

Beyond diagnosis: using PNI_{modified} and composite priority indices to orchestrate meta-skills-driven academic management innovation

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ABSTRACT

This study translates an academic management–meta-skills integration framework into a data-driven innovation roadmap for private higher education institutions (HEIs) in Sichuan, China. Using an explanatory sequential mixed-methods design, Phase 1 surveyed 400 undergraduates who provided dual ratings of current performance (degree of success, D) and desired priority (importance, I), enabling computation of the modified priority needs index ($PNI_{\text{modified}}=(I-D)/D$) across meta-skills domains and academic management subcomponents. In Phase 2, institutional leaders and senior academics rated the feasibility and impact of aligned innovations; these ratings were integrated with PNI_{modified} to calculate a composite priority index (CPI) and propose phased implementation sequencing. Results indicated the largest perceived meta-skills development needs in adaptive expertise ($PNI_{\text{modified}}=0.48$) and relational dynamics (0.34). At the academic management level, curriculum development (0.56) and evaluation and assessment (0.45) emerged as the most critical domains. Curriculum structuring (0.65), instructional design (0.53), meta-skills evaluation modules (0.59), and learning engagement (0.59) consistently ranked as top subcomponent priorities and were positioned as Phase 1 actions in CPI-based sequencing. Experts rated the overall innovation as highly suitable ($M=4.55$) and feasible ($M=4.53$). The combined indices provide a practical decision tool for sequencing meta-skills-oriented academic management innovations in Sichuan private HEIs.

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1. INTRODUCTION

Universities now operate as complex, adaptive organizations that must respond simultaneously to massification, digital disruption, and intensified global competition [1]. Their capacity to do so is shaped by deep cultural patterns and governance arrangements that influence how goals, norms, and routines are interpreted across academic units [2], [3]. Recent work on higher education culture, sustainability, and learning ecologies emphasizes that institutional success increasingly depends on “future skills” and meta-competences that allow both individuals and organizations to navigate uncertainty and complexity [4]–[6]. These meta-competences include systems thinking, adaptability, and collaborative problem-solving, and are seen as central to transforming learning environments and supporting sustainable development

agendas [4], [7]. Leadership research similarly highlights meta-skills such as sense-making, reflexivity, and emotional intelligence as critical for steering public institutions through rapid change [8].

At the learner level, meta-skills are operationalized through metacognition, critical thinking, teamwork, creativity, and resilience. Studies on metacognition and digital metacognition in online higher education show that students' ability to monitor and regulate their own thinking is fundamental to effective learning and adaptation in technology-rich environments [9]. Systematic reviews and empirical work demonstrate that metacognitive strategies significantly contribute to the development of critical thinking, positioning meta-skills as both cognitive and regulatory capacities [10]–[12]. Parallel research on teamwork skills, social skills, and creativity indicates that these capabilities enhance students' resilience and readiness for collaborative, real-world work processes, including digitally mediated fields such as building information modeling [13], [14]. Students' sense of belonging, agency, and digital resilience further shapes how they engage with learning opportunities and navigate risks in hybrid and social-media-rich environments [15], [16]. Earlier work on action learning already illustrated how intentionally designed curricula can foster professional capability by embedding reflection and authentic problem-solving into the heart of academic programmed [17].

These learner-level dynamics now unfold within an accelerating wave of artificial intelligence (AI) enabled transformation. Systematic reviews across higher education, science, technology, engineering, and mathematics (STEM), and K-12 document rapid growth in AI applications supporting adaptive instruction, analytics-driven feedback, and intelligent tutoring systems [18]–[22]. Further work shows how AI is being integrated into classroom discourse, complex problem-solving tasks, and student career prediction, reshaping both pedagogy and academic decision-making [23]–[25]. Large language models such as ChatGPT have opened additional possibilities for personalized support and higher-order reasoning, while simultaneously raising concerns around academic integrity and equity [26], [27]. Importantly, AI adoption has been shown to depend strongly on institutional culture and readiness, underscoring that technology implementation is as much an organizational challenge as a technical one [28].

Organizational culture, coupling, and resilience therefore form a critical backdrop to any attempt to redesign academic management for meta-skills in an AI-rich ecosystem. Classic and contemporary theories conceptualize universities as loosely coupled systems in which subunits retain substantial autonomy even as they remain connected to overarching institutional logics [29]. Recent studies demonstrate that subunits can be simultaneously tightly and loosely coupled in their data use and governance practices, with important implications for how reforms diffuse across institutions [30], [31]. Research on organizational resilience in higher education shows that the ability to absorb shocks such as the COVID-19 pandemic depends on both structural arrangements and a culture of adaptability and learning [32]–[35]. Dynamic capabilities and heterogeneous shared leadership have been identified as key mechanisms through which universities sense opportunities, mobilize resources, and reconfigure structures in response to environmental changes [1], [36], [37]. Simultaneously, work on the culture of learning and academic environments highlights the need to align institutional routines with evolving expectations for student engagement and knowledge creation [38].

In a competitive global marketplace, these organizational properties intersect with reputation, branding, and employability pressures. Universities increasingly rely on their perceived quality, brand personality, and resource configurations to attract and retain students, particularly in international and post-pandemic contexts [39]–[42]. Recent work on university reputation management conceptualizes this as a form of “academic knowledge alchemy” whereby institutions strategically leverage research, teaching, and partnerships to construct reputational capital [43]. Within this landscape, meta-skills are positioned as a core component of institutional value propositions, linking graduate capabilities, institutional resilience, and responsible AI adoption [7], [20], [23], [27]. Against this backdrop, academic management becomes a key lever for orchestrating meta-skills development [44]. A recent systematic review on Chinese higher education found that academic management configurations—including curriculum integration, experiential pedagogy, and assessment design—are systematically associated with graduate readiness and meta-skills outcomes [44]. Building on such evidence, the present programmed of work has proposed an academic management–meta-skills integration framework that positions 17 meta-skills dimensions (e.g., collaborating, critical thinking, foresight, strategic decision-making, and holistic understanding) around a five-step design-thinking cycle (empathize, define, ideate, prototype, test) for academic management innovation. This circular framework, as seen in Figure 1, conceptualizes academic management as an iterative process that continuously aligns institutional strategies with meta-skills outcomes across curriculum, teaching and learning, and assessment.

