GAS Journal of Education and Literature (GASJEL)

Volume 1, Issue 5, 2024 Journal Homepage: https://gaspublishers.com/gasjel-home/ ISSN: 3048-6777

Study on the Mechanisms for High-Quality Development of Science Research Management in Private Higher Education Institutions in China

Zeting Shen, Zihao Pan, Xiaojun Ke*

Guangzhou Institute of Science and Technology, Guangzhou, 510540, China

Received: 16.12.2024 | **Accepted:** 18.12.2024 | **Published:** 23.12.2024

***Corresponding Author:** Xiaojun Ke*

DOI: 10.5281/zenodo.14545606

Abstract **Original Research Article**

This study investigates the mechanisms for high-quality science research management in private higher education institutions (HEIs) in China, addressing critical challenges such as resource scarcity, inadequate incentive structures, and insufficient policy support. Using grounded theory, the study develops a dynamic and integrative model encompassing six core components: resource allocation, incentive mechanisms, performance evaluation, result transformation, policy support, and management optimization. Data were collected through semi-structured interviews with administrators, project leaders, and staff from 10 representative private HEIs across China.Findings reveal that resource optimization and multidimensional incentive mechanisms are pivotal for stabilizing research teams and fostering innovation. The study further emphasizes enhancing performance evaluation frameworks to prioritize research quality and societal impact. Strengthening university-industry partnerships and streamlining administrative processes are also identified as critical pathways to improve research productivity and application.The proposed model provides a theoretical contribution by integrating resource-limited conditions into high-quality science research management frameworks, offering novel insights for managing HEIs globally. Practically, the findings deliver actionable strategies for policymakers, institutional administrators, and researchers, aiming to align research outputs with societal and institutional goals effectively.

Keywords: High-Quality Development, science research management, Private HEIs, Grounded Theory, Incentive Mechanisms

1. INTRODUCTION

The development of private higher education institutions (HEIs) has come to the fore in the context of continuous development in China's higher education system ("Analysing the Quality of Public and Private Higher Educational Institution in China," 2022). However, the private HEIs face a multitude of challenges regarding science research management. Particularly, lack of sufficient funding for research, inefficiency in allocating resources towards research, and inadequate incentive mechanisms for personnel involved in research significantly hamper the science research management systems of private HEIs (Auranen & Nieminen, 2010). In the latest years, with the promotion of the national innovation-driven development strategy, high-quality development of science research management has become an important goal for various types of higher education institutions (Sawyerr, 2004). The Chinese government has promulgated a number of policies to promote the development of higher education, including private HEIs, and underlined the following: innovation in science research management is the significant element for enhancing quality in academic research (Mok et al., 2020). However, studies to date show that private HEIs still lack sufficient funding and an out-of-date science research management system that seriously restricts research capacity (Nchinda, 2002). Besides, some literature has mentioned that there is a lack of systematic planning and low efficiency in transforming research outcomes, which leads to the ineffective use of research resources and limited innovation (De Vries et al., 2016).

Government policy support provides a solid foundation for this study. Some examples include the "Innovation-Driven Development Strategy" and the construction plan known as "Double First-Class"; through these, the Chinese government has called explicitly for the strengthening of the research capacity of private HEIs and encouraged the investment increase in research to improve research quality (Tan, 2022). These policies not only give a way for the reform of science research management in private HEIs but also act as the policy basis for this study. As these policies are gradually implemented, it becomes an urgent question of how private

HEIs can optimize their science research management mechanisms within the framework of national policies to enhance their research capacity (Stephens & Graham, 2010). Therefore, it is of great theoretical and practical significance to explore the mechanisms for high-quality development in science research management, suited to private HEIs in China, promote structural optimization, and improve the efficiency of resource allocation (Wang & Fu, 2023).

The key issue of this research is "mechanisms for high-quality development of science research management in private HEIs in China." Based on the institutional framework, this study will also investigate how to build private HEI-fitting science research management models to advance the high-quality development of their research. Among them are the following questions: what does "high-quality development of science research management" mean and how can it be implemented in practice? What are the main bottlenecks and challenges that private HEIs face in science research management? How to optimize the mechanisms of science research management for improving the quality and efficiency of research in private HEIs? Finally, the policies and practices that may drive high-quality development in research at private HEIs. Based on these questions, this study provides a new perspective for understanding how to manage research at private HEIs and offers theoretical support and practical guidance for policymakers and institutional managers.

The above objects are to be reached in the present study by adopting the approach of the so-called grounded theory, based on data collection and analysis through semi-structured interviews. Grounded theory, as an exploratory research method, is particularly suitable for theoretical construction in cases where data are scarce or the research field is relatively novel (Timmermans & Tavory, 2012). Through semi-structured interviews, the study collects the experiences and insights of key stakeholders, including science research management department heads, research project leaders, and research administrative staff, to thoroughly analyze the current state and challenges of science research management in private HEIs. In particular, it carries out interviews with five department heads of science research management, ten research project leaders, and five research administrative staff to ensure the diversity and comprehensiveness of data. The selection of these interviewees provides a multi-dimensional and comprehensive perspective, revealing the critical issues in science research management at private HEIs and laying the theoretical foundation for constructing mechanisms for high-quality science research management.

The structure of this dissertation is as follows: Chapter One introduces the background, significance, and framework of the study. Chapter Two presents a literature review, summarizing the progress of domestic and international research on private HEIs' science research management and high-quality development. Chapter Three describes the research methodology in detail, including the design of the study, methods, and the process of data collection. Chapter Four elaborates on the data analysis and results, discussing from a key perspective some issues in the management of research and ways of optimization. Finally, Chapter Five summarizes the findings, policy recommendations, and practical strategies, and also provides avenues for future research.

2. LITERATURE REVIEW

2.1 Theoretical Approach

Grounded Theory was first introduced in 1967 by Glaser and Strauss as a qualitative method of research oriented to data-driven theory development, rather than the verification of predefined hypotheses (Glaser & Strauss, 2017). In essence, this approach focuses on iterative comparison and coding processes to abstract concepts and categories from data, eventually creating an explanatory theoretical framework (Chun Tie et al., 2019). Particularly, it is applicable in exploratory areas of research, providing strong insights.

