

ระบบสารสนเทศเชิงแนวคิดสำหรับการทำงานร่วมกันระหว่างบ้านและโรงเรียน ในประเทศจีน

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บทคัดย่อ

การวิจัยนี้มุ่งแก้ไขปัญหาการขาดแคลนกรอบแนวคิดระบบสารสนเทศที่มีความเป็นระบบสำหรับความร่วมมือระหว่างบ้านและโรงเรียนในบริบทการศึกษาของประเทศจีน ซึ่งแนวปฏิบัติที่มีอยู่ในปัจจุบันยังคงพึ่งพาเครื่องมือการสื่อสารที่กระจัดกระจายและขาดกลไกการประสานงานเชิงโครงสร้าง โดยการศึกษาได้นำแนวคิดการวิจัยเชิงออกแบบมาใช้ในการพัฒนาและประเมินกรอบแนวคิด เพื่อสนับสนุนการตัดสินใจร่วมกัน ความชัดเจนของบทบาทและการบูรณาการกลไกการป้อนกลับแบบพลวัต กรอบแนวคิดที่นำเสนอประกอบด้วยสามระบบย่อย ได้แก่ บ้าน โรงเรียน และระบบสารสนเทศเพื่อการทำงานร่วมกัน (Collaborative Information System: CIS) ภายใต้โครงสร้างแบบวงจรป้อน Input-Process-Output-Feedback (IPOF) โดยเน้นข้อมูลนำเข้าที่ขับเคลื่อนด้วยความต้องการของผู้เรียน การจำลองสถานะทางอารมณ์ และการประสานงานผ่านเทคโนโลยีเพื่อเพิ่มประสิทธิภาพของความร่วมมือ

กรอบแนวคิดดังกล่าวได้รับการประเมินโดยผู้เชี่ยวชาญจำนวน 7 คน โดยใช้แบบสอบถามมาตรประมาณค่า 5 ระดับ ผลการประเมินพบว่ามีความเหมาะสมโดยรวมอยู่ในระดับสูงมาก (Mean = 4.55, SD = 0.52) ครอบคลุมด้านองค์ประกอบระบบ ความชัดเจนของโครงสร้าง และความสอดคล้องเชิงตรรกะ นอกจากนี้ การวิเคราะห์เพิ่มเติม ได้แก่ Kendall's coefficient (W = 0.198, $p < 0.01$) พิสัยระหว่างควอไทล์ และการวิเคราะห์องค์ประกอบหลัก แสดงให้เห็นถึงระดับความเห็นพ้องในระดับปานกลาง ควบคู่กับความหลากหลายเชิงโครงสร้างของมุมมอง จำเป็นต้องชี้ให้เห็นเป็นพิเศษว่า แม้ค่าสัมประสิทธิ์ความสอดคล้องเคนดอลล์ (W = 0.198) จะอยู่ในระดับต่ำ แต่การทดสอบไคสแควร์ มีผลนัยสำคัญทางสถิติ ($p < 0.01$) ซึ่งแสดงให้เห็นว่ามีความเห็นพ้องต้องกันทางสถิติ ความขัดแย้งดังกล่าวเกิดจากคะแนนประเมินที่กระจุกตัวอย่างมาก โดยช่วงควอไทล์ระหว่างกลางของทุกรายการประเมินมีค่าไม่เกิน 1 ผู้เชี่ยวชาญส่วนใหญ่ให้คะแนนอยู่ในช่วง 4-5 คะแนน ซึ่งยืนยันถึงการ

ยอมรับกรอบงานนี้เป็นอย่างกว้างขวาง เนื่องจากค่า W มีความไวต่อความแตกต่างของลำดับข้อมูล เมื่อข้อมูลมีการผันผวนน้อยและพื้นที่ในการแยกแยะค่าถูกจำกัด จึงทำให้ค่าสัมประสิทธิ์มีค่าต่ำตามไปด้วย