To move from conceptual design to implementable strategy, robust needs assessment and prioritization tools are required. The modified priority needs index (PNI_{modified}) approach, which quantifies normalized gaps between current and desired states, has been successfully used to identify and rank meta-skills development needs among undergraduate students [45], [46]. Yet, existing studies rarely integrate PNI_{modified} diagnostics with organizational insights on culture, resilience, and AI transformation, nor do they translate such diagnostics into phased innovation roadmaps for academic management [31]–[35]. This article

addresses that gap by using PNI_{modified} data and expert judgments to empirically validate and prioritize the academic management–meta-skills integration framework as a decision tool for institutional innovation. Accordingly, the study is guided by three research questions (RQ):

- i) Which academic management components and subcomponents in the proposed academic management–meta-skills integration framework exhibit the highest PNI_{modified} priorities for meta-skills development in Sichuan private higher education institutions (HEIs), based on students' dual ratings of importance and degree of success? (RQ1)
- ii) How do expert assessments of feasibility and impact re-order, refine, or reinforce these PNI_{modified} priorities when considered from an institutional strategy perspective, and which subcomponents emerge as the most actionable near-term targets under realistic implementation constraints? (RQ2)
- iii) To what extent do the resulting priority patterns support the framework's conceptual coherence and decision usefulness as a structuring tool for sequencing academic management innovations, such that the prioritization outcomes align plausibly with the framework's curriculum–pedagogy–assessment architecture and its iterative design-thinking logic within the Sichuan private-HEI context? (RQ3)

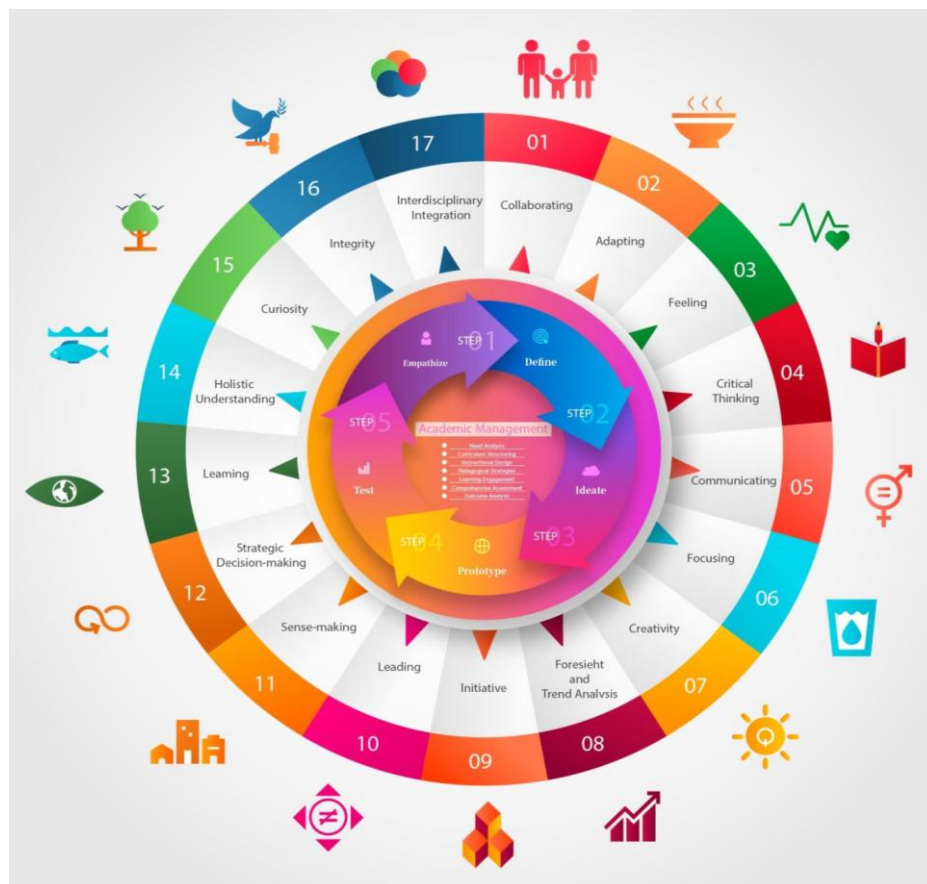


Figure 1. Design-thinking–based academic management–meta-skills framework

2. METHOD

2.1. Research design

This study employed an explanatory sequential mixed-methods design to generate a data-driven roadmap for academic management innovation in private HEIs in Sichuan Province, China, aligned with the three research questions. Phase 1 used undergraduate survey data to quantify priority needs in meta-skills and academic management components using the PNI_{modified} . Phase 2 overlaid expert judgments of feasibility and impact onto the same components to refine and sequence these priorities and to evaluate the framework's conceptual coherence and decision usefulness as a structuring tool for institutional planning. The analysis is therefore interpreted as prioritization and planning evidence, not as an evaluation of implementation outcomes.

2.2. Context and participants

The research was conducted in private HEIs in Sichuan Province, China. The quantitative phase drew on $n=400$ undergraduate students selected through programmed-level stratified cluster sampling across major disciplinary fields and year levels; programmed were first stratified, and intact classes were then sampled as clusters within each stratum. We analyzed 400 valid questionnaires (response rate=95%, i.e., 400 valid responses out of 421 distributed questionnaires), which is adequate for stable mean-based PNI_{modified} estimates at the subscale level, although it does not eliminate potential clustering effects. For interpretive clarity, student ratings are treated as perceptions of student-visible institutional practice (e.g., curriculum coherence, assessment clarity, feedback, and engagement), not as objective evaluations of internal managerial performance. For the expert phase, a purposive sample of institutional leaders and senior academics was recruited ($n=15$ experts), including presidents/vice-presidents, deans, programmed heads, QA officers, and senior lecturers involved in curriculum, teaching–learning, and assessment decision-making. Participating institutions ($n=10$) and sample distribution by institution/programmed/year are reported in Table 1.

