

Article

Exploring PDM in Higher Education: Management Strategies, Learning Dynamics, and Adaptive Governance for Institutional Sustainability

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Abstract

Participatory decision-making (PDM) is increasingly recognized as a critical governance mechanism for enhancing institutional sustainability in higher education. However, the internal pathways through which participation contributes to organizational learning and adaptive governance remain insufficiently understood and empirically tested. Drawing on collaborative governance and organizational learning theories, this study develops a feedback-based governance framework that links PDM, learning feedback (LF), and adaptive governance capacity within universities. This study adopts a quantitative research design and employs covariance-based structural equation modeling (CB-SEM) to examine the proposed framework. The analytical strategy integrates confirmatory factor analysis, mediation analysis, moderation analysis, and multi-group comparisons to capture both internal transmission mechanisms and contextual heterogeneity. As an empirical illustration, questionnaire data were collected from 512 respondents across 32 universities in China, encompassing both research-oriented and practice-oriented institutions. The survey instruments measured respondents' perceptions of PDM, LF, adaptive governance capacity (AGC), managerial support, and digital collaboration tools using established multi-item scales. The results show that PDM enhances adaptive governance primarily through LF, indicating that participation contributes to sustainability by operating as a perceived learning mechanism rather than a one-off procedural input. Overall, the findings suggest interpreting participatory governance as a perception-based, feedback-oriented decision–learning–adaptation process, highlighting the role of learning in adaptive university governance.



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This article is an open access article distributed under the terms and conditions of the [Creative Commons Attribution \(CC BY\)](https://creativecommons.org/licenses/by/4.0/) license.**Keywords:** participatory decision-making; higher education management; learning feedback; adaptive governance

1. Introduction

Universities function as complex social organizations in which governance, learning, and decision-making processes are structurally interrelated and jointly shape institutional adaptability and performance [1]. Within these interdependent environments, the quality of decision processes—particularly the extent to which stakeholders participate in them—plays a decisive role in how universities are perceived to learn, respond, and adjust under

conditions of uncertainty and reform pressure [2]. From a participatory governance perspective, higher education management is not merely a top-down administrative function but a collective decision system, in which academic staff, administrators, and students co-create strategies through shared deliberation and mutual learning [3,4]. Such decision systems are increasingly recognized as important for supporting institutional stability, resilience, and sustained governance improvement, rather than short-term administrative efficiency. In the context of higher education, participatory governance generally refers to governance arrangements in which multiple stakeholder groups are formally or informally involved in decision-making processes related to academic, administrative, and strategic affairs [5]. Drawing on traditions of collegial governance and democratic self-management, participatory governance in universities is characterized by shared deliberation, distributed authority, and institutionalized channels for stakeholder voice, rather than unilateral managerial control [6]. Core conditions for participatory governance to occur include the existence of recognized representative bodies, transparent decision procedures, and norms that value dialogue, consultation, and collective reasoning.

Historically, universities have been regarded as organizations with a distinctive democratic and collegial character, in which academic freedom and self-governance are safeguarded through participatory institutions such as faculty boards, academic senates, departmental committees, and student representative bodies [7]. Within this institutional context, participatory decision-making (PDM) typically involves academic staff, administrators, and students as primary governance actors, while other stakeholders, such as families or external partners, may exert indirect influence through consultative or advisory mechanisms rather than direct participation [8]. Participation is therefore not defined by universal inclusion of all possible stakeholders, but by the structured involvement of those actors who are institutionally embedded in governance processes and responsible for academic and organizational decision-making.

Although PDM has been widely endorsed in higher education policy, its internal mechanisms remain insufficiently understood [9]. Many universities still operate through hierarchical and fragmented governance structures that limit the flow of information and constrain stakeholder engagement [10]. Variations in managerial openness, communication culture, and digital collaboration capacity interrupt feedback continuity, leading to uneven organizational learning outcomes and weak adaptive responses [11]. These governance limitations reduce not only immediate decision effectiveness but also the capacity of universities to cope with long-term pressures and recurrent shocks. As a result, participation often remains procedural rather than substantive—inviting stakeholder input without effectively translating it into feedback-oriented governance processes that support organizational learning and resilience.

Previous studies have explored participatory governance from normative, descriptive, or case-based perspectives, emphasizing inclusiveness, transparency, or democratic legitimacy [12]. However, fewer studies have empirically investigated how participation functions as an operational governance mechanism that is associated with learning feedback (LF) and adaptive governance capacity (AGC) [13]. Research on organizational learning in universities has similarly highlighted the importance of knowledge sharing and collective reflection, yet it rarely models the structural relationships through which participatory decision processes are linked to adaptive governance outcomes [14]. Consequently, the process-oriented role of PDM in supporting governance capacity and institutional resilience remains theoretically underdeveloped and empirically underexplored. Consequently, the process-oriented role of PDM in supporting governance capacity and institutional resilience remains theoretically underdeveloped and empirically underexplored.

within integrative, model-based empirical frameworks that explicitly link participation, LF, and governance capacity.

To address this gap, the present study develops and empirically tests a PDM model that integrates LF and adaptive governance in higher education management. The model conceptualizes PDM as an information-rich governance process in which stakeholder inclusion is associated with perceived LF and adaptive responses. The framework depicts a feedback-oriented governance structure in which decision outcomes are interpreted and reflected upon by organizational members, rather than empirically observed as temporal feedback cycles. Figure 1 presents the conceptual framework underlying this study, illustrating the perceived structural relationships among PDM, LF, and AGC, as well as the conditioning roles of managerial support and digital collaboration tools.

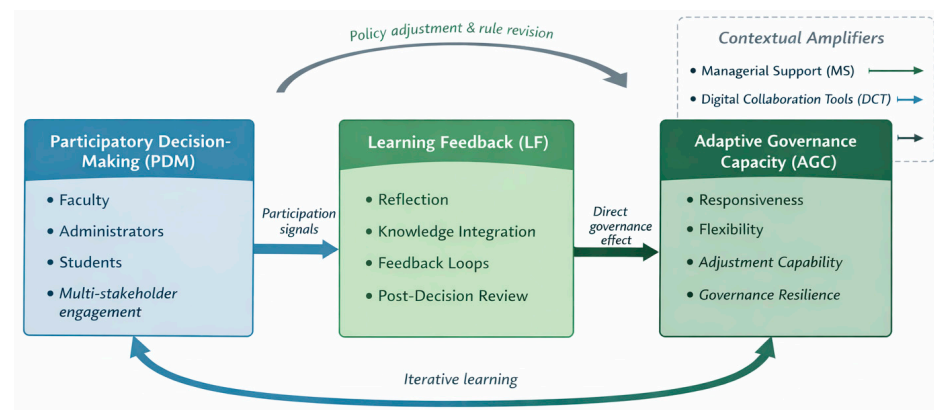


Figure 1. A feedback-based governance framework for higher education.