ผลการศึกษาชี้ให้เห็นว่ากรอบแนวคิดนี้มีพื้นฐานทางทฤษฎีที่มั่นคงและมีความสอดคล้องเชิงตรรกะ เหมาะสมสำหรับใช้เป็นแนวทางในการออกแบบระบบสารสนเทศเพื่อสนับสนุนความร่วมมือระหว่างบ้านและโรงเรียน อย่างไรก็ตาม งานวิจัยในอนาคตควรมุ่งเน้นการตรวจสอบเชิงประจักษ์เพิ่มเติมผ่านการพัฒนาต้นแบบและการนำไปใช้งานจริง

คำสำคัญ: ความร่วมมือระหว่างบ้านและโรงเรียน/ กรอบแนวคิดระบบสารสนเทศ/
การวิจัยเชิงออกแบบ/ ระบบสารสนเทศเพื่อการทำงานร่วมกัน/
แบบจำลองเชิงแนวคิด/

A Conceptual Information System for Home–School Collaboration in China

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Abstract

This study addresses the lack of systematic information system frameworks for home–school collaboration in the Chinese educational context, where existing practices rely on fragmented communication tools and lack structured coordination mechanisms. Adopting the design science research paradigm, this study develops and evaluates a conceptual framework to support collaborative decision-making, role clarity, and dynamic feedback integration. The proposed framework integrates three subsystems-home, school, and a central Collaborative Information System (CIS) -within an Input-Process-Output-Feedback (IPOF) closed-loop structure. It incorporates student need-driven inputs, affective state modeling, and technology-mediated coordination to enhance collaboration effectiveness.

The framework was evaluated by seven experts using a five-point Likert scale questionnaire. Results indicate a very high level of overall appropriateness (Mean = 4.55, SD = 0.52) across system components, structural clarity, and logical consistency. Additional analyses, including Kendall's coefficient ($W = 0.198$, $p < 0.01$), interquartile range, and principal component analysis, reveal moderate consensus alongside structured cognitive diversity. It is particularly noteworthy that although Kendall's coefficient of concordance ($W = 0.198$) is relatively low, the chi-square test yields a significant result ($p < 0.01$), indicating a statistical consensus among the raters. This apparent discrepancy is attributed to the high concentration of rating scores: the interquartile range (IQR) of all items is no greater than 1, and most experts assigned scores between 4 and 5,

which reflects general recognition of the framework. Since Kendall's W is sensitive to rank differences, the minimal data variation and limited discrimination range inevitably result in a low coefficient value.

The findings suggest that the framework provides a theoretically grounded and logically consistent foundation for designing collaborative information systems. Future research should focus on empirical validation through prototype development and real-world implementation.

Keywords: Home–School Collaboration/ Information System Framework/
Design Science Research/ Collaborative Information System/
Conceptual Model

Introduction

Information technology has evolved from a tool primarily used for data storage into a critical infrastructure that supports coordination and collaboration across multiple organizations [1], [2]. In the context of home-school collaboration in China, however, current practices remain largely dependent on fragmented communication tools, such as parent-teacher meetings and instant messaging platforms. These approaches lack a structured information system architecture capable of systematically integrating data, clarifying stakeholder roles, and supporting collaborative decision-making processes. Consequently, such limitations lead to information fragmentation and hinder the sustainability of collaborative practices [3], [4].

The Chinese educational context is characterized by an asymmetric collaboration model, often described as “school-dominant with family participation” [3]. This model necessitates information systems that can simultaneously support centralized coordination and enable meaningful stakeholder engagement. However, existing technological tools predominantly emphasize communication efficiency rather than governance-level coordination, resulting in a mismatch between system capabilities and the institutional requirements of structured collaboration.

Although the application of digital technologies in education has expanded significantly, prior research has primarily focused on parental involvement and communication effectiveness. There remains a notable lack of conceptual frameworks that explicitly model key elements such as system components, stakeholder roles, information flows, and feedback mechanisms from an information system architecture perspective [5]. As a result, limited attention has been given to understanding how information systems can function as a “coordination infrastructure” that systematically supports

collaboration. This gap is particularly evident in light of the structural differences between Chinese and Western educational governance systems.