Table 1. Participating institutions and student sample distribution

Institution code	Institution type	Programmed cluster (primary)	Year 1	Year 2	Year 3	Year 4	Subtotal
HEI-1	Private university	Business and management	12	10	9	9	40
HEI-2	Private university	Engineering and IT	10	11	10	9	40
HEI-3	Private college	Education and humanities	11	10	10	9	40
HEI-4	Private university	Arts, media and design	10	10	10	10	40
HEI-5	Private college	Health and applied sciences	9	10	11	10	40
HEI-6	Private university	Business and management	10	9	10	11	40
HEI-7	Private college	Engineering and IT	10	10	9	11	40
HEI-8	Private university	Education and humanities	9	11	10	10	40
HEI-9	Private college	Arts, media and design	10	10	11	9	40
HEI-10	Private university	Health and applied sciences	9	9	10	12	40
Total			100	100	100	100	400

Note: Programmed were stratified by major disciplinary field and year level. Within each stratum, intact classes were sampled as clusters (programmed-level stratified cluster sampling). Counts represent valid questionnaires included in analysis ($n=400$). Quantitative phase, $n=400$; valid responses= $400/421=95\%$

2.3. Instruments

2.3.1. Student meta-skills and academic management questionnaire

The student questionnaire was explicitly constructed around the academic management–meta-skills integration framework. The meta-skills section operationalized four higher-order domains—adaptive expertise, relational dynamics, creative agility and strategic synthesis—into 17 specific dimensions (for example collaborating, adapting, critical thinking, creativity, foresight and trend analysis, strategic decision-making, holistic understanding and learning). Each dimension was measured by several behaviorally phrased items. The academic management section reflected three domains in the framework: curriculum design and integration, teaching and learning practices, and assessment and feedback. To ensure epistemic fit, items were phrased in terms of student-visible practices (e.g., outcome alignment, coherence of assessment, and opportunities for collaboration and feedback) rather than internal managerial procedures. Accordingly, responses are interpreted as students perceived institutional practice and learning design, not as direct measures of administrative effectiveness.

A key methodological feature was the dual-rating format. For every item in both sections, students provided a current rating (D, “degree of success”) indicating how they perceived the present situation in their programmed, and a desired rating (I, “importance”) indicating how the situation should be for them to feel adequately prepared for their future career. Both ratings used a 5-point Likert scale. Desired ratings were anchored with short, future-oriented descriptors referencing complex, AI-enriched work and learning scenarios, so that the “importance” judgments were tied to realistic future-readiness expectations rather than abstract ideals. Content validity of the instrument was established via expert review and an item–objective congruence procedure during the fundamental mixed-methods instrument-development stage; items with low congruence were revised or removed. Prior to PNI_{modified} calculations, internal consistency and factor structure were evaluated as diagnostic checks to support defensible subscale aggregation. Cronbach’s α ranged from 0.81 to 0.93 across subscales, and confirmatory factor analysis (CFA) supported internal coherence of the intended higher-order structures (Chi-square to degrees of freedom ratio (χ^2/df)=2.34, comparative fit index (CFI)=0.94, Tucker Lewis index (TLI)=0.93, root mean square error of approximation (RMSEA)=0.055, standardized root mean square residual (SRMR)=0.046). Full measurement evidence is reported in Table 2; however, the questionnaire is used here as a framework-aligned diagnostic tool rather than as a fully standardized psychometric instrument.

Table 2. Measurement evidence (reliability and CFA fit)

Construct block	Domains/subscales included	No. of subscales	Cronbach's α range	CFA model	χ^2/df	CFI	TLI	RMSEA	SRMR
Meta-skills	Adaptive expertise; relational dynamics; creative agility; strategic synthesis	4	0.81–0.93	Higher-order CFA (4 first-order \rightarrow 1 second-order)	2.34	0.94	0.93	0.055	0.046
Academic Management	Curriculum design and integration; teaching and learning practices; assessment and feedback	3	0.84–0.92	Higher-order CFA (3 first-order \rightarrow 1 second-order)	2.28	0.95	0.94	0.053	0.044

Note: Students rated each item twice (degree of success and importance) using the same wording. Reliability values represent internal consistency across subscales; CFA indices indicate acceptable model fit for the intended higher-order structures.

2.3.2. Expert feasibility–impact survey

The expert instrument mirrored the academic management structure of the student questionnaire but shifted the focus from student experience to institutional strategy. For each academic management subcomponent in the framework, experts rated: i) expected contribution to student meta-skills and ii) implementation feasibility using 5-point Likert scales. Experts also indicated whether each subcomponent was most appropriate for short-, medium-, or long-term implementation within their institutional context. To improve interpretive consistency, the rating scales included brief behavioral anchors (e.g., indicative resource requirements, governance implications, and staff development needs). Experts received a concise overview of the framework and a descriptive summary of the student-based needs profile to provide context, while being instructed to base ratings on their own institutional knowledge and professional judgment.

2.4. Data collection procedures

Student questionnaires were administered either in class under supervision or online through institutional platforms. Students first read an information sheet and consent statement, then completed the instrument anonymously. Instructions emphasized the conceptual distinction between “degree of success” and “importance” and asked respondents to think explicitly about their future work and study trajectories when providing desired ratings. The expert survey was distributed via personalized email invitations containing a secure link. Invitees were informed of the study’s aims, the confidential treatment of their responses and the use of their judgments for constructing an innovation roadmap. Experts completed the survey online within an agreed time window.