It should be noted that, given the cross-sectional nature of the data, the feedback mechanisms examined in this study represent perceived and institutionalized governance processes, rather than directly observed temporal feedback loops or iterative decision cycles. The proposed model does not capture the chronological sequencing of decisions or accumulation of effects over time, but instead reflects respondents' shared assessments of how PDM, LF, and AGC are associated within their institutions. Accordingly, feedback is interpreted in a perceptual and structural sense, consistent with prior cross-sectional research on governance and organizational learning.

Specifically, it links three key dimensions:

- (1) Participatory decision processes involving multiple university stakeholders;
- (2) LF mechanisms that mediate knowledge exchange and policy refinement;
- (3) AGC, reflected in the institution's ability to adjust strategies and maintain long-term improvement under changing conditions.

Rather than conceptualizing institutional sustainability as a standalone performance outcome, this study approaches sustainability from a governance-capability perspective. AGC is treated as the organizational condition through which sustainability is supported and maintained, insofar as it reflects the institution's ability to respond, adjust, and remain functional in complex environments. By examining how PDM and LF are associated with AGC, the study focuses on the capability-based foundations of institutional sustainability in higher education. Drawing upon collaborative governance and organizational learning theories, this research constructs a structural model connecting these dimensions and tests it empirically using survey data collected from multiple universities across China. Structural Equation Modeling (SEM) is employed to evaluate the causal relationships and mediation effects, while multi-group comparisons provide robustness checks across governance contexts and institutional types.

The findings demonstrate that PDM significantly enhances both individual and collective learning processes, and that LF serves as a crucial mediator linking participation with adaptive governance. Furthermore, managerial support and digital collaboration tools strengthen these relationships, underscoring the role of socio-technical enablers in supporting stable and responsive governance performance.

This study contributes in three ways. Theoretically, it reconceptualizes participatory governance as a measurable, feedback-oriented governance process rather than a purely normative ideal. Methodologically, it integrates decision-making and organizational learning perspectives within a structural modeling framework that is appropriate for cross-sectional analysis. Practically, it offers insights for higher education leaders seeking to design participatory and learning-oriented governance arrangements that support institutional resilience and adaptive capacity. Accordingly, the cybernetic and systems-oriented terminology used in this study serves as an interpretive framework for organizing governance relationships, rather than as a claim of empirically observed control mechanisms or dynamic system regulation.

The remainder of this paper is organized as follows. Section 2 reviews the literature on participatory governance, decision feedback, and organizational learning in higher education. Section 3 outlines the conceptual model and research hypotheses. Section 4 presents the empirical design, data collection, and analysis. Section 5 discusses the findings and managerial implications for adaptive governance. Section 5 concludes with theoretical contributions, limitations, and future research directions.

2. Literature Review

Higher-education institutions are increasingly seen as decision-oriented organizations, where governance is not only about compliance or hierarchy but about inclusive decision systems engaging multiple stakeholders. In such contexts, decision arrangements are expected to support not only immediate coordination but also the perceived continuity and stability of institutional functioning under changing conditions. For example, Saleh and Gamar [15] explore democratic, evidence-based decision-making in state-regulated Arab higher-education systems, emphasizing how institutional committees involve faculty and other stakeholders in governance. Similarly, recent work on school–university shared governance highlights the importance of participation and transparency for decision legitimacy and institutional responsiveness [16]. These studies indicate that participatory decision processes are more than formal structures—they shape how policies are formed, implemented and adjusted, and influence whether governance arrangements remain robust under changing conditions. Yet, while participation has been widely advocated, there remains limited empirical modelling of how participation influences learning and adaptive management within universities.

Another important strand emphasizes the role of feedback and learning loops in organizational governance. In the higher-education context, governance frameworks must support institutional agility and adaptation rather than static control, particularly when universities face recurrent reforms, resource constraints, and external uncertainty. For instance, recent research on AGC in Chinese tertiary institutions shows how governance practices evolve through learning-oriented feedback and institutional responsiveness [17]. Moreover, broader discussions on university governance note that effective decision-making requires not only structure but also culture, feedback channels and openness to change [18]. This literature points to the significance of LF mechanisms—where decision outcomes are observed, reflected upon, and inform subsequent management actions—in enabling universities to maintain responsive and resilient governance arrangements in complex higher-education systems [19].

While the above streams provide rich insights, important gaps remain. First, much of the literature on participation treats it as a normative ideal (e.g., student involvement, shared governance) rather than as an operational mechanism that links decision processes to organizational learning and adaptation. For example, a recent systematic review of student participation across governance domains in higher-education institutions emphasizes conceptual debates but offers little on how participatory structures translate into enduring adaptive processes [20].

Second, research on LF and governance tends to be either qualitative or descriptive, lacking structural modelling of how PDM translates into adaptive governance outcomes over time. For instance, existing studies have developed feedback-engagement scales to examine how participants react to feedback in organizational settings, but these efforts typically do not link individual feedback reactions to institution-level decision–feedback structures that shape longer-term governance performance [21]. Third, there is still scarce empirical evidence modelling the mediation role of LF between decision participation and institutional adaptability in higher-education contexts. A recent study in United Arab Emirates higher education shows that participatory evaluation enhances stakeholder engagement and institutional performance, but stops short of modelling mediation or adaptive governance effect [22]. Accordingly, a conceptual framework that integrates these elements—PDM, LF mechanisms, and AGC—is warranted.

In response to these gaps, this study develops a structural model that links PDM (as antecedent), LF (as mediator), and AGC (as outcome) within higher-education institutions. By empirically testing this model, the study aims to show how shared decision processes can enhance institutional learning and responsiveness, thereby supporting continuous improvement, governance robustness, and stable performance under conditions of change.