To address this gap, this study adopts the design science research paradigm to develop and evaluate a conceptual information system framework tailored to home-school collaboration in China. Rather than emphasizing technical implementation, the study focuses on establishing a conceptual design foundation to inform future system development and management. The specific objectives of this study are: (1) to develop a conceptual framework for a home-school collaborative information system, and (2) to evaluate its appropriateness and logical consistency. The findings are expected to contribute to the advancement of information system theory and provide a structured reference for designing systems that align with the governance characteristics of the Chinese educational context.

Materials and Methods

1. Research Design

This study adopts the design science research (DSR) paradigm to develop and evaluate a conceptual framework for a home-school collaborative information system. DSR is widely recognized as an appropriate approach for constructing and validating artifacts intended to solve identified problems in information systems research [5]. In this study, the conceptual framework serves as the primary research artifact, focusing on conceptual design rather than technical implementation.

2. Research Instruments

2.1 Conceptual Framework

The conceptual framework of the home-school collaborative information system was developed as the core artifact of this study. The framework integrates three primary subsystems—home, school, and a central

Collaborative Information System (CIS)—and is structured based on an Input–Process–Output–Feedback (IPOF) mechanism. The framework also incorporates an Interaction–State–Feedback closed-loop operational model to support coordination, decision-making, and dynamic system adaptation. Figure 1 presents the conceptual framework of the proposed CIS-driven home–school collaborative information system.

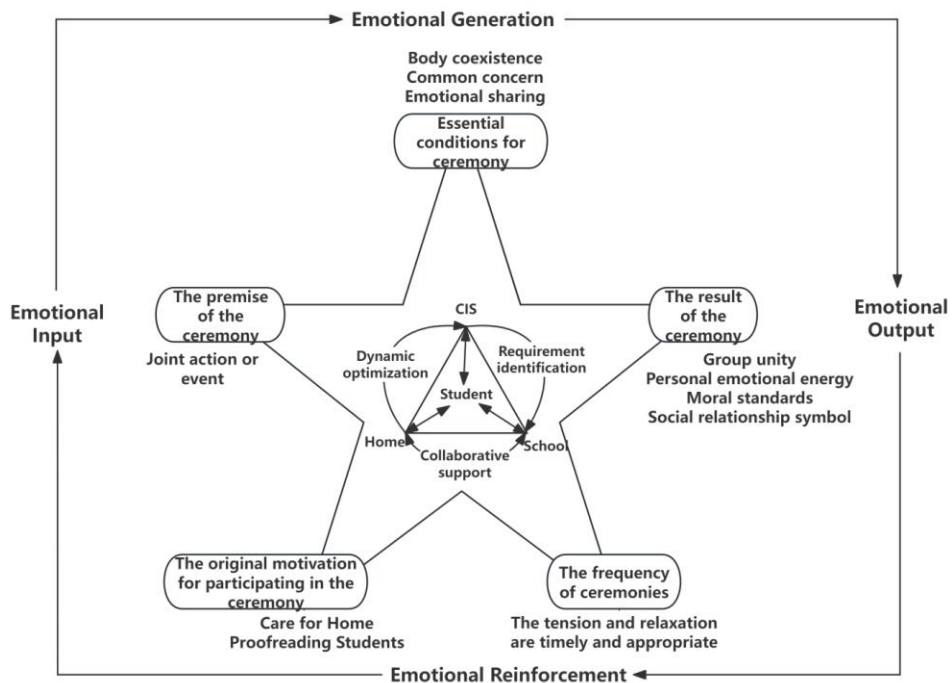


Figure 1 CIS-Driven Home–School Collaborative Information System:
An Interaction–State–Feedback Closed-Loop Operational
Mechanism Model

2.2 Expert Evaluation Questionnaire

A structured questionnaire using a five-point Likert scale was developed to evaluate the proposed framework. Likert-scale instruments are commonly

used to measure perceptions, attitudes, and levels of agreement in social science and information systems research [6].

