabling multi-modal, context-aware intelligent interactions), AI-powered digital humans have evolved from passive electronic vending machines into quasi-social agents capable of human-like communication. While this qualitative shift has enhanced the user experience, it has also complicated the psychological mechanisms through which they influence consumer behavior, posing new challenges to existing theories.

Purchase intention is a core concept in consumer behavior research, referring to the likelihood that a consumer will engage in a purchasing behavior for a specific product or service (Fishbein & Ajzen, 1975). In the context of AI-powered digital human live streaming, consumers' purchase intentions are influenced by a variety of emerging factors, including the anthropomorphic characteristics, intelligent in-

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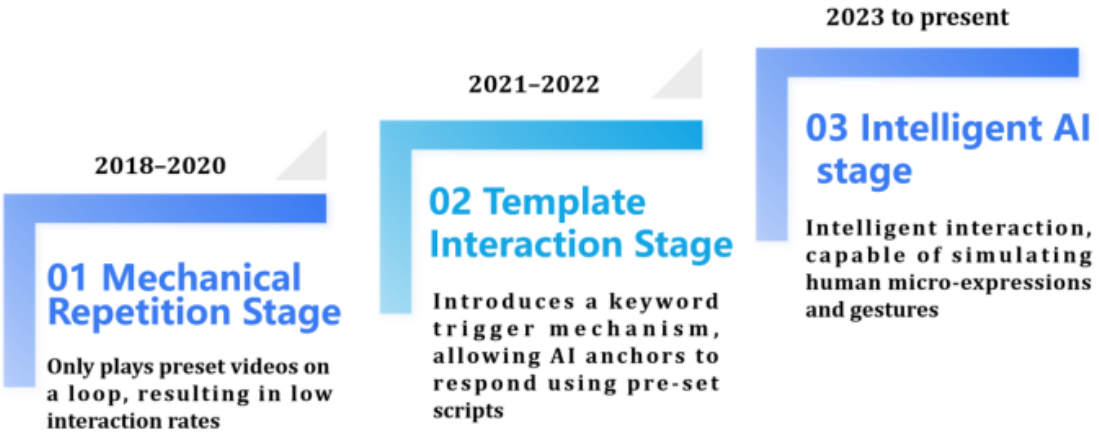

Figure 1 | Three stages of development in China's AI-powered digital human live streaming

teractivity, and personalized recommendation capabilities of AI-powered digital humans. However, has academic research on how this new type of intelligent agent influences consumer psychology and behavior kept pace with technological advancements? Can existing theoretical frameworks (such as the Technology Acceptance Model and the Theory of Quasi-Social Interaction) effectively explain the unique influence mechanisms of these quasi-social agents? However, the answers to these questions remain unclear.

Accordingly, this paper adopts a systematic literature review methodology to systematically collate existing research findings centre on the core question of how AI-powered digital human live streaming influences Chinese consumers' purchase intention. The research objectives of this paper include: **1)** defining the conceptual evolution and technical characteristics of AI-powered digital humans; **2)** identifying and integrating the primary factors influencing consumer purchase intention; **3)** revealing the underlying mechanisms through which these factors influence purchase intention; and **4)** reviewing existing research methods and proposing future research directions. Through the aforementioned work, this paper aims to provide a systematic knowledge base for theoretical construction and subsequent empirical research in the field of AI-powered digital human live streaming.

Conceptual Definition and Technical Characteristics of AI-Powered Digital Human Live Streaming

From virtual humans to AI-powered digital humans: Conceptual evolution

In the research context of AI-powered digital human live streaming, the precise definition of relevant terminology is of paramount importance. Currently, both academia and industry widely employ multiple terms such as virtual humans, digital humans, virtual digital humans, AI-powered digital humans, virtual anchors, and AI anchors. These concepts overlap and differ in both their connotations and denotations, which can lead to confusion. To clarify the conceptual boundaries of core terms, this paper synthesizes relevant literature to construct a three-tier conceptual framework comprising virtual humans, digital humans, and AI-powered digital humans.