3. Research Methods

To examine the intrinsic relationships among PDM, LF, and adaptive governance, this study constructs an empirical research framework grounded in systems thinking and SEM [23]. The framework is designed to capture how decision processes, feedback mechanisms, and governance responses interact across governance contexts within complex institutional systems. The overall methodological process is illustrated in Figure 2, which depicts the integrated research logic and technical pathway. Specifically, the framework proceeds through three major stages: first, a conceptual model and measurement system are developed through literature analysis and expert consultation; second, questionnaire data are collected from multiple universities to construct latent variable indicators; and third, SEM is employed to test the causal paths and mediating effects among PDM, LF, and adaptive governance. This framework reflects a progressive logic from theoretical modelling to empirical validation and highlights a theory-driven, feedback-oriented analytical structure used to examine perceived associations among governance components, rather than to model real-time system dynamics.

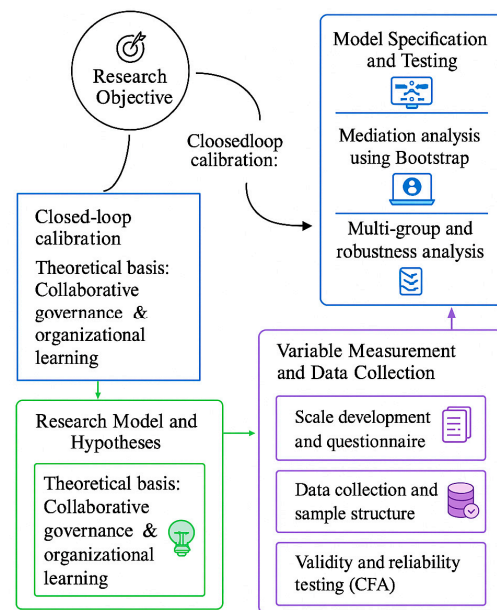


Figure 2. Overall research methodological framework.

3.1. Closed-Loop Theoretical Calibration and Conceptual Model Development

The methodological design follows the closed-loop logic illustrated in Figure 1, beginning with the clarification of the research objective and advancing through iterative calibration involving literature synthesis, expert consultation, preliminary diagnostic assessment, and statistical validation. This feedback-oriented structure emphasizes structural calibration and internal consistency rather than one-off optimization, allowing the conceptual model to be refined analytically rather than anchored to a single theoretical interpretation.

The theoretical foundation draws upon collaborative governance theory and organizational learning theory, which together offer a coherent explanation for decision processes and adaptive behavior in higher-education institutions. Collaborative governance theory emphasizes inclusive participation, coordinated interaction, and shared problem-solving under complex conditions, whereas organizational learning theory highlights continuous reflection, feedback assimilation, and adaptive adjustment of routines and policies. Together, these perspectives justify conceptualizing PDM as the driver of information exchange and shared cognition; LF as the mechanism for knowledge integration and corrective refinement; and AGC as the institutional outcome reflecting the ability to maintain flexibility, responsiveness, and resilience across different decision contexts.

Following this theoretical alignment, a feedback-driven structural pathway is formulated linking PDM, LF, and AGC. The model assumes that PDM enhances LF through improved information transparency and deliberation quality; that LF strengthens AGC through reflective adjustment; and that PDM may also exert a direct influence on AGC. This structure reflects a dynamic governance process in which decision inputs are continuously processed, evaluated, and recalibrated rather than producing isolated outcomes. Managerial support (MS, version 1.0) and digital collaboration tools (DCT, version 2.0) are introduced as contextual moderators that condition the strength of these relationships.

In this study, the term “contextual amplifiers” is used as an analytical shorthand to describe governance conditions that strengthen or weaken the effectiveness of PDM, rather than as a metaphorical or abstract construct. Specifically, MS and DCT are conceptualized as two distinct but complementary categories of organizational enablers that operate within university governance processes.

Managerial support refers to the extent to which senior leadership explicitly endorses PDM, allocates time and resources for stakeholder involvement, and signals that

participatory input is valued and consequential for governance outcomes. In practical terms, this includes leadership openness to stakeholder voice, formal encouragement of participation in committees or deliberative forums, and managerial follow-through on participatory recommendations. Such support reduces symbolic participation and increases the likelihood that participatory inputs are taken seriously and translated into LF and governance adjustment.

Digital collaboration tools denote the institutional availability and routine use of digital platforms that facilitate information sharing, consultation, and coordination across organizational units, such as online decision-support systems, shared document platforms, internal communication tools, and digital meeting infrastructures. These tools do not generate participation by themselves, but lower coordination costs, increase transparency, and enable timely aggregation and dissemination of participatory information, thereby enhancing the effectiveness of LF processes.

Within the proposed framework, MS and DCT are treated as moderating conditions because they do not directly constitute PDM or LF, but instead condition how strongly participatory inputs are transformed into AGC. Their moderating role reflects differences in governance infrastructure and leadership climate across universities, rather than metaphorical amplification in a physical sense.

Based on the conceptual framework, four hypotheses are proposed to capture the core structural associations and contextual contingencies.

H1: *PDM is positively associated with LF.*

H2: *LF is positively associated with AGC.*

H3: *LF mediates the association between PDM and AGC.*

H4: *Contextual governance conditions—specifically managerial support and digital collaboration tools—moderate the association between PDM and AGC.*

These moderation effects may be examined either through latent moderated structural equations (LMS), using latent interaction terms, or through multi-group structural comparison, provided that measurement invariance is satisfied.

The empirical data are collected at the individual respondent level, with respondents nested within universities. However, the theoretical focus of this study is on university-level governance systems as perceived by organizational members. Accordingly, individual responses are interpreted as indicators of shared institutional governance conditions rather than as isolated individual attitudes. The data used in this study were collected at the individual respondent level, with respondents nested within universities. The focal constructs—PDM, LF, AGC, managerial support, and digital collaboration tools—were measured as individual perceptions of institution-level governance processes. Accordingly, the unit of theoretical interest is the organizational governance context, as perceived by organizational members, rather than individual psychological outcomes. Given this conceptualization, the analysis focuses on structural associations among institution-level governance constructs as reflected in individual perceptions, rather than on variance partitioning across individual and institutional levels.

In line with prior governance and organizational research based on cross-sectional survey data, a single-level SEM approach was adopted to model the structural associations among these constructs. This approach is appropriate when (i) constructs are conceptualized as shared or institutionalized perceptions, (ii) the research focus is on structural relationships rather than variance decomposition across levels, and (iii) the number of

higher-level units is relatively limited. In the present study, the sample includes 32 universities, which is below commonly recommended thresholds for stable estimation in multilevel SEM, particularly when mediation and moderation effects are simultaneously specified.