The questionnaire consists of three evaluation dimensions:

1. Appropriateness of information system components
2. Clarity of the conceptual framework structure
3. Logical consistency and rationality of the framework

2.3 Item–Objective Congruence (IOC)

The Item–Objective Congruence (IOC) method was employed to assess the content validity of the questionnaire. IOC is a widely accepted technique for evaluating the alignment between measurement items and research objectives [7]. The IOC index was calculated prior to data collection to ensure the validity and relevance of all questionnaire items.

3. Research Sample

3.1 Population

The target population consists of experts in information systems and management information technology with academic or professional experience in system design, development, or evaluation.

3.2 Sample and Sampling Technique

Purposive sampling was employed to select seven experts with relevant expertise in information systems and management information technology. This sampling technique is appropriate for studies requiring specialized knowledge and expert judgment [8].

Although the sample size is relatively small, it is consistent with prior design science studies that rely on expert-based evaluation of conceptual artifacts [5].

3.3 Expert Qualifications

Experts participating in the evaluation were required to meet at least one of the following criteria:

- (1) Experience in designing, developing, or managing information systems
- (2) Experience in information technology for management
- (3) Research experience or academic publications related to information systems
- (4) Experience in evaluating or providing consultancy services on information systems in organizations or educational institutions

4. Data Collection

Data collection was conducted in two stages:

1. Instrument validation

The expert evaluation questionnaire was first validated using the IOC method. The IOC values ranged from 0.86 to 1.00, indicating high content validity and strong alignment between the questionnaire items and research objectives.

2. Expert evaluation

A panel of seven experts was convened to evaluate the conceptual framework. During the session, the research objectives and the proposed framework were presented in detail. The experts then completed the evaluation questionnaire.

5. Data Analysis

Quantitative data were analyzed using descriptive statistics, including mean and standard deviation, to determine the level of agreement across evaluation dimensions. To further examine expert consensus, the following statistical techniques were employed:

- Kendall’s coefficient of concordance (W) to measure agreement among experts [9]
- Interquartile range (IQR) to assess the dispersion of responses
- Principal component analysis (PCA) to explore the underlying structure of expert evaluations [10]

Due to the relatively small sample size, PCA results are interpreted as exploratory rather than generalizable.

Results

The evaluation results of the seven experts on the three dimensions of the CIS framework—system element appropriateness, structural clarity, and logical consistency—are presented in Table 1.

Table 1 Summary of Expert Evaluation Results on the Conceptual Framework of Home-School Collaborative Information System

Evaluation dimensions	Mean	SD	Rating Level
Appropriateness of Information System Components			
1.Completeness of the system core components (Data–Process–Output–Feedback)	4.71	0.49	Very High
2.Rationality of role allocation among the three actors (Home–School–CIS System)	4.57	0.53	Very High
3.Necessity of student state variables and data modeling design	4.43	0.53	High

4.Extent to which system functional modules meet collaborative needs	4.57	0.53	Very High
5.Capability of information flow and interaction mechanisms to support collaborative decision-making	4.43	0.53	High
Overall mean: Appropriateness of information system components			
Clarity of Conceptual Framework Structure			
6.Clarity of system structural hierarchy and module division	4.71	0.49	Very High
7.Clarity of boundaries among Home–School–CIS subsystems	4.57	0.53	Very High
8.Clarity of the Input–Process–Output–Feedback structural representation	4.71	0.49	Very High
9.Interpretability of the three-actor collaborative topology structure	4.43	0.53	High
10.Clarity of information flow and feedback path structure	4.57	0.53	Very High
Overall mean: Clarity of conceptual framework structure			
	4.60	0.51	Very High