The virtual human is the broadest term, referring generally to any digital avatar created using computer-generated technology that possesses human appearance or behavioral characteristics, and is widely applied in fields such as film and television animation, virtual social interaction, and education and training. Magnenat-Thalmann and Thalmann (2005) argue that virtual humans emphasize visual realism and character design, and do not necessarily possess intelligent behavior; for instance, a virtual idol or game character lacking language comprehension capabilities may still be classified as a virtual human. Griffor et al. (2017) further note that virtual humans encompass all computer-generated anthropomorphic figures, emphasizing their virtual existence.

The digital human is a technical term that has evolved from the concept of virtual humans; it typically refers to human-like avatars generated through high-precision 3D modeling, speech synthesis, and facial and motion capture technologies. Compared to virtual humans, digital humans place greater emphasis on realism and naturalness across multiple modalities, including visual and auditory aspects, and are widely used in real-world interactive scenarios such as finance, government services, healthcare, and customer service. Hetherington and McRae (2017) describe digital humans as human characters created using computer-generated imagery (CGI) technology. Although these characters are highly photorealistic, their behavior and emotional expressions rely primarily on pre-set animations and scripted controls, lacking autonomous intelligence.

AI-powered digital humans represent the next generation of virtual entities, integrating artificial intelligence tech-

nology with the foundation of digital humans. Machidon et al. (2018) define AI-powered digital humans as AI-generated characters possessing a human appearance. Song and Xiong (2025) note that intelligent digital human systems driven by large language models integrate core technologies, such as automatic speech recognition, natural language processing, and emotional text-to-speech, enabling hyper-realistic real-time interaction with users. This paper adopts AI-powered digital humans as the core terminology, positioning them at the innermost layer of the conceptual hierarchy comprising virtual humans, digital humans, and AI-powered digital humans. Compared to traditional virtual avatars, AI-powered digital humans not only possess human-like appearances but also integrate AI-driven semantic understanding and interactive capabilities, marking a substantial leap in the evolution of virtual interaction media.

Technical characteristics of AI-powered digital human live streaming

In China, the rise of AI-powered digital human live streaming began around 2020 and has developed rapidly on e-commerce platforms such as Taobao, JD.com, and Douyin (the Chinese version of TikTok). As a specific application of AI-powered digital humans in e-commerce scenarios, AI-powered digital human live streaming exhibits three key technical characteristics that distinguish it from traditional live streaming.

First, scalability in the temporal dimension. AI-powered digital humans can deliver 24/7 uninterrupted live streaming without the need for human breaks, demonstrating significant advantages in terms of operational costs and time flexibility. Second, intelligence in the interactive dimension. Based on large language models and natural language processing technology, AI-powered digital humans are capable of open-ended dialogue and context-aware responses, enabling deep interaction with users.Third, personalization in the content dimension. By analyzing user behavior data in real time, AI-powered digital humans can dynamically adjust recommendation strategies, providing tailored product recommendations and content presentation for different users. These technical characteristics mean that AI-powered digital humans are not merely efficiency tools but have become a new type of marketing medium with quasi-social subject attributes, profoundly influencing consumers' trust in technology-mediated commercial interactions and their behavioral expectations.

Key Factors Influencing Chinese Consumers' Purchase Intention

Core dimensions of AI-powered digital human live streaming

The external appearance, interactive capabilities, and content delivery mechanisms of AI-powered digital humans collectively constitute the core feature dimensions influencing consumers' purchasing intentions. Existing research primarily focuses on three aspects.

Anthropomorphism is a key distinguishing feature of AI-powered digital humans, compared to traditional virtual characters. Research indicates that the external appearance and internal attributes of AI-powered digital humans collectively constitute their anthropomorphic characteristics, serving as core factors influencing consumers' first impressions and their willingness to engage in sustained interaction. Arulsivakumar (2025) empirically found that the morphological, behavioral, and emotional authenticity of AI-powered digital human personas positively influences consumer engagement and attachment, with behavioral and emotional authenticity playing a particularly significant role. Guo et al. (2024) noted that anthropomorphic cues (impressional, interactive, and empathic cues) can promote engagement among digital human live streaming users by enhancing social presence and trust. Magtibay et al. (2025) further validated that anthropomorphism has a significant positive impact on Gen Z consumers' trust and their attitudes toward brands. Anthropomorphism encompasses two dimensions: physical realism and behavioral anthropomorphism. These anthropomorphic elements not only positively influence consumers' sense of social presence and trust but also enhance purchase intentions. Notably, the impact of anthropomorphism extends beyond the outwards appearance of AI-powered digital humans to their intelligent semantic processing capabilities; a high level of semantic understanding and situational adaptability is key to enhancing users' technological trust and sense of control.