In particular, the applicability of GT is especially important for such a study on mechanisms of high-quality science research management in private HEIs (Zhang et al., 2022). First, private HEIs science research management itself involves numerous stakeholders with complex interactions, and different unique management models take place in private HEI settings (Yarime et al., 2012). With the depth of analysis that Grounded Theory allows, for example, critical issues and their possible solutions can be delineated in science research management practices based on actual experiences of administrators, faculty members, and research staff (Hosseini et al., 2022). The openness and flexibility of Grounded Theory mean that the theoretical model will reflect real conditions, thereby increasing the relevance of the research findings (Chun Tie et al., 2019).

The process of the Grounded Theory consists of three stages: open coding, axial coding, and selective coding, according to Corbin & Strauss (2014). During open coding, researchers are involved in preliminary data analysis to identify key concepts and emergent themes as mentioned by Bradley et al. (2007). In axial coding, related concepts are categorized and relationships among them are developed. Finally, in the selective coding stage, core categories are integrated to form a systematic theoretical framework (Charmaz & Bryant, 2019). This bottom-up analytical approach ensures that the resulting framework possesses high explanatory power and practical value (Koontz & Newig, 2014).

Furthermore, high-quality development has become a critical topic in modern higher education, which is expected to advance intrinsic development by rationalizing resource distribution, increasing management efficiency, and innovation in research (Harvey & Williams, 2010). In higher education, high-quality development pays attention not only to the quantity of research outputs but also focuses on originality, practical applications, and social influence (Chankseliani et al., 2021). How private HEIs, under resource-constrained circumstances, develop their innovative management mechanism for high-quality development is an urgent priority in research (Jayabalan et al., 2021).

Grounded Theory provides an effective methodological tool for exploring the underlying factors that constrain high-quality development in science research management at private HEIs (Charmaz & Thornberg, 2021). By integrating the principles of high-quality development with the analytical framework of Grounded Theory, this study seeks to uncover key issues in science research management at private HEIs and propose targeted optimization strategies (Salehi et al., 2023).

2.2 Relevant Concepts

High-value science research management has become a hotspot in higher education, emphasizing the perfection of mechanisms, enhancement of efficiency in resource allocation, and innovation stimulation for simultaneous quantity and quality improvement of research outcomes (Hao et al., 2023). This concept not only emphasizes the volume of research outputs but also prioritizes their originality, utility, and societal impact, aiming to promote the intrinsic development of higher education (Rådberg & Löfsten, 2024). In recent years, with the implementation of the "Double First-Class" initiative and the "Innovation-Driven Development Strategy," the concept of high-quality development has gained significant attention in Chinese universities, particularly in private HEIs (Tan, 2022). Achieving high-quality science research management requires an innovation-driven approach, efficient resource allocation, effective outcome transformation, and sustainable development to maximize the societal and economic contributions of research activities(Tan, 2022).

The construction of mechanisms is central to achieving high-quality science research management, directly influencing management efficiency and the quality of research outcomes (He et al., 2024). A comprehensive science research management mechanism typically includes dimensions such as resource allocation mechanisms, incentive systems, performance evaluation frameworks, and outcome transformation strategies (Modell, 2001). Resource allocation mechanisms aim to ensure the optimal distribution of research resources, supporting priority projects through systematic management and enhancing overall resource utilization efficiency (Drummond et al., 2008). Incentive systems combine material and non-material incentives to stimulate the creativity and motivation of researchers (Hui & Yun-Mei, 2017). Performance evaluation frameworks utilize objective and fair metrics to assess the effectiveness of research activities, ensuring the reasonable utilization of research resources (Ferreira & Otley, 2009). Outcome transformation mechanisms connect research outputs with societal needs through robust intellectual property protections and technology transfer systems, maximizing the practical impact of research activities (Geuna & Muscio, 2009). These mechanisms collectively provide strong support for research activities and form the foundation for achieving high-quality development (Perez-Aleman, 2010).

In the specific context of private HEIs in China, achieving high-quality science research management faces multiple challenges (Mei & Symaco, 2022). First, research resources in private HEIs primarily rely on tuition income, placing them at a relative disadvantage in resource allocation compared to public universities (Garwe, 2016). This limitation significantly affects the scale and depth of research activities (Caner & Tyler, 2015). Second, faculty development remains a prominent issue for private HEIs (James Jacob et al., 2015). Due to diverse sources and high turnover rates among faculty members, the stability and overall quality of their research capacity often lag behind public universities (Auranen & Nieminen, 2010). Additionally, uneven policy support exacerbates this challenge. Although the government has introduced numerous policies to support private HEIs, these institutions still face significant barriers in accessing research funding and policy benefits (Dahle & Neumayer, 2001). However, the management flexibility of private HEIs offers room for innovative mechanisms. For instance, private HEIs manage to enhance science research management efficiency and outcome transformation rates significantly through market-oriented operation or university-industry collaboration (Jongbloed, 2015).

In a word, high-quality science research management and mechanism construction are of theoretical and realistic significance, and the characteristics of private HEIs determine the necessity of the research. This paper will explore how best to optimize mechanisms for resource allocation, incentive measures, performance evaluation, and outcome transformation, and then analyze how private HEIs address resource constraints and adverse policy environments, so as to provide theoretical support and practical guidance for high-quality science research management in private HEI. This context-specific research enriches the theoretical framework of

high-quality development and science research management but also offers direct insights for the practical advancement of private HEIs.

3. RESEARCH METHODOLOGY

3.1 Sample Information

This study uses the theory of Grounded Theory to develop mechanisms that could explain high-quality science research management in private HEIs in China. A total of 20 respondents were interviewed using semi-structured interviews, including five department heads of a science research management department, ten research project leaders, and five research administrative staff. The participants came from a sample of ten private HEIs that are representative across different provinces, considering a variation of institutional characteristics and operational contexts. The institutions were selected to reflect a broad spectrum of organizational structures and geographical regions for comprehensive insight into the challenges and opportunities in private HEI science research management. The macro-level contribution from the heads of the science research management departments provided insight regarding policy frameworks, strategic priorities, and resource allocations in designing and implementing research strategies. The project leaders, being the major performers of the research activities, shared practical experiences related to project application, funding allocation, and the challenges in the transformation of research output. Research administrative staff provided complementary input, especially regarding the procedural and operational aspects of research support, pointing out the administrative complications that create hindrances to efficiency and effectiveness. Each respondent has spent at least three years working, ensuring the stability to capture detailed perspectives in this exploration of science research management practices.