Logical Consistency & Rationality			
11.Rationality of the student-need-driven input logic	4.57	0.53	Very High
12.Consistency of the mechanism chain of Need→ Collaboration→ Emotion→ Feedback	4.43	0.53	High
13.Rationality of emotion and engagement states as feedback variables	4.29	0.49	High
14.Completeness of the IPOF closed-loop operational mechanism	4.71	0.49	Very High
15.Necessity of the CIS technological mediation role	4.57	0.53	Very High
16.Rationality of the system's dynamic optimization and adaptive mechanisms	4.43	0.53	High
17.Consistency between theoretical foundations and system design	4.57	0.53	Very High
Overall mean: Logical consistency and rationality	4.51	0.52	Very High
Mean: Conceptual information system framework	4.55	0.52	Very High

The evaluation results from 7 experts show that the CIS framework proposed in this study achieves a "very high" level in terms of structure, components, and mechanisms (Mean = 4.55, SD = 0.52). This indicates that the system has a complete structure, closed loop logic, interpretable coordination mechanisms, and a clear role of technology mediation.

The overall mean scores for all three dimensions were above 4.50 (range: 4.51–4.60), representing a "very high" level. specifically: for system element appropriateness (Mean = 4.54, SD = 0.52), experts particularly acknowledged that the framework contains a complete IPOF closed-loop structure and reasonable role division supporting collaborative decision-making. for structural clarity (Mean = 4.60, SD = 0.51), the hierarchy, boundaries, and operational paths of the system were highly evaluated, indicating favorable interpretability and implementability. for logical consistency (Mean = 4.51, SD = 0.52), the closed-loop mechanism chain driven by student needs, with emotion as feedback and CIS as the technical mediator, was recognized as highly internally rational and theoretically consistent.

Key statistical indicators including Kendall's W, IQR, and PCA are summarized in Table 2 to quantify expert consensus, facilitating an understanding of surface-level agreement in evaluations.

Table 2 Summary of Consensus Analysis

Indicator	Value	Interpretation
Eigenvalue (λ_1)	2.405	Dominant component exists
Eigenvalue Ratio (λ_1/λ_2)	1.33	Moderate consensus
Variance Explained (PC1)	34.36%	Acceptable explanatory power
Kendall's W	0.198	Low-moderate agreement
p-value	0.003	Statistically significant
Interquartile Range (IQR)	≤ 1	High agreement (ceiling effect)
Overall Consensus Level	Moderate	Structured but not strongly homogeneous

Results showed a consistency coefficient $W = 0.198$, with a significant chi-square test ($\chi^2(16) = 20.227$, $p = 0.003 < 0.01$), indicating statistically significant non-random agreement among experts. However, the relatively low W value (0.198) was in contrast with the highly significant p -value. This can be explained by the highly concentrated ratings: all items had $IQR \leq 1$, with at least half of experts scoring between 4 (agree) and 5 (strongly agree), reflecting broad approval of the framework's surface quality. As Kendall's W is sensitive to ranking differences, the restricted rating variation compressed the discriminant space and reduced the W coefficient.

Since W only reflects ordinal consistency rather than the underlying cognitive structure, exploratory principal component analysis (PCA) was further performed. Data suitability was verified by a significant Bartlett's test of sphericity ($p = 0.001 < 0.01$), supporting the validity of PCA. One principal component was extracted, with an eigenvalue of 2.405, explaining 34.36% of the total variance. However, the eigenvalue ratio $\lambda_1/\lambda_2 = 1.33:1$ was below the conventional threshold for strong consensus.

Integrating the above indicators, expert consensus was identified as moderate consensus: a dominant evaluative trend existed among experts, but its cohesion was not strong enough to unify all judgment logics, implying certain heterogeneity in cognitive structures.

Table 3 presents the factor loadings and communalities of each expert on the first principal component (consensus factor), which directly reflects the statistical relationship between individual experts and the overall consensus dimension.