To further mitigate concerns regarding aggregation bias, respondents were drawn from multiple roles within each institution (academic staff, administrators, and support personnel), reducing the likelihood that the results reflect idiosyncratic subgroup perspectives. Moreover, robustness checks and multi-group comparisons across institutional types were conducted to assess whether the estimated structural relationships vary systematically across governance contexts. These analyses provide indirect support for the stability of the identified associations across institutions.

3.2. Measurement Development, Instrument Design, and Validation of the Measurement Model

The second methodological component corresponds to the “Variable Measurement and Data Collection” stage in Figure 1 and focuses on the operationalization of latent constructs, scale development, and measurement validation. All constructs—PDM, LF, AGC, MS, and DCT—are specified as reflective latent variables and measured through multi-item Likert scales adapted from validated instruments in governance, management, and organizational learning research [24]. Item wording was refined through expert consultation and pilot assessment to ensure conceptual clarity, semantic precision, and contextual alignment with higher-education governance settings, thereby supporting consistent interpretation of governance processes across institutions and over time.

The measurement model is evaluated using Confirmatory Factor Analysis (CFA). The reflective specification follows the standard linear measurement formulation:

$$\mathbf{x} = \Lambda_x \boldsymbol{\zeta} + \boldsymbol{\delta}, \mathbf{y} = \Lambda_y \boldsymbol{\eta} + \boldsymbol{\epsilon} \quad (1)$$

where Λ_x and Λ_y denote the factor-loading matrices and $\boldsymbol{\delta}$ and $\boldsymbol{\epsilon}$ represent measurement errors. Convergent validity is assessed through factor loadings as well as Composite Reliability (CR) and Average Variance Extracted (AVE): With $CR \geq 0.70$ and $AVE \geq 0.50$ indicating acceptable convergent validity.

$$CR = \frac{\left(\sum_{i=1}^k \lambda_i\right)^2}{\left(\sum_{i=1}^k \lambda_i\right)^2 + \sum_{i=1}^k \theta_i}, AVE = \frac{\sum_{i=1}^k \lambda_i^2}{\sum_{i=1}^k \lambda_i^2 + \sum_{i=1}^k \theta_i} \quad (2)$$

Discriminant validity is confirmed using the Fornell–Larcker criterion and the Heterotrait–Monotrait ratio (HTMT), ensuring empirical distinctiveness across latent constructs that represent different yet interrelated governance functions.

To address potential common method variance (CMV)—a recognized concern in perceptual and self-reported survey research—both procedural and statistical remedies were applied. Procedurally, item order was randomized, respondent anonymity was assured, and scale items were carefully worded to reduce evaluation apprehension and consistency motives. Statistically, multiple complementary tests were conducted. First, Harman’s single-factor test indicates that the first unrotated factor accounts for 32.4% of the total variance, below the commonly cited heuristic threshold of 40%. Second, a single-factor confirmatory factor analysis (CFA) model was estimated and compared with the hypothesized multi-factor measurement model. The single-factor model exhibits substantially poorer fit (with marked deterioration in χ^2 , CFI, and RMSEA), indicating that a single latent factor cannot adequately account for the observed covariance structure. In addition, an unmeasured latent method factor was incorporated into the CFA, with all indicators loading simultaneously on their theoretical constructs and on a common method

factor. The inclusion of the method factor does not materially alter the significance or relative magnitude of the substantive factor loadings, and the method factor accounts for a limited proportion of total variance. These results suggest that CMV is unlikely to be a dominant threat to the validity of the estimated relationships.

This stage ensures that all latent constructs are measured with adequate reliability and validity, thereby providing a robust foundation for testing the structural relations specified in the subsequent methodological component.

3.3. Structural Model Specification, Path Estimation, and Robustness Assessment

The final methodological stage corresponds to the “Model Specification and Testing” module in Figure 1 and concerns the estimation of the theoretical pathways linking PDM, LF, AGC, MS, and DCT. A covariance-based structural equation modelling (CB-SEM) approach is adopted due to its suitability for theory-driven causal modelling and its ability to incorporate measurement error into latent-variable estimation, which is essential for examining structural associations among interdependent governance components.

The structural relations are expressed as:

$$LF = \alpha_1 + \beta_1 PDM + \zeta_1, AGC = \alpha_2 + \beta_2 PDM + \beta_3 LF + \zeta_2, \quad (3)$$

where β_1 , β_2 , and β_3 represent the core theoretical effects. The indirect (mediated) effect of PDM on AGC through LF is given by:

$$\beta_{\text{ind}} = \beta_1 \times \beta_3 \quad (4)$$

and the total effect by:

$$\beta_{\text{tot}} = \beta_2 + \beta_1 \beta_3 \quad (5)$$

The statistical significance of mediation is evaluated using bias-corrected bootstrap confidence intervals (5000 resamples), providing a non-parametric and distribution-free assessment of indirect effects that captures the reinforcing role of feedback-related associations within governance settings. Moderation effects involving MS and DCT are tested using latent moderated structural equations (LMS) by specifying latent interaction terms, and—where conceptually appropriate—using multi-group structural comparison.

Before multi-group comparisons, measurement invariance is examined across groups following the hierarchical sequence of configural, metric, and scalar invariance. Structural path differences are evaluated only when measurement equivalence is adequately supported, using criteria such as $\Delta CFI \leq 0.01$, thereby ensuring that governance relationships are comparable across institutional contexts.

Robustness assessments further include alternative model specifications (e.g., exclusion of the mediation component or alternative causal ordering), the introduction of theoretically justified control variables, sensitivity tests for multicollinearity, and optional exploratory heterogeneity detection using finite mixture SEM (FIMIX-SEM) [25]. These procedures assess whether the identified governance mechanisms remain stable under alternative assumptions and across analytical variations, ensuring that the estimated relationships are not artifacts of modelling assumptions but reflect persistent structural patterns.