3.2 Data Collection

These interviews were conducted between May and July 2024; this incorporated both face-to-face, online video, and telephone formats to fit their time scales easily. Informed consent concerning the aims of the study, confidentiality of information, and data use was sought from respondents prior to interviews. The nature of the semi-structured interview ensured that essential themes were covered while providing participants with time to elaborate based on their individual experiences. The discussions focused on their comprehension of high-quality science research management, the major challenges and bottlenecks within the existing system, the operational dynamics of key management processes such as resource allocation and performance evaluation, and recommendations to improve science research management practices. Interviews were digitally recorded and transcribed verbatim by removing redundant conversational elements to maintain clarity and focus in the dataset.

Each participant was given a unique code to allow for easy and systematic analysis; the heads of the science research management departments were coded as A1–A5, the research project leaders as B1–B10, and the research administrative staff as C1–C5. The formal nature of the coding done allowed for easy thematic and comparative analyses.

3.3 Data Analysis

The actual data analysis was performed through the systematic procedures of Grounded Theory, using NVivo 12 software for coding and theme development. The analysis had been conducted in three stages: open coding, axial coding, and selective coding. At the open coding stage, the transcripts are reviewed line by line to identify key concepts and emerging themes. For example, statements like "the application process for research funding is overly complicated" were coded as "resource access challenges," while "administrative procedures are too lengthy" was labeled "administrative inefficiency." The stage aimed to capture an exhaustive set of initial concepts in order to represent the participants' lived experiences.

Axial coding was then applied, grouping these first-order concepts into higher-order themes according to their relationships. For example, the codes "resource access issues" and "inequitable distribution of funding" were grouped into the theme "inefficiency in resource management," while the codes "procedural delays" and "administrative tasks duplication" were grouped into "optimization of administrative workflow." This step made it clear how each code was related to higher-order categories.

In the selective coding phase, core categories were synthesized into overarching themes that captured the main focus of the study. These include the articulation of "resource management inefficiencies" to "optimization of resource allocation mechanisms" and "administrative workflow optimization" to "streamlining research administration." This iterative process thus guaranteed that the findings would remain grounded in the data yet germinate toward the objectives of the study.

Finally, the analytic tools in NVivo 12, such as word frequency analysis and cross-group comparisons, were used to tease out the differences and similarities across the three groups of respondents. Department heads of science research management departments focused on strategic resource planning and implementation of policies; the project leaders discussed pragmatic problems with funding and output

transformation, while administrative staff focused on operational efficiency and simplification of processes. These insights together contributed to the development of a theoretical framework that takes a look into the systemic and contextual factors that influence high-quality science research management in private HEIs.

4. RESEARCH RESULTS

4.1 Open Coding

Open coding is considered one of the crucial analytical steps in qualitative research, whereby key concepts are articulated from the raw data and put together into categories. In the present study, the open coding was carried out through a line-by-line reading of interview transcripts from 20 participants by identifying meaningful semantic units and labeling them. Through this process, the main issues and mechanisms underlying the high-quality development of science research management in private HEIs were identified. Open coding has not only allowed the identification of major themes but also laid a structured platform for axial coding.

During the open coding phase, 11 primary categories were obtained from the participants' responses. These span crucial aspects such as resource management, incentive mechanisms, performance evaluation, transforming research output, and administrative processes. They reflect the experiences and insights of participants about science research management practices and highlight various specific challenges and needs for different stakeholder groups.

All interview data were systematically processed by the research team using NVivo 12 software to ensure objectivity and consistency. Where possible, participants' own expressions were used as initial concept labels. Concepts which occurred less than twice were excluded, and broad or vague classifications were avoided. The categories below represent, comprehensively, participants' core concerns regarding the high-quality development of science research management. Table 1 represents the open coding categories and verbatim statements of participants.

Table 1: Open Coding Categories

Category	Original Statements (Descriptive Phrases)
Insufficient Resource Allocation	"The process for applying for research funding is too complicated, and many researchers give up halfway." (A1)
	"Equipment resources are unevenly distributed, making it difficult for certain disciplines to carry out research." (B3)
	"There is insufficient total funding, leaving many projects without start-up capital." (C2)
Inadequate Incentive Mechanisms	"The research reward mechanism is overly simplistic, emphasizing results rather than processes." (B4)
	"There is a lack of long-term support for research teams, leading to instability." (A2)
	"More attractive incentive policies are needed, such as higher opportunities for professional title promotion." (C3)
Unbalanced Performance Evaluation	"We focus too much on the quantity of results, while quality assessments are relatively weak." (A3)
	"The performance evaluation indicators are unclear, so people don’t know how to improve." (B5)
	"Indicators should be more scientific, with greater emphasis on societal impact." (C4)
Lack of Research Output Transformation Support	"There are no specialized institutions to facilitate the marketization of research results." (A4)
	"The promotion of research results is inadequate, and they often remain unused." (B6)
	"There is a lack of clear procedural guidance in the transformation process." (C5)
Complicated Administrative Processes	"The approval time for projects is too long, seriously affecting research progress." (A5)
	"Many steps in the process are repetitive, wasting significant time and effort." (B7)
	"More efficient administrative support is needed to reduce the burden on researchers." (C1)
Team Instability	"Research team turnover is too high, and many project personnel are temporary." (B8)
	"Our team lacks core members, and there is little long-term collaboration." (A1)

Limited Policy Support	"Compared to public universities, the policy support we receive is very limited." (B9)
	"Many policies look good on paper but are ineffective in practice." (A2)
	"We hope for specific research funding policies tailored for private universities." (C2)
Weak Academic Culture	"The institution's internal emphasis on research is insufficient, reducing enthusiasm." (A3)
	"There are too few opportunities for academic exchange, making it hard to spark inspiration." (B10)
	"We hope for more academic activities to enhance the atmosphere." (C4)
Insufficient Project Management Expertise	"Many researchers lack professional knowledge in project management." (A4)
	"Relevant training is needed to help improve project management capabilities." (B6)
	"Poor planning leads to frequent problems later in projects." (C3)
Weak Market Connections	"It is difficult to match research results with market needs, and personal contacts are often relied on." (A5)
	"More opportunities for industry-university collaboration are needed to promote output transformation." (B8)
	"Universities should proactively establish long-term partnerships with enterprises." (C5)
Limited Opportunities for Research Display	"There are few platforms to showcase research results, so people's efforts are overlooked." (A2)
	"More opportunities for display would motivate everyone." (B3)
	"The lack of display platforms limits the dissemination of research results." (C2)

4.2 Axial Coding

The task of axial coding is to identify the logical relationships between categories and group the open codes identified in the previous phase into core themes. In this study, we analyzed the conceptual associations and hierarchical structures among the categories to develop higher-level core codes, thereby uncovering the underlying mechanisms driving the high-quality development of science research management in private higher education institutions (HEIs). Through systematic organization, this study identified six core categories covering resource management, incentive mechanisms, performance evaluation, research output transformation, policy support, and management optimization. The core categories and their corresponding open coding categories are presented in Table 2.