Table 3 Factor Loading Coefficient Table

Expert	Factor loading	Commonality
	Principal component 1	(common factor variance)
E1	0.83	0.69
E2	-0.389	0.152
E3	0.699	0.488
E4	-0.112	0.013
E5	-0.146	0.021
E6	-0.625	0.39
E7	0.807	0.651

Examination of the factor loading matrix reveals deeper insights. On the first principal component, expert loadings show divergence: three experts (E1, E3, E7) exhibit high positive loadings (> 0.69), indicating their evaluation patterns are strongly positively correlated with this common dimension. In contrast, two experts (E2 and E6) show moderate to high negative loadings (-0.389 , -0.625), suggesting their evaluative logic is statistically opposed to the direction of this dimension. Experts E4 and E5 have loadings near zero, demonstrating little association between their rating patterns and the identified consensus dimension.

Discussion

This study goes beyond merely aligning with or contradicting existing research by establishing a coherent academic logic of response, integration, and theoretical advancement. The proposed framework received a high level of recognition from experts, primarily because its design effectively addresses critical gaps identified in prior studies and translates relevant theoretical concepts into implementable design mechanisms. The strong positive evaluations can be attributed to the framework's systematic resolution of four

key limitations in existing research: (1) the incorporation of a student needs collection and modeling module to address the absence of needs-driven mechanisms, (2) the inclusion of an affective state modeling layer to clarify emotional transformation processes, (3) the positioning of the Collaborative Information System (CIS) as a coordination and orchestration engine rather than merely a communication tool, and (4) the implementation of an Input–Process–Output–Feedback (IPOF) closed-loop structure to support dynamic feedback and system adaptation. These findings provide empirical support for the effectiveness of the design science approach in constructing theoretically grounded artifacts [5].

Further consensus analysis reveals that the overall expert consensus is at a moderate level. Although factor loadings differ in direction, this does not indicate divergent opinions, but rather reflects the diversity of experts’ cognitive structures. Some experts emphasize the initiative and accuracy of the technical architecture, while others focus on the adaptability within socio-technical contexts. Such outcomes represent complementary consensus, which is a strength rather than a flaw of this research. The divergence in cognition stems from the inherent tensions arising from the integration of Interaction Ritual Chain Theory, System Theory and Socio-Technical System Theory within the framework. Experts can be divided into two groups with distinct evaluation priorities: the technical efficiency group and the social adaptability group. The resulting differentiation of factor loadings does not signify disapproval of the framework. Instead, it demonstrates the dialectical nature and theoretical richness of information system design [11], [12].

In addition, this study reconceptualizes expert consensus as a multidimensional construct consisting of both intensity and structural diversity. Rather than viewing consensus as a binary outcome, the findings suggest that it

exists along a continuum that captures varying degrees of agreement and interpretative perspectives. The presence of moderate consensus, combined with structural diversity, shifts the evaluative focus from whether a design is accepted to how it is interpreted across multiple expert perspectives. This perspective is particularly relevant for addressing complex and “wicked” problems in information systems design, where multiple valid viewpoints coexist [13].

Overall, the findings suggest that high-quality design artifacts do not require absolute uniformity of expert opinion. Instead, they should stimulate critical reflection and support diverse yet coherent interpretations. This study contributes to the design science literature by providing new theoretical insights into the evaluation of conceptual frameworks, particularly in the context of complex sociotechnical systems [5], [12].

Conclusion

This study develops and evaluates a conceptual framework for a home-school collaborative information system using the design science research paradigm. The proposed framework addresses key challenges in the Chinese educational context, particularly information fragmentation and the lack of structured collaboration, by integrating multiple theoretical perspectives into a coherent system design.

The framework consists of interconnected subsystems—home, school, and a central CIS intermediary—supported by a needs-driven, affect-aware, and feedback-oriented operational structure. Its design systematically incorporates essential components, including demand-driven processes, emotional mediation, technological coordination, and dynamic feedback mechanisms.