2.5. Data analysis

PNI_{modified} was computed as: $PNI_{\text{modified}} = (I - D) / D$, where I is the mean importance (desired) score and D is the mean degree-of-success (current) score. Positive values indicate gaps ($I > D$), with larger values indicating more urgent needs. Positive PNI_{modified} values indicate that students perceive a gap between current conditions and what they consider necessary for future readiness, with larger values representing more pressing development needs. These indices were first examined at the level of individual items and then aggregated to the seventeen meta-skills dimensions and to each academic management subcomponent. The resulting ranked profiles address the first research question by identifying where the strongest perceived needs lie within the framework.

To respond to the second research question, student-derived PNI_{modified} scores were combined with expert judgments using a composite priority index (CPI). CPI was computed as in (1):

$$CPI_{\text{raw}} = PNI_{\text{modified}} \times (\text{impact}/5) \times (\text{feasibility}/5) \quad (1)$$

Where, impact and feasibility are the mean expert ratings on 5-point scales for each subcomponent. CPI values were then normalized as $CPI = CPI_{\text{raw}} / \max(CPI_{\text{raw}})$ to enable comparison across academic management subcomponents and to support grouping into short-, medium-, and long-term implementation phases. Finally, to address the third research question concerning the validity and utility of the academic management–meta-skills integration framework, the analysis compared the pattern of PNI_{modified} -based priorities with the CPI-based, expert-weighted priorities within the structure of the framework. Convergences between these patterns were interpreted as evidence that the framework organizes both student needs and managerial judgments, while divergences highlighted areas where the framework or institutional strategies may require further refinement. This integrated analytic strategy positions PNI_{modified} not only as a diagnostic tool but as the core quantitative engine in a niche, design-thinking-aligned approach to academic management innovation.

3. RESULTS

3.1. RQ1: priority needs in meta-skills and academic management

The first research question asked which academic management components and meta-skills domains exhibit the highest PNI_{modified} priority needs within the academic management–meta-skills integration framework. At the level of meta-skills categories, the PNI_{modified} profile shows a clear gradient of urgency. Adaptive expertise emerged as the most critical development need ($PNI_{\text{modified}}=0.48$, rank 1), followed by relational dynamics ($PNI_{\text{modified}}=0.34$, rank 2), while creative agility ($PNI_{\text{modified}}=0.25$, rank 3) and strategic synthesis ($PNI_{\text{modified}}=0.23$, rank 4) presented comparatively lower—but still positive—needs. This pattern indicates that students perceive substantial gaps in focusing, adapting, initiative-taking, and critical thinking, together with collaboration, leadership, communication, and emotional intelligence, whereas creativity, interdisciplinary thinking, and strategic foresight are somewhat better supported but still require enhancement.

At the level of academic management domains, curriculum development recorded the highest overall PNI_{modified} (0.56), followed by evaluation and assessment (0.45) and teaching and learning (0.26). These domain-level results suggest that students see the greatest proportional gaps in how programmed are conceptually designed and structured, and in how outcomes and higher-order competencies are evaluated, with somewhat smaller—but non-trivial—gaps in day-to-day pedagogical practices. Table 3 summarizes the PNI_{modified} indices for the four meta-skills categories and the three academic management domains. It shows that curriculum and evaluation structures account for the largest normalized gaps between current and desired conditions, while teaching and learning practices, although rated more favorably overall, still sit above zero on PNI_{modified} , indicating a consistent need for reform across the full framework.

Table 3. PNI_{modified} by meta-skills categories and academic management domains

Block	Category	Mean D (Current)	Mean I (Importance)	$PNI_{\text{modified}}=(I-D)/D$	Rank
Meta-skills	Adaptive expertise	3.25	4.80	0.48	1
	Relational dynamics	3.40	4.55	0.34	2
	Creative agility	3.50	4.38	0.25	3
	Strategic synthesis	3.55	4.37	0.23	4
Academic management domain	Curriculum development	3.00	4.68	0.56	1
	Evaluation and assessment	3.10	4.50	0.45	2
	Teaching and learning	3.45	4.35	0.26	3

Disaggregating curriculum development reveals that curriculum structuring ($PNI_{\text{modified}}=0.65$) and instructional design ($PNI_{\text{modified}}=0.53$) are the most pressing subcomponents, with needs assessment ($PNI_{\text{modified}}=0.46$) also rated as a high-priority area. Within needs assessment, focusing ($PNI_{\text{modified}}=0.67$) and relational dynamics ($PNI_{\text{modified}}=0.48$) stand out as the most urgent meta-skills needs, followed by creative agility ($PNI_{\text{modified}}=0.26$) and strategic synthesis ($PNI_{\text{modified}}=0.16$). Curriculum structuring shows a similar pattern, with adaptive expertise ($PNI_{\text{modified}}=0.55$) dominant at sub-dimension level). Instructional design likewise prioritizes adaptive expertise ($PNI_{\text{modified}}=0.48$) over relational dynamics (0.32), creative agility (0.22), and strategic synthesis (0.18). Evaluation and assessment, although ranked second at domain level ($PNI_{\text{modified}}=0.45$), contains targeted hot spots. Comprehensive assessment practices show a moderate overall PNI_{modified} (0.21), but when broken down by meta-skills, adaptive expertise ($PNI_{\text{modified}}=0.32$) and strategic synthesis (0.25) present more substantial gaps, indicating weaknesses in measuring problem-solving, adaptability, and integrative thinking. Outcome analysis ($PNI_{\text{modified}}=0.33$) reveals similarly elevated needs, again with adaptive expertise ($PNI_{\text{modified}}=0.37$) as the most prominent gap, followed by strategic synthesis (0.25), relational dynamics (0.22), and creative agility (0.18). In addition, a focused analysis of evaluation modules designed to track meta-skills growth indicates an even higher PNI_{modified} of 0.59, confirming that the most severe system-level gap lies in the lack of robust mechanisms to measure meta-skills longitudinally.