These core codes not only reflect the primary challenges and opportunities in science research management within private HEIs but also reveal the deeper logical relationships within management mechanisms. These insights provide theoretical foundations for constructing efficient and scientific science research management models.

Table 2: Core Coding Categories

Core Category	Subcategories (Open Coding Categories)
Resource Management Optimization	Insufficient Resource Allocation
	Low Efficiency in Resource Distribution
	Lack of Research Output Transformation Support
Incentive Mechanism Reform	Inadequate Incentive Mechanisms
	Team Instability
Performance Evaluation Improvement	Unbalanced Performance Evaluation
	Limited Opportunities for Research Display
Enhancement of Research Output Transformation	Lack of Research Output Transformation Support
	Weak Market Connections
Strengthening Policy Support	Limited Policy Support
	Insufficient Project Management Expertise
Management Process Optimization	Complicated Administrative Processes
	Weak Academic Culture

By organizing the open coding categories into core themes, axial coding highlights the interrelationships and hierarchical structures within the identified challenges. These core categories reveal the systemic and interdependent nature of the mechanisms underpinning the high-quality development of science research management in private HEIs, offering critical insights for constructing effective management strategies.

4.3 Selective Coding

Selective coding represents a further integration and refinement of axial coding in qualitative research, aiming to identify a core category that unifies all dimensions and systematically reveals the logical connections among them. In this study, through an in-depth analysis of the axial coding results, the core category "Resource Integration and Mechanism Optimization for High-Quality science research management Development" was developed. Around this core category, a "storyline" was created to illustrate the complex dynamic mechanisms influencing the high-quality development of science research management in private higher education institutions (HEIs).

This core category reflects the deep interconnections between resources, incentives, performance, research output transformation, policy support, and management optimization. It highlights the key factors and interactions required for achieving high-quality science research management in the context of limited resources. The results of selective coding are presented in Table 3, and the logical relationships between the core category and subcategories are illustrated through typical relationships in Table 4.

Table 3: Selective Coding

Core Category	Axial Coding Categories	Subcategories (Open Coding Categories)
Resource Integration and Mechanism Optimization	**Resource Management Optimization**	Insufficient Resource Allocation
		Low Efficiency in Resource Distribution
		Lack of Research Output Transformation Support
	Incentive Mechanism Reform	Inadequate Incentive Mechanisms
		Team Instability
	Performance Evaluation Improvement	Unbalanced Performance Evaluation
		Limited Opportunities for Research Display
	Enhancement of Research Output Transformation	Lack of Research Output Transformation Support
		Weak Market Connections
	Strengthening Policy Support	Limited Policy Support
		Insufficient Project Management Expertise
	Management Process Optimization	Complicated Administrative Processes
		Weak Academic Culture

Table 4: Typical Relationship Structures

Typical Relationship	Description	Representative Statements from Respondents	Corresponding Open Coding Statements
Resource Optimization → Research Output Efficiency Improvement	Optimizing resource allocation mechanisms significantly improves the production and transformation efficiency of research outputs.	"The funding application process is too complicated, and many researchers give up halfway." (A1)	"Low resource allocation efficiency prevents key projects from progressing smoothly." (B3)

Incentive Mechanism → Enhanced Stability of Research Teams	A well-designed incentive mechanism boosts team morale, reduces turnover, and improves overall research team stability.	"Only successful projects receive rewards, but efforts during the process are not recognized." (B5)	"Lack of long-term incentive policies leads to high team turnover." (C3)
Performance Evaluation Optimization → Research Display and Academic Exchange	Optimizing the performance evaluation system provides more opportunities for research dissemination and promotes academic exchange and cultural innovation.	"Performance evaluation standards focus more on quantity rather than quality, making recognition difficult." (A3)	"More platforms and opportunities to showcase research achievements are needed." (B6)
Policy Support → Increased Success Rate of Research Projects	Tailored policy support for private HEIs significantly enhances the success rate of research projects, addressing resource and management shortfalls.	"Compared to public universities, we receive much less policy support." (B9)	"Policy support is limited, and its implementation is insufficient." (A7)
Research Output Transformation → Enhanced Research Influence	An improved transformation mechanism facilitates the market application of research outputs, increasing the social impact of university research.	"The research output transformation process lacks dedicated support, leaving many results unused." (A4)	"The absence of university-industry collaboration mechanisms prevents results from connecting to market demand." (B8)
Management Process Optimization → Improved Research Efficiency	Streamlined administrative processes allow researchers to focus more on their work, significantly boosting research efficiency.	"The project approval process takes too long, seriously affecting research progress." (C1)	"Complex administrative processes divert researchers' attention from their work." (B10)

Selective coding consolidates the key themes of resource integration and mechanism optimization, providing a cohesive narrative and theoretical foundation for understanding and addressing the challenges of science research management in private HEIs. This process offers practical insights and a structured approach to enhance efficiency and impact in resource-constrained environments.

4.4 Theoretical Model Framework and Corresponding Strategies

This research will construct a systematic theoretical model framework through the analysis of grounded theory on mechanisms of high-quality science research management development in private HEIs in China. It aims to comprehensively reveal the pathways for optimizing science research management in private HEIs operating under resource-constrained conditions. The theoretical model encompasses six modules: resource integration and allocation optimization, incentive mechanism reform, performance evaluation improvement, research output transformation support, policy support enhancement, and management process optimization. It emphasizes the importance of multidimensional synergies in promoting high-quality science research management.

While identifying the key factors that have a bearing on science research management, the framework of the theoretical model makes certain complicated practical problems become detailed sub-modules that can be taken as a guide for private HEIs in the structural improvement of research quality and fostering innovation. The detailed analysis of the model's main components is presented below.