Intelligent interactivity is a fundamental capability of AI-powered digital humans that enables human-like communication. Wang et al. (2023) point out that the real-time responsiveness of AI-powered digital humans—including verbal replies, physical reactions and facial expressions—significantly enhances consumers' experience of social coherence. The more timely and natural the response, the easier it is for consumers to build trust and develop a willingness to purchase. Consumer control and engagement within the interactive experience should not be overlooked; interactive mechanisms such as likes, live comments, and voting enhance consumers' sense of control over the live stream's pace and content (Liu, 2024). Multimodal interactive experiences, such as emotional expression through voice intonation and the synchronization of subtitles with animations, create richer sensory stimulation scenarios for consumers, helping deepen the emotional connection between users and streamers. Yu et al. (2025) further confirmed that multimodal anthropomorphic interactions by AI assistants (including the integration of multiple channels, such as voice, facial expressions, and movements) can significantly improve user satisfaction and perceived service quality.

Personalized recommendation represents a key functional advantage of algorithm-driven AI-powered digital humans over traditional human anchors. Nie and Wang (2025) found through experimental research that, for standard products, there is a marked difference in effectiveness be-

tween recommendations made by real people and those made by AI. Chen and Zhang (2023) point out that the degree of alignment between recommended content and users' interests and needs is a core factor influencing the effectiveness of recommendations. Precise recommendations not only enhance users' perceived value but also foster positive attitudes towards presenters and the platform. The ability to adapt recommendations to specific scenarios is also key to improving the user experience; introducing appropriate product combinations within specific contexts enhances the situational relevance of recommendations, thereby increasing users' immersion and engagement (Feng, 2024).

Psychological mechanisms: Identification of mediating variables

How do the feature dimensions of AI-powered digital human live streaming translate into consumer' purchase intention? Existing research has identified two core psychological pathways:

Emotional pathway: Social presence

Social presence is the core psychological experience through which users perceive the authenticity of interpersonal communication during virtual interaction. Chen (2024) conducted a scenario experiment to test that, when an AI anchor understands and responds to their emotions in live-streaming e-commerce scenarios, the stronger the social presence consumers perceive, the greater the enhancement in their purchase intention. Liu et al. (2025) further found that when consumers perceive an AI anchor's understanding and response to their emotions, they experience emotional resonance and a sense of companionship, which in turn enhances trust and purchase intention. Li et al. (2025), in a grounded theory study based on the SOR model, also confirmed that social presence is a key mediating factor linking the differences in characteristics between AI and human anchors, thereby influencing consumer' purchase intention. This creates an atmosphere of product endorsement, immersing consumers in product display scenarios.

Cognitive pathway: Trust in AI

Within this immersive atmosphere, consumers develop a sense of trust in the AI anchor. An empirical study by Shui et al. (2025), grounded in SOR theory, found that the image characteristics of AI anchors (cuteness, vitality) and their suitability to the scenario significantly stimulate consumers' perception of trust, thereby enhancing purchase intention, with trust playing a partial mediating role in this relationship. Zhong et al. (2025) further confirmed, from the perspective of technophobia, that the intelligent human-computer interaction capabilities of AI anchors (guidance, recognition, analysis, and feedback) effectively establish initial consumer trust by influencing perceived usefulness and perceived ease of use. The formation of trust involves a multidimensional assessment encompassing both cognitive judgements regarding the capabilities and reliability of AI systems and emotional perceptions of their benevolence and honesty (Qian and Liu, 2025).