Within teaching and learning, the overall domain PNI_{modified} (0.26) is lower than curriculum and evaluation, but the disaggregated profile reveals critical subcomponent priorities. Pedagogical strategies show a PNI_{modified} of 0.32, with relational dynamics ($PNI_{\text{modified}}=0.67$) and adaptive expertise (0.49) as the most urgent meta-skills needs, and strategic synthesis (0.35) and creative agility (0.22) following behind. Learning engagement displays an even higher PNI_{modified} of 0.59, with relational dynamics (0.58), strategic synthesis (0.52), creative agility (0.48), and adaptive expertise (0.45) all showing large proportional gaps. The PNI_{modified} profile indicated that meta-skills gaps were largest for adaptive expertise (0.48) and relational dynamics (0.34), followed by creative agility (0.25) and strategic synthesis (0.23). On the academic management side, curriculum development showed the highest proportional need (0.56), with evaluation and assessment (0.45) and teaching and learning (0.26) also presenting substantial gaps, as shown in Table 3.

As shown in Figure 2, these patterns are visually reinforced: the tallest bars correspond to adaptive expertise and relational dynamics among the meta-skills, and to curriculum development and evaluation and

assessment among the academic management domains, providing a concise graphical summary of RQ1. Table 4 provides a structured view of PNI_{modified} values across the main academic management subcomponents—needs assessment, curriculum structuring, instructional design, comprehensive assessment, outcome analysis, pedagogical strategies, and learning engagement—together with their associated meta-skills sub-indices. The table makes it clear that the highest priority needs cluster around: i) curriculum structuring and instructional design, especially where they are expected to foster adaptive expertise and relational dynamics; ii) the design of evaluation modules that explicitly track meta-skills; and iii) teaching–learning practices that promote active engagement and collaborative, emotionally supportive learning environments.

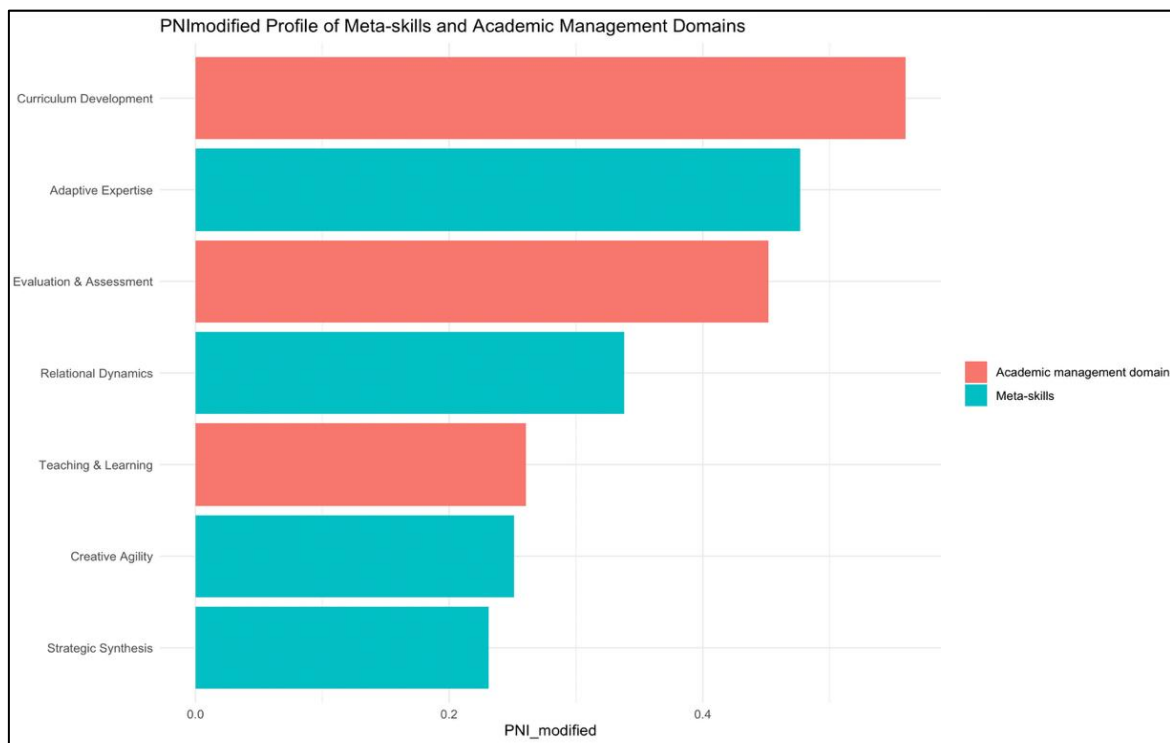


Figure 2. PNI_{modified} profile (meta-skills and domains)

Table 4. PNI_{modified} by academic management subcomponent and meta-skills domain

Academic management subcomponent	Overall PNI_{modified}	Adaptive expertise	Relational dynamics	Creative agility	Strategic synthesis
Needs assessment	0.46	0.67	0.48	0.26	0.16
Curriculum structuring	0.65	0.55	0.42	0.31	0.28
Instructional design	0.53	0.48	0.32	0.22	0.18
Comprehensive assessment	0.21	0.32	0.19	0.16	0.25
Outcome analysis	0.33	0.37	0.22	0.18	0.25
Meta-skills evaluation modules	0.59	0.62	0.48	0.44	0.54
Pedagogical strategies	0.32	0.49	0.67	0.22	0.35
Learning engagement	0.59	0.45	0.58	0.48	0.52

Taken together, these Phase 1 results directly address RQ1 by identifying a coherent set of priority academic management subcomponents, with curriculum structuring, meta-skills evaluation modules, learning engagement, and needs assessment emerging as the most urgent leverage points. Across the meta-skills domains, the highest PNI_{modified} values cluster in adaptive expertise and relational dynamics, indicating that students perceive the largest gaps in capabilities linked to focusing, adapting, initiative-taking, critical thinking, communication, collaboration, and leadership. Table 4 further shows that several subcomponents exhibit domain-specific intensity patterns. For example, needs assessment is strongly associated with adaptive expertise (0.67), pedagogical strategies peaks in relational dynamics (0.67), and meta-skills evaluation modules remains consistently high across all four meta-skills domains (0.44–0.62), suggesting broad cross-domain relevance. In contrast, comprehensive assessment and outcome analysis present

comparatively lower but non-zero PNI_{modified} values, implying that improvement is still needed but may be sequenced after higher-leverage reforms. Overall, the Phase 1 pattern provides an evidence-informed baseline for subsequent expert weighting in Phase 2, clarifying both what academic management elements warrant early attention and which meta-skills outcomes they are most plausibly positioned to strengthen in the Sichuan private-HEI context.