Resource integration and optimization of allocation are the essential driving forces for research activities. This module focuses on enhancing the utilization efficiency of limited resources, with the goal of ensuring that research activities are conducted in an orderly manner. The core of this module is the optimization of resource allocation mechanisms, with the aim of establishing transparent rules for resource distribution, focusing on key projects, and avoiding resource wastage. Promoting cross-departmental resource-sharing mechanisms can further enhance the overall utility of resources, providing more effective support for research activities.

The mechanism for incentives is the most crucial to enhance researchers' motivations and ensure team stability. In private HEIs, the existing mechanisms for material and non-material incentives, such as honor or career development opportunities, need further extension. Furthermore, long-term incentive policies can lower team quit rates, preserve continuity and stability within research teams, and better guarantee the smooth development of research projects.

Performance evaluation systems should directly affect the direction and emphasis of research work. This module of the scientific approach to performance evaluation proposes incorporating quality-oriented and social impact-oriented evaluation criteria into the existing system and reducing overdependence on quantitative indicators. Building a display platform for research achievements can also broaden the channels of propagation of research results, improving the sense of fulfillment of researchers, raising the academic reputation of the institution, and ensuring social recognition.

Transformation of research output is the crucial step in research activities for creating practical social value. This module highlights that private HEIs should strengthen the mechanism of university-industry collaboration and establish special support institutions for research output transformation. The problems of inadequate support for the transformation of research output and difficulties in market integration can be resolved by optimizing the transformation process to facilitate rapid application of research outputs, hence maximizing the social benefits of university research activities.

Policy support is the indispensable outer protective umbrella in conducting science research management for private HEIs. In consideration of the relatively insufficient resources and policy support that private HEIs currently face, this module will suggest that governments and universities should jointly formulate specific policy support programs to facilitate an increase in research funding and resources distribution. It also adds targeted training in project management and research output transformation to enhance overall management capability and to make sure policies can be effectively put into place.

Simplification of the management process and optimization of academic culture are basic guarantees for improving research efficiency and increasing innovation. This module removes some repetitive approval procedures, which will improve administrative efficiency and provide researchers with more time for research. In addition, construction of academic culture-for instance, research salons, academic exchange meetings-can create an innovative environment that encourages the ingenuity of research teams through cooperation.

Based on the theoretical framework, this study provides certain proposals of strategies to respond to practical challenges in managing research in private HEIs, as explained in the model below.

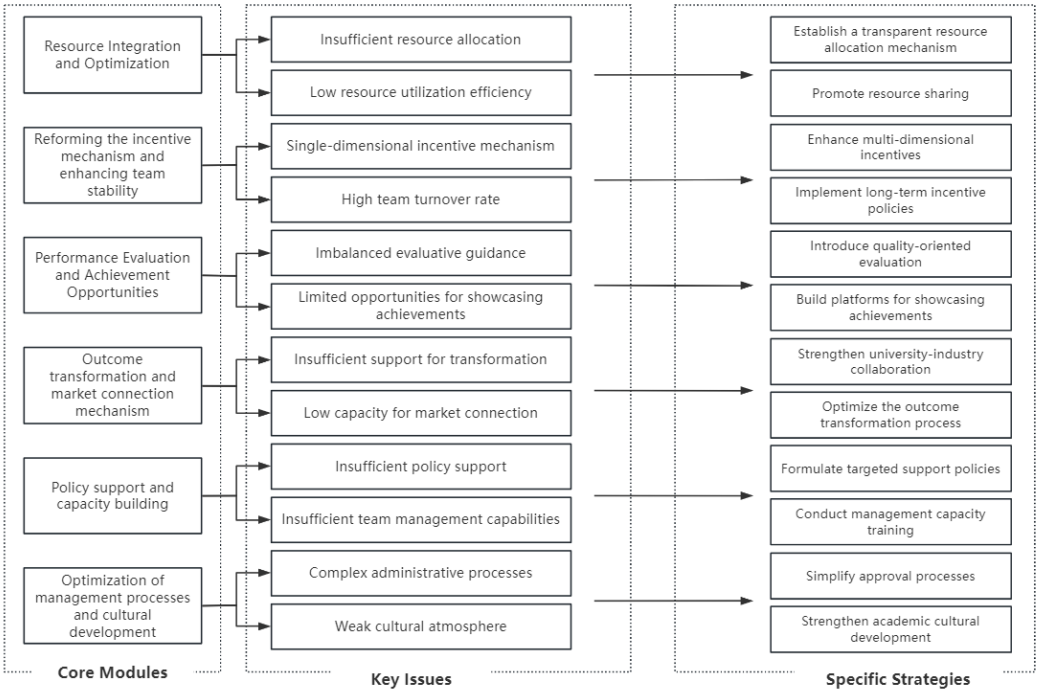

Figure 1. Theoretical Model of High-Quality science research management Development in Private Higher Education Institutions

The theoretical model constructed in this study integrates six critical modules: resource integration and allocation optimization, incentive mechanism reform, performance evaluation improvement, research output transformation support, policy support enhancement, and management process optimization. These interconnected components form a systematic framework designed to address the challenges of science research management in private higher education institutions (HEIs) and provide both theoretical and practical guidance for improving science research management.

The resources-incentives-assessment-transformation-policy-management process model accentuates dynamic interplay at all levels for the achievement of high-quality development; hence, multidimensional coordination plays an important role in it. On the basis of the abovementioned framework, the private HEIs would be able to align the institutional strategy and thereby work more effectively for research, overcome limited resources, and ensure innovation.

4.5 Theory Validation

This study adopts the grounded theory as the core research methodology to construct a theoretical model and strategic framework for the high-quality development of science research management in Chinese private HEIs. The triangulation model is adopted as a critical method for validation to ensure the reliability and validity of the research findings. The triangulation model is an important approach in qualitative research, through which data from different respondent groups are synthesized to show the multidimensionality and consistency of the findings, enhancing the scientific rigor and reliability of the study.

During the validation process, the research focused on interview data from three groups: heads of science research management departments, research project leaders, and research administrative staff. Core themes discussed in this research included resource integration, incentive mechanisms, performance evaluation, transformation of research output, policy support, and process optimization. The results reflected both the shared understanding of the problems in science research management and the differences in perspective. For example, all groups have continuously identified "resource integration and optimization of allocation" and "incentive mechanism reform for team stability." However, there were some differences in the emphasis on policy support and process optimization. This multi-perspective validation further consolidates the applicability of the theoretical model and lays a sound basis for its implementation.