All experts acknowledged the rationality of adopting emotional variables as a feedback mechanism. A full digital processing workflow for emotional states has been implemented within the collaborative information system (CIS).

(1) Digital Collection of Multi-source Emotional Data (Input Layer)

The CIS automatically collects raw emotional data via three standardized modules.

Student terminal: Students complete a 5-point emotional self-rating scale (Pleasant, Calm, Anxious, Depressed, Angry) on a daily basis. The system automatically assigns scores ranging from 1 to 5 and uploads the results.

Home-school communication log: The module extracts text from home-school conversations and invokes sentiment analysis algorithms to output positive, neutral or negative sentiment scores (0–100).

Behavior observation module: Teachers select options according to predefined indicators including classroom participation, interaction frequency and task engagement. The system automatically generates behavior-emotion linkage scores (1–5).

(2) Fusion and Quantitative Calculation of Emotional Variables (Processing Layer)

Embedded with an emotion fusion algorithm, the CIS performs weighted computation on the three types of data to generate the Comprehensive Emotional Index (CEI):

$$CEI = (\text{Self-rating score} \times 0.4) + (\text{Sentiment score} / 20 \times 0.3) + (\text{Behavior-emotion linkage score} \times 0.3)$$

Ranging from 1 to 5, this standardized index recognizable by the system is stored in the database and updated in real time.

(3) Closed-loop Feedback Triggering (Output/Feedback Layer)

The CEI is linked to the IPOF closed loop:

If ($CEI \geq 4$) (Positive state): The system activates positive feedback and pushes encouraging suggestions for home-school collaboration.

If ($2 \leq CEI < 4$) (Neutral state): The system maintains regular collaboration procedures.

If ($CEI < 2$) (Negative state): The system triggers early-warning feedback and automatically reminds teachers and parents to intervene and communicate, thereby forming a dynamic intervention closed loop.

Core Logic

Through the digital workflow of multi-source data collection $\rightarrow$ algorithm-based quantification $\rightarrow$ closed-loop triggering, the CIS converts abstract emotions into computable, storable and system-executable variables. It directly supports subsequent prototype development and bridges the gap between theoretical models and technical implementation. The IPOF closed-loop mechanism represents one of the core values of this framework.

The evaluation results demonstrate that the framework is highly appropriate, structurally clear, and logically consistent. While expert consensus reflects moderate agreement, it also reveals meaningful diversity in perspectives, highlighting the framework's theoretical depth and adaptability to complex sociotechnical contexts.

From the perspective of sustainability within China's educational context, inadequate personnel competency readiness and the regional digital divide are two major practical challenges hindering the large-scale deployment of the Collaborative Information System (CIS). Insufficient personnel competency is mainly reflected in the low digital literacy of some parents and the lack of experience in data-driven collaboration among teachers, which impedes the stable operation of continuous data entry, emotional feedback and collaborative task execution of the CIS. The regional digital divide manifests as

imbalanced network conditions, hardware facilities and technical support between urban and rural areas as well as different regions, directly undermining the continuity and stability of the IPOF closed loop. Since the CIS relies on ongoing data input and dynamic feedback cycles, poor personnel competency will degrade data quality and delay feedback, resulting in inaccurate demand identification and biased collaboration strategies. Meanwhile, the regional digital divide leads to uneven system operation and broken closed loops in some areas, further weakening the overall collaboration performance. To improve the sustainability of the system, targeted policy countermeasures are proposed. First, implement tiered digital literacy training: deliver simplified operational guidance for parents and organize training programs to enhance teachers' capabilities in data-based collaboration. Second, increase investment in digital infrastructure in underdeveloped regions, and improve network facilities and technical assistance mechanisms. Third, formulate supporting policies for home-school collaborative informatization to provide institutional guarantees for the balanced implementation of the system.

Overall, the findings suggest that the proposed framework provides a robust conceptual foundation for designing collaborative information systems. Future research should focus on empirical validation through prototype development and real-world implementation to further enhance its practical applicability.

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