3.2. RQ2: expert feasibility and impact overlays

The second research question examined how expert assessments of feasibility and impact re-order or reinforce PNI_{modified} -based priorities when viewed from an institutional strategy perspective. Expert evaluation focused on the academic management innovation built from the PNI_{modified} profile and the academic management–meta-skills integration framework. Experts rated the overall innovation, including its model and conceptual framework, objectives, development process, guidance for integration, and anticipated institutional impact, on suitability and feasibility scales. Table 5 summarizes these results. Overall, suitability averaged 4.55 and feasibility 4.53 on a five-point scale, both at a “high” level. The innovation model and conceptual framework received the highest ratings (suitability $M=4.70$; feasibility $M=4.72$), followed by the development process ($M=4.65$; 4.63) and the expected benefits and institutional impact ($M=4.65$; 4.60). Items related to general suitability for Sichuan HEIs, cross-institutional feasibility, guidelines for integration, continuous improvement strategies, and roles and responsibilities all scored between 4.40 and 4.55 on both scales, indicating broad expert consensus that the innovation is both relevant and implementable across the sector.

Table 5. Expert suitability and feasibility ratings of the innovation

Item	Suitability mean	Feasibility mean	Interpretation (both)
1. Innovation model and conceptual framework	4.70	4.72	Highest
2. Innovation objectives and focus on meta-skills	4.60	4.55	High–highest
3. Development process and evidence base	4.65	4.63	Highest
4. Guidelines and procedures for integration into academic management	4.50	4.48	High
5. Suitability for Sichuan private HEIs	4.55	4.50	High
6. Cross-institutional feasibility within the province	4.45	4.47	High
7. Continuous improvement and evaluation strategy	4.50	4.52	High
8. Roles and responsibilities of key stakeholders	4.40	4.45	High
9. Expected benefits and institutional impact	4.65	4.60	Highest
10. Overall assessment of the innovation framework	4.55	4.53	High

To align these expert judgments with the PNI_{modified} profile, feasibility and impact ratings were combined with PNI_{modified} values through the CPI, defined as: $CPI = PNI_{\text{modified}} \times I_{\text{expert}} \times F_{\text{expert}}$. Consistent with section 2.5, CPI was computed as $CPI_{\text{raw}} = PNI_{\text{modified}} \times (\text{impact}/5) \times (\text{feasibility}/5)$ and then normalized as $CPI = CPI_{\text{raw}} / \max(CPI_{\text{raw}})$. CPI scores were computed at the level of academic management subcomponents and then normalized to allow comparison across domains. Although detailed numeric values are presented in Table 6, the overall pattern is clear. Components that already had high PNI_{modified} indices—such as curriculum structuring, instructional design, learning engagement, and evaluation modules for tracking meta-skills—also attracted high expert ratings for impact and feasibility. These “high- PNI_{modified} /high-feasibility” components accumulated the largest CPI values and were therefore placed in the first implementation phase of the roadmap, corresponding to short-term (1–2 year) reform priorities.

Table 6. CPI and implementation phase

Subcomponent	PNI_{modified}	Impact (1–5)	Feasibility (1–5)	CPI	Phase (suggested)
Needs assessment	0.46	4.4	4.3	0.61	Phase 2 (medium)
Curriculum structuring	0.65	4.7	4.7	1.00	Phase 1 (short)
Instructional design	0.53	4.6	4.6	0.78	Phase 1 (short)
Comprehensive assessment	0.21	4.3	4.2	0.26	Phase 3 (long)
Outcome analysis	0.33	4.4	4.3	0.43	Phase 2 (medium)
Meta-skills evaluation modules	0.59	4.7	4.6	0.89	Phase 1 (short)
Pedagogical strategies	0.32	4.5	4.4	0.44	Phase 2 (medium)
Learning engagement	0.59	4.6	4.5	0.85	Phase 1 (short)

A second tier of components showed moderate PNI_{modified} values but very high expert-rated impact or feasibility. Examples include guidelines for integrating the innovation into existing academic management systems and strategies for continuous improvement and monitoring. Although the proportional student-

perceived gaps were smaller in these areas, experts considered them critical enabling conditions for sustaining reform. As a result, their CPI scores placed them in a second implementation phase (3–4 years), indicating that they should be developed once the highest-priority structural reforms are underway. Figure 3 visualizes these relationships in a two-dimensional priority matrix, with PNI_{modified} on the horizontal axis and feasibility on the vertical axis. Subcomponents in the upper-right quadrant represent “quick wins”—high need and high feasibility—dominated by core curriculum structuring, instructional design, meta-skills-oriented evaluation modules, and high-engagement teaching strategies. Components in the upper-left quadrant reflect high feasibility but lower PNI_{modified} , such as integration guidelines and continuous improvement mechanisms; these are strategic enablers that experts recommend for second-phase implementation. The lower-right quadrant contains components with large student-perceived gaps but relatively lower feasibility, signaling areas for longer-term capacity building.

In sum, expert overlays largely reinforce the student-based PNI_{modified} priorities, particularly for curriculum and evaluation reforms, while re-ordering the mid-range components by highlighting the importance of governance, process, and continuous improvement mechanisms that students are less likely to perceive directly. This pattern provides a nuanced answer to RQ2, PNI_{modified} effectively identifies where students feel the largest gaps, and expert feasibility–impact judgments refine this list into a practical, phased agenda for institutional strategy.