4. Illustrative Examples

Building on the methodological framework developed in this study, the following empirical analysis examines the internal mechanisms linking participatory decision-making (PDM), learning feedback (LF), and adaptive governance capacity (AGC) in higher education. The analysis focuses on how participatory decision processes and feedback-related

governance mechanisms are associated under different institutional conditions. It first introduces the data sources, indicator system, and sample characteristics, followed by reliability and validity assessments of the measurement model. On this basis, the results of the structural equation modeling analysis are presented, including path estimates as well as mediation and moderation effects. Finally, robustness checks and heterogeneity analyses are conducted to extend the empirical findings and derive governance implications. Taken together, the analyses aim to operationalize the theoretical logic of “participation–learning–adaptive governance” into empirically observable associations that inform governance practices supporting stability and adaptive capacity.

4.1. Data Sources, Indicator System and Sample Characteristics

Questionnaire data were collected from 32 universities across eight provinces in eastern, central, western and northeastern China, covering both research-oriented and practice-oriented institutions. A total of 573 questionnaires were returned. After excluding responses with abnormal completion time, highly homogeneous answering patterns or substantial missing values, 512 valid responses remained, yielding an effective response rate of 89.4%. As shown in Table 1, the average age of respondents is 38.5 years. Approximately 61% are full-time academic staff, 27% are administrative personnel, and the remaining 12% consist of counsellors and teaching-support staff. In terms of institutional type, research-oriented and practice-oriented universities account for roughly 46% and 54% of the sample, respectively. Regionally, universities in eastern, central, western and northeastern China account for about 35%, 30%, 25% and 10% of the sample.

Table 1. Overview of sample characteristics.

Indicator	Value
Valid sample size (<i>N</i>)	512
Mean age (years)	38.5
Gender ratio (male/female)	52%/48%
Share of full-time academic staff	61%
Share of administrative personnel	27%
Share of other staff	12%
Institutional type (research-oriented/practice-oriented)	46%/54%
Regional distribution (east/central/west/northeast)	35/30/25/10%

Table 1 indicates that the sample covers universities with strong traditions of academic autonomy and research orientation as well as institutions whose missions are more closely aligned with application and regional service. The distribution across eastern, central, western and northeastern regions is relatively balanced, which provides a sound basis for subsequent multi-group and heterogeneity analyses. From a governance perspective, this structural diversity implies potential differences in participation mechanisms, feedback channels and governance routines, allowing observation of how governance arrangements respond and adjust under different institutional environments.

In terms of indicator construction, the design follows the closed-loop calibration pathway of “literature–data–expert–statistics” outlined in the methodological framework of this study. Literature review and preliminary interviews were first used to clarify the conceptual boundaries of PDM, LF, AGC, MS and DCT. Measurement items were then adapted from established scales in the fields of collaborative governance, organizational learning and higher-education management. Three rounds of expert consultation were conducted to localize the wording and ensure that the items remain internationally comparable while being contextually appropriate for Chinese university governance. All items were measured on a five-point Likert scale (1 = “strongly disagree”, 5 = “strongly agree”),

and all constructs were specified as reflective latent variables to capture relatively stable governance patterns rather than transient perceptions.

Descriptive statistics and correlations among the core variables are reported in Table 2.

Table 2. Descriptive statistics and correlations of latent variables.

Variable	Mean	SD	Cronbach's α	1	2	3	4	5
PDM	3.72	0.68	0.90	1				
LF	3.65	0.71	0.88	0.58	1			
AGC	3.79	0.66	0.89	0.47	0.55	1		
MS	3.83	0.74	0.85	0.42	0.39	0.44	1	
DCT	3.68	0.77	0.87	0.36	0.33	0.38	0.41	1

As shown in Table 2, the mean values of all constructs lie between 3.6 and 3.8, suggesting that universities in the sample are, on average, at an upper-medium level in terms of PDM, LF and AGC, while still leaving room for improvement. Cronbach's α values exceed 0.85 for all constructs, indicating strong internal consistency. The correlation between PDM and LF is about 0.58, between LF and AGC 0.55, and between PDM and AGC 0.47, all at moderate or higher levels, consistent with the theoretical expectation that “participation promotes learning and learning reinforces governance.” Correlations between MS, DCT and the three core constructs range from 0.33 to 0.44, suggesting that managerial support and digital collaboration tools play an amplifying role in the governance process. These descriptive patterns indicate that participatory inputs, feedback processes, and adaptive responses are systematically interrelated rather than episodic or isolated. These descriptive patterns provide an intuitive empirical background for subsequent structural equation modelling.

4.2. Confirmatory Factor Analysis of the Measurement Model

Before estimating the structural model, the measurement structure of PDM, LF, AGC, MS and DCT was rigorously assessed to ensure that subsequent path estimates rest on reliable and valid measurement. A unified confirmatory factor analysis (CFA) was conducted, with items specified as reflective indicators of their respective latent variables and parameters estimated using maximum likelihood. The main CFA results are reported in Table 3.

Table 3. Factor loadings, composite reliability and AVE.

Latent Construct	Number of Items	Loading Range	CR	AVE	Conclusion
PDM	5	0.74–0.86	0.91	0.63	Convergent validity satisfactory
LF	4	0.71–0.88	0.90	0.61	Convergent validity satisfactory
AGC	5	0.73–0.87	0.89	0.60	Convergent validity satisfactory
MS	3	0.70–0.82	0.85	0.55	Meets statistical standards
DCT	3	0.72–0.87	0.90	0.62	Meets statistical standards

The overall fit of the measurement model is satisfactory: $\chi^2/\text{df} = 2.18$, comparative fit index (CFI) = 0.956, Tucker–Lewis index (TLI) = 0.949, root mean square error of approximation (RMSEA) = 0.047 and standardized root mean square residual (SRMR) = 0.039, all meeting commonly accepted thresholds ($\chi^2/\text{df} < 3$, CFI and TLI > 0.90, RMSEA and SRMR < 0.08). As shown in Table 3, all standardized factor loadings are significant and exceed 0.70. Composite reliability (CR) values range from 0.85 to 0.91, and average variance extracted (AVE) values exceed 0.55 for all constructs, indicating good internal consistency

and convergent validity. This confirms that the latent constructs provide a reliable basis for analyzing governance mechanisms that operate consistently across decision contexts.

Further Fornell–Larcker tests show that, for each construct, the square root of the AVE is greater than its correlations with other constructs, and heterotrait–monotrait ratios (HTMT) are below 0.85. These results confirm adequate discriminant validity, in line with established measurement quality criteria.