Furthermore, individual consumer perception factors (such as satisfaction, perceived value, and immersive experience) play a mediating role in the aforementioned pathways. Sun and Zhu (2024) pointed out that consumer satisfaction can bridge the gap between the characteristics of AI-powered digital human live streaming and purchase intention. Gong et al. (2024) validated the significant positive influence of perceived functional and emotional value on purchase intention, with both jointly constituting the psychological foundation of consumer purchase intention. Ma (2024) proposed that a high-quality immersive experience increases viewing duration and significantly enhances purchase intention.

Boundary conditions: The role of moderating variables

The strength of these influence pathways is moderated by specific contextual factors. Existing research has identified two key moderating conditions:

Product type is a key moderating variable

Li et al. (2025), in their systematic review of the effects of virtual influencer marketing, noted that product category and characteristics are important moderating factors influencing the effectiveness of virtual influencer marketing (including AI-powered digital humans and virtual anchors), with significant differences in consumer acceptance of AI anchors between search-based and experience-based products. Wang et al. (2023) further demonstrated through eye-tracking experiments that, for search-based products, there is little difference in influence between AI-powered digital humans and human anchors; however, in experiential product scenarios, consumers are more inclined to accept recommendations from human anchors, primarily due to differences in the need for emotional connection and a sense of presence.

Individual consumer characteristics also play a moderating role

Li et al. (2025) found that highly innovative consumers are more sensitive to the intelligent performance of AI-powered digital humans and exhibit higher purchase intention. Deng et al. (2025) noted that consumers with a higher acceptance of new technologies are more likely to perceive the usefulness of generative AI content, thereby enhancing their motivation of purchase. Furthermore, the Uncanny Valley effect exerts a significant negative moderating influence on the relationship between the anthropomorphic appearance of AI-powered digital humans and brand attitudes, reducing consumers' trust in the brand and their purchase intentions (Yang and Long, 2025).

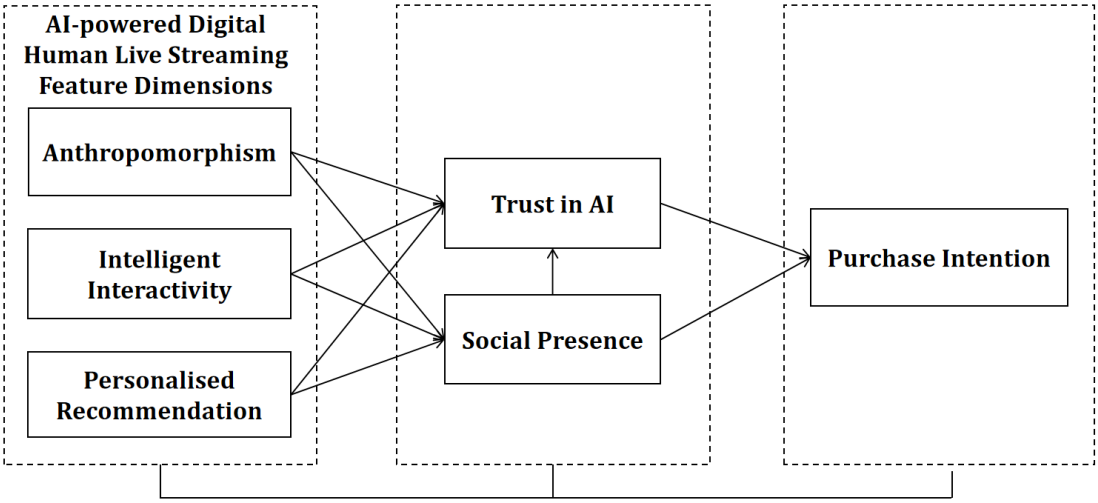

Figure 2 | Integrated model of the presence-trust dual pathway

Mechanisms of Action: From Single Mediation to an Integrated Model

Identifying and comparing mediating mechanisms

Existing research has explored the mediating mechanisms through which AI-powered digital human live streaming influences consumer purchase intention from multiple dimensions. Early studies predominantly focused on single mediating pathways, such as trust, satisfaction, or social presence, acting as independent mediating variables. While such research provides preliminary support for understanding consumer psychological responses, it struggles to explain more complex behavioral decision-making processes.