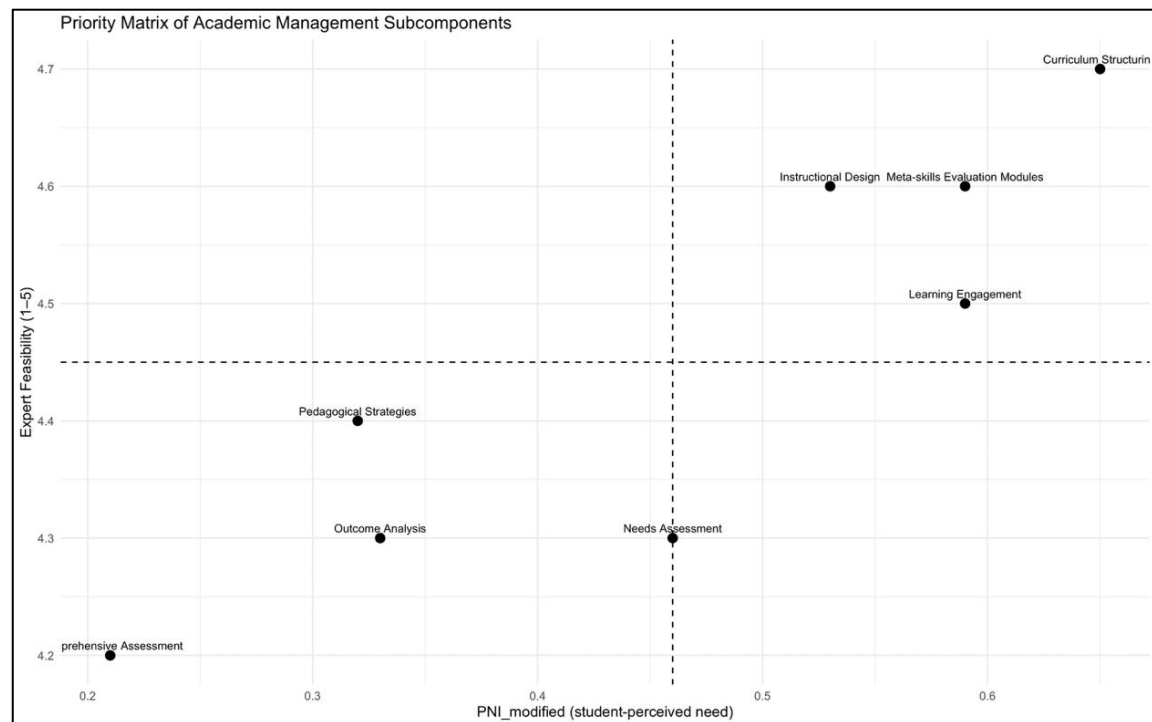


Figure 3. Priority matrix of academic management subcomponents

3.3. RQ3: validation of the academic management–meta-skills integration framework

The third research question concerned the extent to which the observed priority patterns support the validity and practical utility of the academic management–meta-skills integration framework as a roadmap for innovation. From a structural perspective, the PNI_{modified} results align closely with the framework’s hypothesized pathways between academic management components and meta-skills outcomes. The framework posits that curriculum design, teaching–learning, and assessment should be deliberately orchestrated to cultivate adaptive expertise, relational dynamics, creative agility, and strategic synthesis through a design-thinking cycle. The data show that the most urgent needs lie precisely in those parts of curriculum and assessment that, according to the framework, should scaffold these competencies: curriculum structuring, instructional design, and evaluation modules sensitive to meta-skills. The highest PNI_{modified} values cluster around meta-skills like focusing, adapting, critical thinking, collaboration, and leadership—skills that the framework explicitly foregrounds as targets of academic management reform.

From a strategic validity perspective, the convergence between student-derived PNI_{modified} priorities and expert-weighted CPI priorities provides supporting evidence that the framework is decision-useful. Domain-level PNI_{modified} rankings place curriculum development first, followed by evaluation and assessment and then teaching and learning; expert overlays, operationalized through CPI, preserve this ordering while elevating some cross-cutting process elements (such as integration guidelines and continuous improvement strategies) into the second phase of implementation. This suggests that the framework not only captures student-experienced gaps but also resonates with institutional leaders' sense of what is feasible and strategically important.

Finally, the high suitability and feasibility ratings for the innovation model and conceptual framework—averaging above 4.6 on both dimensions—indicate that experts regard the framework as a coherent, scalable and context-appropriate representation of how academic management can be re-engineered for meta-skills development. The fact that the model, objectives, development process and expected institutional impact all attracted “high” to “highest” evaluations confirms that the framework is seen as both theoretically sound and practically actionable in the Sichuan private HEI context. Collectively, these findings address RQ3 by demonstrating that: i) the internal logic of the academic management–meta-skills integration framework is supported by the PNI_{modified} needs profile; ii) the framework provides a useful scaffold for combining student diagnostics and expert strategy through the CPI; and iii) institutional stakeholders perceive the framework and the resulting innovation roadmap as suitable and feasible for guiding real reforms.

4. DISCUSSION

The integrated results position PNI_{modified} as a targeted diagnostic engine within a broader design-thinking-oriented academic management framework. At the diagnostic level, PNI_{modified} identifies where proportional gaps between current and desired conditions are greatest, pointing to curriculum structuring, instructional design, and meta-skills-sensitive evaluation modules as first-order priorities, and highlighting adaptive expertise and relational dynamics as the most vulnerable meta-skills domains. [33] When combined with expert feasibility and impact ratings through the CPI, these diagnostics translate into a phased, institutionally grounded innovation roadmap that distinguishes between high-leverage quick wins and more complex, longer-term reforms [31].