Potential common method bias was addressed through both procedural and statistical controls. Procedurally, items were randomly ordered, anonymity was assured, and several items were reverse-coded. Statistically, Harman’s single-factor test indicates that the first common factor accounts for 32.4% of the total variance, below the 40% heuristic threshold. In addition, a single-factor CFA model was compared with the hypothesized multi-factor model; the single-factor specification exhibits significantly poorer fit (with substantial deterioration in χ^2 and CFI), indicating that common method variance is not severe enough to invalidate the results. Overall, the measurement model performs robustly across multiple criteria and provides a reliable foundation for subsequent structural path analysis. It should be noted that the measurement model exhibits strong and stable fit indices, reflecting the relatively coherent structure of the governance-related constructs examined in this study. All latent variables are specified at the institutional governance level and capture shared perceptions of decision processes, feedback practices, and adaptive capacity, which are conceptually interrelated by design. As a result, the measurement model already accounts for a substantial portion of the covariance structure among the indicators, providing a stable baseline for subsequent structural estimation.

4.3. Structural Path Estimation and Analysis of Mediation and Moderation

Moderation effects were primarily tested using LMS, while multi-group SEM was used as a robustness and heterogeneity check across institutional types. With the measurement model validated, a CB-SEM was estimated to examine the structural relationships among PDM, LF and AGC, as well as the mediating role of LF and the moderating roles of MS and DCT. The overall structural paths are presented in Figure 3.

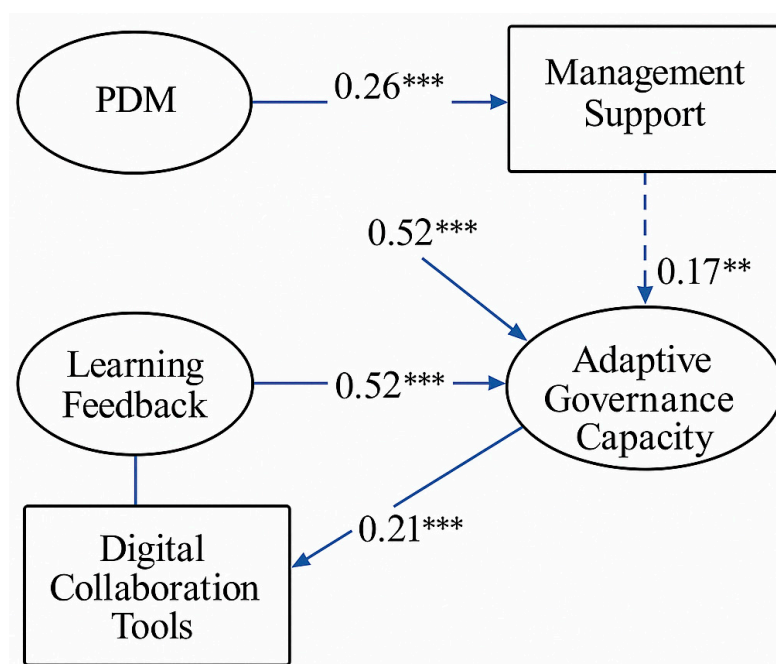


Figure 3. Structural paths among PDM, LF and AGC with moderation by MS and DCT. Note: All coefficients shown are standardized estimates. (Note: Solid arrows represent direct paths, dashed arrows represent moderation effects; ** and *** indicate $p < 0.01$ and $p < 0.001$).

The structural model also demonstrates good fit ($\chi^2/df = 2.24$, CFI = 0.952, TLI = 0.944, RMSEA = 0.049, SRMR = 0.042), indicating that the introduction of structural paths does not compromise model adequacy. The similarity between the fit indices of the measurement and structural models reflects the fact that the hypothesized structural relations are consistent with the latent covariance structure already captured by the measurement model, rather than indicating model overfitting. While the coefficients reported in Figure 3 and Table 4 reflect the full-sample estimates, Figure 4 presents the corresponding standardized coefficients obtained from the multi-group SEM. Detailed path estimates and corresponding mediation and moderation effects are reported in Table 4.

Table 4. Structural paths and mediation/moderation effects.

Path/Effect	Standardized β	t-Value	p-Value	Conclusion
PDM $\rightarrow$ LF	0.57	11.24	<0.001	Significant positive effect
LF $\rightarrow$ AGC	0.52	9.87	<0.001	Significant positive effect
PDM $\rightarrow$ AGC (direct effect)	0.26	4.91	<0.001	Significant positive effect
Indirect effect: PDM $\rightarrow$ LF $\rightarrow$ AGC	0.296	-	95% CI excludes 0	Significant mediation
Total effect: PDM $\rightarrow$ AGC	0.556	-	-	Direct and indirect effects both significant
Moderation: PDM $\times$ MS $\rightarrow$ AGC	0.17	2.90	0.004	Significant positive moderation
Moderation: PDM $\times$ DCT $\rightarrow$ AGC	0.21	3.64	<0.001	Significant positive moderation

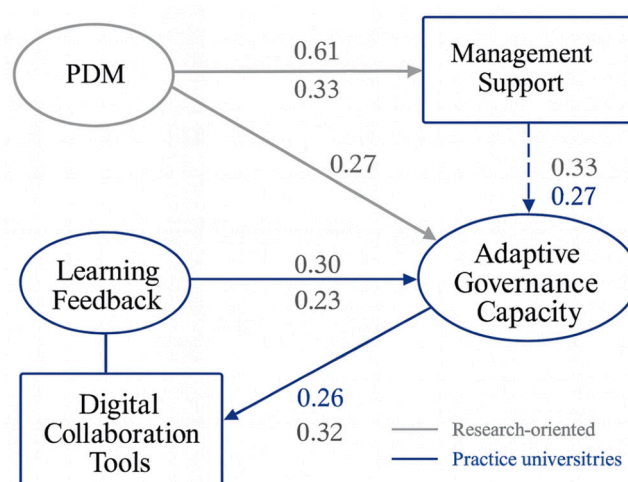


Figure 4. Comparison of core path coefficients between research-oriented and practice-oriented universities. (Note: Gray arrows indicate results for research-oriented universities, while blue arrows indicate results for practice-oriented universities).