Subsequently, some studies have adopted parallel mediation pathways, simultaneously examining the independent effects of emotional and cognitive pathways. Qin and Guo (2025) validated that the anthropomorphic characteristics of AI-powered digital humans influence purchase intention through a parallel mediation mechanism involving social presence and trust. While such studies have revealed the multichannel nature of consumer psychological responses, they have failed to elucidate the intrinsic connections between different mediation pathways.

In recent years, a small number of studies have explored chained mediation pathways. A significant theoretical advancement in this regard is the identification of a chained pathway involving social presence and psychological distance: consumers first generate an emotional sense of presence during interactions, which subsequently shortens the psychological distance, ultimately influencing purchase intention (Zhang, 2025). This chained model offers a new theoretical perspective for understanding the temporal relationship between emotional responses and cognitive judgements in AI live-streaming contexts.

Integrated presence-trust dual-path model

Based on the above analysis, this paper proposes a dual-pathway integration model of presence and trust (see **Figure 2**) to systematically explain the mechanism by which AI-powered digital human live streaming influences consumer purchase intention. The core tenets of this model are as follows.

First, the coexistence of dual pathways. The feature dimensions of AI-powered digital human live streaming (anthropomorphism, intelligent interactivity, and personalized recommendation) simultaneously activate two psychological pathways in consumers: the emotional pathway, with social presence as its core mediator, emphasizes the emotional resonance and immersive experience generated during interaction; the cognitive pathway, with trust in AI as its core mediator, emphasizes consumers' rational judgements regarding the capabilities and reliability of the AI system.

Second, the interconnection between pathways. The two pathways are not entirely independent; rather, there is a sequential relationship in which the emotional pathway precedes the cognitive one. Consumers first experience a sense of 'the presence of the other' (social presence) through anthropomorphic interactions; this emotional experience subsequently enhances their cognitive evaluation of the AI anchor's capabilities and benevolence (trust in AI), ultimately jointly promoting the formation of purchase intentions.

Third, moderating contextual factors. The relative importance of these two pathways is moderated by contextual factors such as product type and consumer characteristics. In experiential product contexts, the emotional pathway may play a more prominent role, whereas among highly innovative consumer groups, the cognitive pathway may exert a stronger influence.

This integrated model transcends the explanatory limitations of single-mediator and parallel-mediator approaches, providing a systematic theoretical framework for under-

standing the complex consumer psychological processes in AI-powered digital human live streaming, while also identifying testable hypotheses for future studies.

Evolution and review of research methods

In terms of research methodology, the existing literature demonstrates an evolutionary trend from early conceptual exploration to the current systematic empirical validation.

Regarding data collection methods, structured questionnaire surveys remain predominant, with researchers typically designing questionnaires based on theoretical frameworks such as the SOR and TAM models, and sample sizes generally ranging between 300 and 500 participants. Scenario-based experiments are becoming increasingly common, often employing a between-groups design to explore the comparative effects of AI versus human anchors. Behavioral tracking technologies are beginning to be introduced; for instance, eye-tracking experiments are used to analyze the relationship between users' visual attention and interactivity. Although in-depth interviews and mixed-methods approaches are not yet widely used, they have demonstrated unique value in exploring complex mechanisms.

In terms of data analysis techniques, studies generally employ reliability and validity tests, as well as exploratory and confirmatory factor analyses, to ensure the quality of measurement instruments. Structural equation modeling was used to test path relationships, while the Bootstrap method was employed to assess the significance of the mediating effects. Moderation effects are analyzed through regression interaction terms or multi-group comparisons. Some studies have begun to incorporate complex methods such as DEMATEL, ISM, and MICMAC, to explore the hierarchical causal structures among influencing factors (Ding, 2024).

Overall, research methodologies in this field are shifting from a single-dimensional approach to a more multifaceted one and from descriptive analysis to an explanation of the underlying mechanisms. However, issues such as the predominance of cross-sectional designs, lack of qualitative exploration, and absence of longitudinal tracking require attention in future research.