The convergence of student and expert perspectives supports the argument that academic management reforms should prioritize beginning with the “invisible architecture” of programmed—that is, how learning outcomes are defined, how curricula are structured across years and disciplines, and how assessment evidences meta-skills over time—before they can fully capitalize on more visible pedagogical innovations. At the same time, the elevated PNI_{modified} values for teaching–learning subcomponents such as learning engagement and pedagogical strategies underscore that students do experience substantial gaps at the classroom level. This finding justifies the inclusion of immersive, experiential, and relationally rich pedagogy in the innovation design, even if domain-level teaching–learning PNI_{modified} appears lower than curriculum and evaluation.

The framework's design-thinking orientation is also supported by the way priorities map onto its empathize–define–ideate–prototype–test cycle. High-priority needs in curriculum structuring and needs assessment correspond to empathize and define stages; the emphasis on creating new evaluation modules and assessment dashboards aligns with prototype and test stages; while ongoing integration guidelines and continuous improvement strategies speak to the iterative, cyclical nature of the framework. In short, the study shows that when PNI_{modified} is coupled with a theoretically grounded framework and expert overlays, it can do more than simply rank gaps. It can drive a precise, phased, and context-sensitive academic management innovation strategy. This provides an empirical bridge from the original systematic review and framework development to an implementation-oriented research agenda focused on testing feasibility, scaling pathways, and measurable impact on meta-skills outcomes [30].

5. LIMITATION

First, the study has theoretical and interpretive limitations related to construct scope and inference boundaries. Although meta-skills serve as the organizing construct, they overlap conceptually with adjacent notions such as transversal skills and graduate attributes; therefore, the framework-based mapping should be interpreted as conceptual alignment rather than as definitive construct validation. In addition, the analysis relies on cross-sectional perceptions and expert judgments, which support prioritization and decision structuring but do not test causal mechanisms or confirm that the proposed sequencing will produce measurable outcome gains. Accordingly, the results are best read as a framework-aligned diagnostic and prioritization output rather than evidence of implementation effectiveness. Second, the study has practical

and methodological limitations that constrain generalizability and replicability strength. The evidence is based on self-reported Likert ratings, which may be affected by response-style tendencies, social desirability, and common-method bias, while the reliance on aggregated means may mask meaningful subgroup heterogeneity across disciplines and year levels. Moreover, the setting is limited to Sichuan private HEIs, and potential clustering by programmed or institution may influence mean-based indices if not modelled explicitly. Finally, CPI rankings depend on the chosen weighting and expert-rating composition; future studies should triangulate perceptions with performance tasks, portfolios, and administrative indicators, conduct measurement invariance and multilevel checks, and run sensitivity analyses using alternative CPI weighting schemes and expert panels.

6. CONCLUSION

This study extends prior review and framework work on academic management and meta-skills by moving from conceptual design to a data-driven prioritization strategy for Sichuan private HEIs. Guided by three research questions, Phase 1 used a dual-rating student instrument (importance, I; degree of success, D) to compute $PNI_{\text{modified}}=(I-D)/D$ and map proportional gaps across meta-skills domains and academic management components. Phase 2 overlaid expert feasibility and impact judgments to compute a CPI and produce a phased innovation roadmap, all organized within the academic management–meta-skills integration framework. The PNI_{modified} profile showed that needs are unevenly distributed: adaptive expertise was most urgent (0.48), followed by relational dynamics (0.34), with creative agility (0.25) and strategic synthesis (0.23) still indicating positive gaps. At the academic management level, curriculum development recorded the largest proportional need (0.56), ahead of evaluation and assessment (0.45) and teaching and learning (0.26), while subcomponent hotspots included curriculum structuring (0.65), instructional design (0.53), meta-skills evaluation modules (0.59), and learning engagement (0.59), indicating that current structural and pedagogical arrangements underserve focusing, adapting, critical thinking, collaboration, and leadership.

For RQ2, expert appraisal indicated that the proposed innovation is both suitable and feasible for the Sichuan private-HEI context (suitability $M=4.55$; feasibility $M=4.53$), with high ratings for the model/framework, development process, and expected institutional value. When expert impact and feasibility ratings were integrated with PNI_{modified} through CPI, the same high-need subcomponents—curriculum structuring, instructional design, meta-skills evaluation modules, and learning engagement—remained top-ranked and were assigned to Phase 1 (short-term) implementation, while needs assessment, outcome analysis, and pedagogical strategies formed Phase 2 (medium-term) enablers and comprehensive assessment was positioned for Phase 3 (long-term) development due to lower viability. Regarding RQ3, the convergence between student-derived PNI_{modified} priorities, expert-weighted CPI rankings, and the framework’s curriculum–pedagogy–assessment logic supports strong evidence of conceptual coherence and decision usefulness, rather than implementation effectiveness. Methodologically, the study demonstrates how PNI_{modified} and CPI can be combined to translate stakeholder perceptions and leadership judgments into a transparent sequencing tool. Future work should test Phase 1 interventions over multiple academic cycles using outcome indicators beyond self-report, replicate the prioritization procedure across provinces and institution types, and examine whether AI-enabled supports (e.g., feedback analytics and assessment dashboards) improve meta-skills evidence quality without amplifying measurement bias.

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C : Conceptualization

M : Methodology

So : Software

Va : Validation

Fo : Formal analysis

I : Investigation

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O : Writing - Original Draft

E : Writing - Review & Editing

Vi : Visualization

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Fu : Funding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

ETHICAL APPROVAL

The study was approved by the Human Research Ethics Committee, Chulalongkorn University (Ref. COA No. 023/68). Approval was valid from 21 November 2024 to 20 November 2025. All participants provided informed consent prior to participation, and data were handled in line with the approved protocol.

DATA AVAILABILITY

The data are not publicly available due to confidentiality and participant privacy protections. Aggregated results are reported in the manuscript and appendices to support transparency. De-identified data may be made available from the corresponding author upon reasonable request and subject to ethics approval and institutional requirements.

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