As shown in Table 4, the standardized coefficient from PDM to LF is 0.57 and is positive and significant at the 1% level, indicating that PDM substantially enhances LF within university governance systems. In practical terms, when academic staff, administrators and students are afforded greater opportunities to express opinions and participate in deliberations on major issues, decision outcomes are more likely to be systematically reviewed, summarized and revised. The collection and transmission of feedback become more structured and institutionalized, consistent with collaborative governance theory. Such feedback institutionalization supports the reinforcement of organizational learning within decision contexts.

The coefficient from LF to AGC is 0.52 and likewise significant at the 1% level, confirming that feedback mechanisms are crucial in strengthening universities' flexibility and resilience. Institutions with more mature feedback systems are better able to adjust internal rules and resource allocations in response to policy changes, technological de-

velopments and evolving student needs. This adaptive capacity reflects the ability of governance systems to remain functional and responsive under sustained external pressure. The direct effect from PDM to AGC remains significant at 0.26, suggesting that PDM also directly enhances governance capacity by reinforcing decision legitimacy and stakeholder commitment.

Bootstrap analysis yields an indirect effect of 0.296 for the PDM $\rightarrow$ LF $\rightarrow$ AGC pathway, confirming a significant mediating role for LF. The total effect of PDM on AGC reaches 0.556, indicating that PDM exerts a substantial reinforcing influence on governance capacity, operating through both direct and feedback-mediated pathways.

Regarding moderation, the interaction terms PDM $\times$ MS and PDM $\times$ DCT have coefficients of 0.17 and 0.21, respectively, both positive and statistically significant. This indicates that MS and DCT amplify the impact of PDM on AGC. When senior management explicitly endorses participatory governance and encourages stakeholder voice, participation-related information is less likely to be weakened or filtered out in hierarchical transmission, thus magnifying the marginal effect of PDM on AGC. Likewise, when universities possess well-developed digital collaboration platforms and online deliberation tools, the costs of cross-unit communication are reduced, feedback can be collected, aggregated and responded to more rapidly, and lags between decision and implementation are shortened. As a result, PDM exhibits a stronger “amplifier effect” at the governance level. Figure 3 visually summarizes these structural relationships and the corresponding mediation and moderation pathways.

To further explore how the model behaves across different institutional types, the sample was divided into research-oriented and practice-oriented universities, and multi-group SEM was conducted under conditions of measurement invariance. The core path coefficients for the two groups are compared in Figure 4.

Figure 4 shows that the three core paths are positive and significant in both institutional types, but the magnitudes are consistently larger in research-oriented universities. All reported coefficients are standardized and statistically significant ($p < 0.05$). In particular, the PDM $\rightarrow$ LF path is stronger in research-oriented universities ($\beta = 0.61$) than in practice-oriented universities ($\beta = 0.33$). This pattern suggests that in organizational environments where academic autonomy and academic community culture are more pronounced, PDM is more easily internalized as a feedback-oriented process of reflection and learning. In more execution-oriented practice universities, participation also plays an important role, but tends to be more directly linked to task coordination and operational problem-solving.

The LF $\rightarrow$ AGC and PDM $\rightarrow$ AGC paths are likewise stronger in research-oriented universities, indicating that these institutions are more effective in converting participatory information into governance resilience and policy innovation through institutionalized feedback mechanisms. These heterogeneity results further corroborate the system logic of “participation–learning–adaptive governance”, highlighting differentiated feedback elasticities across governance contexts. It should be noted that the feedback mechanisms identified here reflect perceived and institutionalized governance processes, rather than directly observed temporal feedback loops, given the cross-sectional nature of the data.

4.4. Robustness Checks and Integrated Governance Implications

To ensure that the empirical conclusions are not driven by specific model specifications, multiple robustness checks were conducted. First, several alternative structural models were estimated, including models without the mediator, models with only partial paths, and models with altered causal ordering. Although fit indices varied slightly, the directions and significance of the PDM $\rightarrow$ LF, LF $\rightarrow$ AGC and PDM $\rightarrow$ AGC paths remained stable, and the presence of mediation and moderation effects was not overturned, indicating structural

robustness of the core conclusions across alternative assumptions and analytical conditions. Second, additional control variables—such as institutional size, level of degree programs, student–staff ratio and research funding—were incorporated into the structural model. The three main paths and the mediation and moderation effects exhibited only minor changes in magnitude and remained significant, suggesting that the “participation–learning–adaptive governance” mechanism holds under different organizational conditions and remains applicable to ongoing governance improvement under heterogeneous resource constraints.

From a statistical perspective, variance inflation factors (VIFs) for the latent constructs are all below 3, indicating no serious multicollinearity. Re-estimation using robust maximum likelihood (MLR) yields path coefficients and significance levels similar to those obtained with standard ML, implying that deviations from normality have limited influence on the results. From a statistical perspective, variance inflation factors (VIFs) for the latent constructs are all below 3, indicating no serious multicollinearity. Re-estimation using robust maximum likelihood (MLR) yields path coefficients and significance levels similar to those obtained with standard ML, implying that deviations from normality have limited influence on the results. In addition, robustness checks incorporating an unmeasured latent method factor yield substantively similar structural path estimates, suggesting that the observed relationships are not primarily driven by common method variance.

Given the relatively small number of higher-level units (32 universities), multilevel SEM was not pursued. However, the consistency of results across multi-group analyses and robustness checks suggests that the main conclusions are unlikely to be driven by unmodeled nesting effects.

Exploratory analyses using FIMIX-SEM were also conducted to detect potential latent governance profiles. Although no sharply separated latent classes emerge at conventional significance levels, improvements in model fit suggest that some universities may exhibit latent combinations of participation intensity, feedback institutionalization and adaptive performance, indicating differentiated governance routines that may be associated with different levels of adaptive capacity, providing avenues for future longitudinal research. Exploratory analyses using finite mixture SEM were also conducted to detect potential latent governance profiles. Although no sharply separated latent classes emerge at conventional significance levels, improvements in model fit suggest that some universities may exhibit latent combinations of participation intensity, feedback institutionalization and adaptive performance, indicating differentiated governance routines that may be associated with different levels of adaptive capacity, providing avenues for future longitudinal research. Regarding overall model fit, the relatively small differences between the measurement and structural model fit indices are attributable to the high internal coherence of the governance constructs and the theory-driven specification of structural paths. Importantly, alternative model specifications and robustness checks yield comparable fit statistics and do not materially alter the substantive conclusions, suggesting that the reported fit is not driven by over-parameterization or overly homogeneous measurement.