The triangulation model validation process in this study is reflected in the following aspects:

1. Multidimensional Validation: Analyzing interview data across different respondent groups, the research has covered various dimensions like resource management, incentive mechanisms, performance evaluation, and research output transformation to ensure comprehensiveness and depth in the theoretical model. science research management heads prioritized overall optimization of resource allocation and policy support; research project leaders emphasized support for research output transformation and effective incentives; and research administrative staff focused on simplifying administrative processes and enhancing service efficiency. These insights collectively underpin the theoretical model.

2. Verification of Common Themes: The comparative analysis of feedback demonstrated a good convergence of opinions from different groups on important themes such as optimization of resources, reform of the incentive mechanism, and transformation support of research output. These common themes have been identified to be at the core in influencing high-quality development in science research management. The axial and selective coding thus became well matched. This consistency reinforces the validity of the model's critical modules and internal logic.

3. Identification of Differences and Optimization Directions: The triangulation model made it possible to reveal both the differences among respondent groups. In this regard, science research management heads mostly underlined the role and specificity of policy support. Besides, research project leaders placed a higher emphasis on resource allocation in the process of research output transformation, including considerations concerning market alignment. Administrative staff mentioned adverse impacts of complex administrative procedures. These differences not only underscore the diversity of issues in science research management but also inform specific optimization strategies.

4.Integration of Insights into a Theoretical Framework: By integrating and analyzing feedback from all three groups in a systematic manner, this study validated the core themes of the theoretical model while extending the understanding of resource-sharing mechanisms and diversified performance evaluation. For example, all groups emphasized that transparency and equity must be guaranteed in the process of resource distribution, while there is a need to implement diversified measures for incentives. The results further enrich the theoretical basis of the model and provide more precise guidance for practical application.

The confirmation of the triangulation model indicates that from multiple perspectives, the theoretical model is reliable and effective in ensuring high-quality development of science research management in Chinese private HEIs. These findings not only strengthen the importance of core themes such as

"resource integration and optimization of allocation," "reform in incentive mechanism," and "support transformation of research output," but also show group-specific differences which give a clear direction to optimize policies and management practices. The following series of validation underlines the methodological rigor of this study and shows how resource integration, incentive mechanisms, and process optimization contribute to advancing the high-quality development of science research management in private HEIs. It lays a theoretical foundation for further research and practical intervention efforts in this domain.

5.DISCUSSION AND CONCLUSIONS

5.1 Theoretical Implications

The present study offers several key theoretical contributions. It first advances the conceptual definition of "high-quality development in science research management" by systematically analyzing six key modules: resource integration, incentive mechanisms, performance evaluation, research output transformation, policy support, and process optimization. In addition, the multidimensional collaborative framework put forward in this paper underlines dynamic optimization, standing in sharp contrast to prior studies that focused on either singular mechanisms or resource inputs. This framework expands the theoretical boundaries of research in higher education while stressing the interactive processes between the input of resources, support by policies, and the transformation of research output; it therefore covers a crucial gap in the literature on private higher education institutions.

The study uses grounded theory to reveal the dual role of resource allocation in influencing both incentive mechanisms and performance evaluation, offering new insights into science research management when resources are scarce. Specifically, it identifies how rational resource allocation can directly enhance research efficiency while indirectly fostering innovation through incentive mechanisms. In addition, the articulation of the relationship between policy support and transformation of research output further enriches the existing discussions on institutional policy support mechanisms, deepening the theoretical understanding of frameworks for high-quality development.

Finally, the study integrates the special context of private higher education institutions and proposes some innovative management mechanisms in line with resource-poor conditions. This provides a theoretical model for future research on the management of education in resource-scarce conditions that can be replicated. By adopting a dynamic integrative approach, the study calls for a shift in the management of research from single optimization to multidimensional collaboration, which brings new insights into theoretical development in educational management amid an increasingly globalized context.

5.2 Practical Implications

This research gives systematic practical guidance to inspire different kinds of stakeholders in private higher education institution science research management, including university administrators, research teams, policymakers, and social collaborators. It offers a clear roadmap for achieving high-quality development in science research management.

For university administrators, the study highlights the importance of resource sharing and performance evaluation optimization. Establishing interdisciplinary resource-sharing platforms can effectively reduce resource waste and enhance utilization efficiency. Moreover, performance evaluation systems should incorporate multidimensional indicators oriented toward quality and societal impact, avoiding over-reliance on quantitative metrics. Additionally, setting up research output exhibition platforms can enhance researchers' sense of achievement and social recognition while boosting the academic reputation of institutions.

The study recommends that research teams and project leaders design multitiered incentive mechanisms, combining immediate rewards with long-term performance incentives to stimulate enthusiasm and continuous innovation within the team. In order to decrease team turnover, incentive mechanisms should be combined with career development pathways, providing opportunities for academic advancement and innovation recognition to establish stable and long-lasting research teams.

For policymakers, the study suggests that it is necessary to optimize the target support plan for private institutions, especially by offering financial and policy support in resource-poor regions. Support private institutions in using international evaluation standards to improve research quality. The regional policy should be adapted to the specific needs of local institutions, with pilot policy schemes differentiated to improve the adaptability and effectiveness of policy support.

For social collaborators, strategic value has been accentuated in university-industry partnerships within this study. The co-establishment and construction of laboratories and research and development centers between universities and enterprises may encourage the collaborative promotion of industrial application of research outputs. Therefore, this model not only fills the gap between research and market demand but also establishes a sustainable external support system for private institutions, thereby enhancing their societal influence.

In general, this research gives specific guidance to stakeholders on the paths of resource optimization, mechanism reform, and strategies of transformation output. It will give a

systematic solution chain to support high-quality science research management of private higher education institutions under resource-constrained conditions, providing an important practical basis for institutional development.

5.3 Limitations and Future Research

Despite the innovative and practical contributions of the theoretical model proposed in this study, certain limitations necessitate further exploration in future research. First, the study sample is confined to private higher education institutions in China. This geographic and resource-specific focus may limit the model's applicability in varying educational systems. Future studies could incorporate cross-national comparative research to evaluate the model's adaptability in diverse educational and resource contexts.