Research Gaps and Future Prospects

Theoretical gaps: From fragmentation to integration

Current research has not yet clearly defined the core feature dimensions of AI-powered digital human live streaming. Features such as anthropomorphism, intelligence, and personalization are often treated as isolated variables in a fragmented manner, and a classification system with consistency and theoretical guidance has not yet been established. Simultaneously, research into influence mechanisms largely remains at the level of single or parallel mediating pathways, lacking sufficient substantiation regarding the causal sequence, strength of influence, and interactive relationships between variables. Future research should further test integrated models, such as the presence-trust dual pathway, explore multi-path analysis strategies, including chained mediation, moderated mediation, and interaction effects, and construct a systematic logical framework linking AI characteristics, psychological responses, and behavioral intentions.

Contextual gaps: From generalisation to focus

Current research often employs abstract e-commerce platform scenarios or generalized consumer samples in its empirical designs, which to some extent obscures the moderating effects of demographic composition, platform characteristics, and usage contexts on consumer responses. Taking China's Generation Z as an example—the most active consumer group in current AI-powered digital human live streaming scenarios—their technological acceptance of AI-powered digital humans, interaction preferences, and brand loyalty formation mechanisms exhibit distinct generational characteristics. However, existing research has rarely conducted systematic analyses of their behavioral patterns and psychological pathways. Furthermore, mainstream platforms such as Douyin and rednote exhibit significant differences in algorithmic logic, community culture, and interaction mechanisms, which may have profound implications for consumer responses. Future research should emphasize the diversity and localized nature of empirical contexts, focusing on specific platforms and user groups to conduct cross-platform comparisons, generationally segmented sample analyses, and simulations of specific interactive scenarios.

Methodological gaps: From singular to plural

Existing research has predominantly centre on quantitative analysis in its methodological design, with a particular preference for cross-sectional data collection via structured questionnaires. Relying solely on questionnaire-based methods and cross-sectional designs presents limitations in explaining the complex interactions between variables and dynamic evolutionary processes. Although a few studies have attempted to incorporate experimental methods, behavioral tracking, and eye-tracking tests, systematic mixed-methods research designs are scarce. Future research should promote the organic integration of qualitative and quantitative methods, fostering a closer synergy between variable exploration and mechanism construction. Simultaneously, longitudinal tracking studies should be strengthened to reveal the psychological evolution of consumers' long-term interactions with AI-powered digital humans.

Conclusion

This paper presents a systematic literature review of existing research findings centre on the core question of how AI-powered digital human live streaming influences Chinese consumers' purchase intentions. Through an integrated analysis, the paper draws the following main conclusions.

First, AI-powered digital human live streaming has undergone a conceptual evolution from virtual humans to digital humans and finally to AI-powered digital humans, with its core technical characteristics primarily manifested across three dimensions: temporal extensibility, interactive intelligence, and content personalization.

Second, the factors influencing consumers' purchase intentions can be categorized into three types: feature dimensions of AI-powered digital humans (anthropomorphism, intelligent interactivity, and personalized recommendation), psychological mechanisms (social presence and trust in AI), and boundary conditions (product type and consumer characteristics).

Third, the integrated presence-trust dual-path model proposed in this paper reveals the underlying mechanisms through which AI-powered digital human live streaming influences consumers' purchase intentions. The characteristics of AI-powered digital human live streaming simultaneously activate the emotional pathway (social presence) and the cognitive pathway (trust in AI). These two pathways can operate independently or form a chain reaction in which emotion precedes cognition.

Fourth, while existing research methods are dominated by questionnaire surveys and structural equation modeling, scenario experiments and mixed-methods approaches are emerging; however, qualitative exploration and longitudinal tracking require further development.

This study provides a systematic knowledge base for the theoretical development and empirical research in the field of AI-powered digital human live streaming. With the deep integration of AI technology and consumer behavior, research into AI-powered digital human live streaming is expected to become a significant growth area in digital marketing, warranting continued attention and multidisciplinary collaboration.

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