Overall, the empirical evidence in this study supports a coherent governance logic. PDM provides universities with rich, multi-source “input signals”; LF processes, filters and integrates these signals, transforming dispersed individual opinions into usable organizational knowledge supporting governance adjustment through feedback-related interpretation and reflection. AGC reflects the external manifestation of system performance, expressed as sensitivity, response speed and adjustment capability when universities confront policy changes, external shocks and internal demands. MS and DCT function as “system amplifiers”: on one hand, they strengthen participation norms and value orientations, thereby increasing both the frequency and quality of PDM; on the other hand, they lower interdepartmental communication costs and improve the perceived timeliness and

stability of governance processes, reinforcing the capacity to maintain performance under perceived governance pressure and uncertainty.

Compared with studies that treat participation mainly as a normative ideal or a single institutional arrangement, the results of this study suggest that participatory decision-making in higher-education governance is better understood as a process-oriented decision practice embedded in learning feedback and adaptive governance capacity. When participatory information is effectively absorbed and reused through systematic feedback-related interpretation and reflection, participatory governance is more likely to be associated with enhanced governance capacity and resilience under complex institutional conditions. These findings provide empirical support for the theoretical framework developed in this study and offer an evidence-based foundation for the managerial implications and policy discussions presented in the subsequent sections.

5. Conclusions

This study develops a cybernetic governance model to characterize the coupling and adaptive feedback among PDM, LF, and AGC within universities. By operationalizing latent constructs, identifying core paths and mediation/moderation relationships using structural equation modeling, and conducting multi-group robustness checks to capture institutional contingencies, several system-level insights are suggested. First, the results indicate a strong and positive association between PDM and LF, suggesting that governance contexts characterized by higher levels of participation tend to exhibit stronger coordination and information-processing capacity within decision settings. This association is consistent with a learning-oriented governance pattern in which participatory inputs are perceived to enhance reflection, interpretation, and knowledge integration in decision processes. Second, AGC appears to be feedback-dependent in structural terms. LF consistently mediates the relationship between PDM and AGC, indicating that participation is associated with governance resilience primarily through reinforced learning processes rather than functioning as a one-off procedural input. The magnitude of the total effect further suggests that PDM is linked to adaptive capacity through both direct and feedback-mediated structural pathways. Third, socio-technical conditions shape these relationships in a heterogeneous manner. Managerial support and digital collaboration tools significantly strengthen the association between PDM and AGC, and these effects are more pronounced in research-oriented universities. This pattern is consistent with the interpretation that governance environments featuring stronger academic autonomy and collaborative culture exhibit higher feedback elasticity and stronger responsiveness to participatory inputs. Robustness checks across alternative specifications support the stability of these structural relationships across institutional contexts.

These findings also resonate with and extend prior empirical research on participatory governance and organizational learning in higher education. Previous studies have documented that stakeholder participation contributes to perceived legitimacy, transparency, and decision acceptance, while parallel research on organizational learning emphasizes the role of reflection and information sharing in institutional responsiveness. The present results complement this literature by providing structural evidence that participatory decision-making is most strongly associated with adaptive governance capacity when it is accompanied by perceived learning feedback. In this sense, the findings suggest that participation functions less as an isolated governance arrangement and more as part of a broader learning-oriented governance configuration, thereby offering a mechanism-based explanation that bridges participatory governance and adaptive governance research.

At the same time, the results invite reflection on the ethical and governance challenges associated with increasingly digital and feedback-oriented governance systems. As digital

collaboration tools play a strengthening role in transforming participatory inputs into governance capacity, issues such as unequal access to digital platforms, digital literacy gaps, data protection, and information privacy become more salient. Without appropriate safeguards, digitally mediated participation may inadvertently amplify existing inequalities or marginalize certain stakeholder groups, undermining the inclusiveness that participatory governance seeks to promote. These ethical considerations highlight the importance of aligning governance innovation with principles of equity, transparency, and responsible data use.

Looking forward, emerging artificial intelligence (AI) technologies may offer additional opportunities to support feedback-oriented governance by assisting in the aggregation, synthesis, and interpretation of large volumes of participatory input. For example, AI-based text analysis or decision-support systems could enhance the timeliness and consistency of learning feedback. However, the use of AI in governance contexts also raises concerns regarding algorithmic bias, accountability, and the potential displacement of human judgment. Accordingly, AI should be viewed as a supportive governance instrument rather than a substitute for participatory deliberation, and its integration into governance systems warrants careful ethical and institutional consideration.

Theoretically, the participation–learning–adaptation nexus is interpreted through a feedback-oriented, systems-informed governance framework, understood in a structural and perceptual sense rather than as a temporally observed cybernetic system. Rather than treating participation or performance as static proxies, the analytical architecture integrates state observation (measurement validity and model fit), subsystem calibration (reliability and construct consistency), and feedback identification (mediated and moderated structural paths) to examine how participatory inputs are associated with changes in perceived governance capacity. The observed heterogeneity can be interpreted as variation in feedback sensitivity across governance contexts, offering a transferable systems-based perspective for understanding participatory governance in higher education.

From a practical perspective, PDM can be approached as a manageable governance input whose effectiveness depends on the surrounding learning and support conditions. University leaders may enhance governance adaptability by institutionalizing participatory procedures with clear deliberation channels and post-decision review mechanisms, strengthening knowledge-sharing platforms and cross-unit collaboration, fostering managerial endorsement of stakeholder participation, and investing in digital collaboration infrastructure that facilitates timely information exchange. These instruments can be interpreted as governance-supporting conditions that help align participatory inputs with LF and adaptive responses across institutional settings.

Several limitations should be acknowledged. First, all constructs in this study are measured using self-reported perceptual data collected from the same respondents at a single point in time. Although multiple procedural and statistical remedies were employed to mitigate common method variance, the possibility of residual CMV cannot be fully ruled out. Accordingly, the findings should be interpreted as reflecting perceived and associational governance relationships rather than definitive causal effects. This study relies on cross-sectional survey data and latent constructs, which limits causal and temporal inference regarding feedback processes. The model captures perceived and institutionalized governance relationships rather than observed temporal dynamics or iterative decision cycles. Future research could extend this framework by employing longitudinal designs, process-tracing data, or system-dynamics approaches to examine how PDM and LF evolve over time and across governance episodes. Such efforts would further strengthen empirical understanding of feedback-oriented governance in higher education.

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