The second limitation is that this research is basically qualitatively conducted. Even though the interview material succeeds in revealing critical issues in managing the research, the relations among elements of the model have not been validated quantitatively. For example, how resource allocation efficiency will influence performance incentives has not been shown concretely. Future research could also adopt a quantitative approach, like the structural equation model, in order to explore the path and interaction among the model and increase the model's explanatory force and universality.

Third, the study is framed within existing policy and management environments, which imposes temporal constraints. Long-term effects of changes in policy or technological advancement on managing research are difficult to foresee. Future research could employ longitudinal designs that follow over time how the dynamics of policy and resource environments change and their influence on the sustainable development of high-quality science research management.

Last but not least, the sample in this study consists mainly of research managers, project leaders, and administrative staff; thus, other stakeholders' perspectives, such as students and external collaborators, remain unconsidered. Future research should therefore be extended to more stakeholders, especially those involved in university-industry partnerships and broader demand from society. The model would be even more comprehensive and adaptable to the multifaceted challenges of science research management, including the integration of views from external parties.

By addressing these limitations, future research can further refine the theoretical model and extend its relevance, offering more robust insights into the fostering of high-quality science research management in diverse educational and institutional settings.

5.4 Conclusion

This study uses the method of grounded theory to construct the "High-Quality Development Model for science research management in Private Higher Education Institutions," and systematically uncovers the intrinsic logic and synergistic interactions of six core modules: resource integration, incentive mechanism reform, performance evaluation optimization, research outcome transformation, policy support enhancement, and process improvement. The findings reveal that enhancing fairness and efficiency in resource allocation can motivate research teams, multidimensional incentive mechanisms can foster innovation, and policy support combined with research outcome transformation can amplify the research influence of higher education institutions. Together, these approaches enable high-quality science research management under constrained resources.

On the theoretical level, this study expands the academic scope of science research management and enriches the theoretical framework of higher education management through a dynamic systems model. On the practical level, it provides clear action guidelines for university administrators, policymakers, and external collaborators. These guidelines give actionable insights for innovative science research management practices, especially in resource-limited contexts.

The proposed systematic model outlines significant directions for future research, despite its limitations. Future studies can further enhance the model's applicability and practical relevance by integrating quantitative validation, cross-cultural comparisons, and longitudinal analyses. This would contribute robust theoretical and practical support to global higher education reforms and innovation. The study not only advances science research management in China's private higher education institutions but also offers valuable insights into the exploration of high-quality education management on a global scale.

Acknowledgment

This research was funded by Guangzhou Institute of Science and Technology.

Funding Information

This work was funded by the School-Based Research Project of Guangzhou Institute of Science and Technology Research on High-Quality Development Mechanism of Scientific Research Management—Based on the Empirical Analysis of Guangzhou Institute of Science and Technology (No.2023XBZ28).

REFERENCES

Analysing The Quality Of Public And Private Higher Educational Institution In China. (2022). *Journal of Pharmaceutical Negative Results*, 4840-4851. https://doi.org/10.47750/pnr.2022.13.S09.602

Auranen, O., & Nieminen, M. (2010). University research funding and publication performance—An international comparison. *Research Policy*, *39*(6), 822-834. https://doi.org/https://doi.org/10.1016/j.respol.2010.03.003

Bradley, E. H., Curry, L. A., & Devers, K. J. (2007). Qualitative Data Analysis for Health Services Research: Developing Taxonomy, Themes, and Theory. *Health Services Research*, *42*(4), 1758-1772. https://doi.org/https://doi.org/10.1111/j.1475-6773.2006.00684.x

Caner, T., & Tyler, B. B. (2015). The Effects of Knowledge Depth and Scope on the Relationship between R&D Alliances and New Product Development. *Journal of Product Innovation Management*, *32*(5), 808-824. https://doi.org/https://doi.org/10.1111/jpim.12224

Chankseliani, M., Qoraboyev, I., & Gimranova, D. (2021). Higher education contributing to local, national, and global development: new empirical and conceptual insights. *Higher Education*, *81*(1), 109-127. https://doi.org/10.1007/s10734-020-00565-8

Charmaz, K., & Bryant, A. (2019). *The SAGE Handbook of Current Developments in Grounded Theory*. SAGE Publications Ltd. http://digital.casalini.it/9781526452146

Charmaz, K., & Thornberg, R. (2021). The pursuit of quality in grounded theory. *Qualitative Research in Psychology*, *18*(3), 305-327. https://doi.org/10.1080/14780887.2020.1780357

Chun Tie, Y., Birks, M., & Francis, K. (2019). Grounded theory research: A design framework for novice researchers. *SAGE Open Medicine*, *7*, 2050312118822927. https://doi.org/10.1177/2050312118822927

Corbin, J., & Strauss, A. (2014). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. Sage publications. https://doi.org/10.4135/9781452230153

Dahle, M., & Neumayer, E. (2001). Overcoming barriers to campus greening. *International Journal of Sustainability in Higher Education*, *2*(2), 139-160. https://doi.org/10.1108/14676370110388363

De Vries, H., Bekkers, V., & Tummers, L. (2016). INNOVATION IN THE PUBLIC SECTOR: A SYSTEMATIC REVIEW AND FUTURE RESEARCH AGENDA. *Public Administration*, *94*(1), 146-166. https://doi.org/https://doi.org/10.1111/padm.12209

Drummond, M. F., Schwartz, J. S., Jönsson, B., Luce, B. R., Neumann, P. J., Siebert, U., & Sullivan, S. D. (2008). Key principles for the improved conduct of health technology assessments for resource allocation decisions. *International Journal of Technology Assessment in Health Care*, *24*(3), 244-258. https://doi.org/10.1017/S0266462308080343

Ferreira, A., & Otley, D. (2009). The design and use of performance management systems: An extended framework for analysis. *Management Accounting Research*, *20*(4), 263-282. https://doi.org/https://doi.org/10.1016/j.mar.2009.07.003

Garwe, E. C. (2016). Increase in the demand for private higher education: unmasking the "paradox". *International Journal of Educational Management*, *30*(2), 232-251. https://doi.org/10.1108/IJEM-05-2014-0064

Geuna, A., & Muscio, A. (2009). The Governance of University Knowledge Transfer: A Critical Review of the Literature. *Minerva*, *47*(1), 93-114. https://doi.org/10.1007/s11024-009-9118-2

Glaser, B., & Strauss, A. (2017). *Discovery of grounded theory: Strategies for qualitative research*. Routledge. https://doi.org/10.4324/9780203793206

Hao, X., Li, Y., Ren, S., Wu, H., & Hao, Y. (2023). The role of digitalization on green economic growth: Does industrial structure optimization and green innovation matter? *Journal of Environmental Management*, *325*, 116504. https://doi.org/https://doi.org/10.1016/j.jenvman.2022.116504

Harvey, L., & Williams, J. (2010). Fifteen Years of Quality in Higher Education. *Quality in Higher Education*, *16*(1), 3-36. https://doi.org/10.1080/13538321003679457

He, Y., Li, F., & Liu, X. (2024). Research progress on the evaluation mechanism of scientific research teams in the digital economy era. *Journal of Internet and Digital Economics*, *4*(3), 218-241. https://doi.org/10.1108/JIDE-04-2024-0016

Hosseini, E., Saeida Ardekani, S., Sabokro, M., & Salamzadeh, A. (2022). The study of knowledge employee voice among the knowledge-based companies: the case of an emerging economy. *Revista de Gestão*, *29*(2), 117-138. https://doi.org/10.1108/REGE-03-2021-0037

Hui, X., & Yun-Mei, L. (2017, 2017/10). The Influence of Non - material Incentives Based on Team Trust Cognition on Innovation Performance.

Proceedings of the 3rd Annual 2017 International Conference on Management Science and Engineering (MSE 2017), https://doi.org/10.2991/mse-17.2017.39

James Jacob, W., Xiong, W., & Ye, H. (2015). Professional development programmes at world-class universities. *Palgrave Communications*, *1*(1), 15002. https://doi.org/10.1057/palcomms.2015.2

Jayabalan, J., Dorasamy, M., & Raman, M. (2021). Reshaping Higher Educational Institutions through Frugal Open Innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, *7*(2). https://doi.org/10.3390/joitmc7020145

Jongbloed, B. (2015). Universities as Hybrid Organizations. *International Studies of Management & Organization*, *45*(3), 207-225. https://doi.org/10.1080/00208825.2015.1006027

Koontz, T. M., & Newig, J. (2014). From Planning to Implementation: Top-Down and Bottom-Up Approaches for Collaborative Watershed Management. *Policy Studies Journal*, *42*(3), 416-442. https://doi.org/https://doi.org/10.1111/psj.12067

Mei, W., & Symaco, L. (2022). University-wide entrepreneurship education in China's higher education institutions: issues and challenges. *Studies in Higher Education*, *47*(1), 177-193. https://doi.org/10.1080/03075079.2020.1735330

Modell, S. (2001). Performance measurement and institutional processes: a study of managerial responses to public sector reform. *Management Accounting Research*, *12*(4), 437-464. https://doi.org/https://doi.org/10.1006/mare.2001.0164

Mok, K.-H., Welch, A., & Kang, Y. (2020). Government innovation policy and higher education: the case of Shenzhen, China. *Journal of Higher Education Policy and Management*, *42*(2), 194-212. https://doi.org/10.1080/1360080X.2019.1701851

Nchinda, T. C. (2002). Research capacity strengthening in the South. *Social Science & Medicine*, *54*(11), 1699-1711. https://doi.org/https://doi.org/10.1016/S0277-9536(01)00338-0

Perez-Aleman, P. (2010). Collective Learning in Global Diffusion: Spreading Quality Standards in a Developing Country Cluster. *Organization Science*, *22*(1), 173-189. https://doi.org/10.1287/orsc.1090.0514

Rådberg, K. K., & Löfsten, H. (2024). The entrepreneurial university and development of large-scale research infrastructure: exploring the emerging university function of collaboration and leadership. *The Journal of Technology Transfer*, *49*(1), 334-366. https://doi.org/10.1007/s10961-023-10033-x

Salehi, A., Karimian, H., & Sharifirad, G. (2023). Designing the Model of Knowledge Management in Universities: A Qualitative Study [الگوی طراحی کیفی ی مطالعه یک :ها دانشگاه در دانش مدیریت]. *University-of-Hormozgan*, *5*(4), 193-208. https://doi.org/10.22034/5.4.193

Sawyerr, A. (2004). African Universities and the Challenge of Research Capacity Development. *Journal of Higher Education in Africa / Revue de l'enseignement supérieur en Afrique*, *2*(1), 213-242. http://www.jstor.org/stable/24486132

Stephens, J. C., & Graham, A. C. (2010). Toward an empirical research agenda for sustainability in higher education: exploring the transition management framework. *Journal of Cleaner Production*, *18*(7), 611-618. https://doi.org/https://doi.org/10.1016/j.jclepro.2009.07.009

Tan, A. (2022). *Rethinking viewpoints of investigation on global higher education development: Using the case of China to propose an alternative perspective to understand world higher education* Apollo - University of Cambridge Repository]. https://www.repository.cam.ac.uk/handle/1810/364835

Timmermans, S., & Tavory, I. (2012). Theory Construction in Qualitative Research: From Grounded Theory to Abductive Analysis. *Sociological Theory*, *30*(3), 167-186. https://doi.org/10.1177/0735275112457914

Wang, C., & Fu, B. (2023). A study on the efficiency of allocation and its influencing factors on innovation and entrepreneurship education resources in Chinese universities under the five-in-one model. *The International Journal of Management Education*, *21*(1), 100755. https://doi.org/https://doi.org/10.1016/j.ijme.2022.100755

Yarime, M., Trencher, G., Mino, T., Scholz, R. W., Olsson, L., Ness, B., Frantzeskaki, N., & Rotmans, J. (2012). Establishing sustainability science in higher education institutions: towards an integration of academic development, institutionalization, and stakeholder collaborations. *Sustainability Science*, *7*(1), 101-113. https://doi.org/10.1007/s11625-012-0157-5

Zhang, H., Zhang, Q., Huang, G., Ke, J., Zhao, N., Huang, W., & Zhang, J. (2022). Analysis of Evaluation Dimensions of Public Service Motivation of Chinese College Students—Qualitative Study Based on Grounded Theory. *International Journal of Environmental Research and Public Health*, *19*(22). https://doi.org/10.3390/ijerph192215084