

Paradigm shift, path innovation, and institutional guarantee in the construction of humanities and social science laboratories in universities

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Abstract. Against the backdrop of higher education reform and development during the 15th Five-Year Plan period, humanities laboratories specializing in ecological civilization and environmental governance are shifting from "instrumental platforms" to "innovative carriers." Taking provincial-level humanities laboratories as research objects, this paper analyzes the problems existing in their paradigm shift, path innovation and institutional guarantee, and identifies three core tensions: the cognitive tension between disciplinary logic and problem-oriented logic, the value tension between technological empowerment and humanistic persistence, and the institutional tension between short-term performance and long-term accumulation. The key to resolving these tensions lies in realizing a paradigm leap from "instrument-based" configuration to "institution-based" innovation, and further to "culture-based" ecology. Accordingly, the construction of laboratories should adhere to the orientation of "interdisciplinary integration, data-driven research, virtual-real integration and open sharing." By refining top-level design, innovating operational mechanisms, reforming evaluation systems and reinforcing conditional support, we can drive laboratories to evolve from "physical spaces" to "meaningful spaces" and from "experimental platforms" to "ecological spaces," so as to provide support for constructing an independent knowledge system of Chinese philosophy and social sciences.

Keywords: ecological civilization, discipline construction, paradigm shift, support system, humanities laboratory

1. Introduction

Driven by the dual waves of global digital transformation and the New Liberal Arts initiative, humanities laboratories have gradually become core carriers for the transformation of knowledge production paradigms. By facilitating the commercialization of research outcomes to boost industrial upgrading, relying on data simulation to underpin scientific decision-making, and focusing on regional development bottlenecks to advance coordinated progress, humanities laboratories commit themselves to translating academic innovation into tangible productive forces, thereby empowering high-quality development. It should be noted that humanities laboratories are not a recent invention. As early as the mid-19th century, the psychological laboratory founded by Wilhelm Wundt at the University of Leipzig in Germany can be regarded as an early

pioneering practice of humanities laboratories [1]. Since then, experimental methods have been gradually adopted by sociology, political science, economics and other disciplines. In the 1980s, laboratories for humanistic disciplines began to emerge. After entering the 21st century, hundreds of similar institutions have been established worldwide alongside the development of digital technologies. Among them, integrated laboratories featuring interdisciplinary collaboration such as the Language Technology Laboratory at the University of Cambridge, matrix collaborative laboratories such as the Laboratory for Innovation Science at Harvard University, and open networked humanities laboratories such as Yale University's Digital Humanities Laboratory [2] have all become vital platforms for promoting interdisciplinary research.

The development of humanities laboratories in China has undergone three stages: spontaneous exploration by universities (1980s–2005), state-guided advancement (2005–2019), and systematic layout and construction (2019–present). This evolutionary process reflects the expansion of the functional positioning of philosophy and social sciences from "understanding China" to "interpreting and developing China," and has effectively advanced the transformation of humanistic research from "theorizing arguments" to "developing technologies and commercializing products" [3]. In 2021, the Ministry of Education released the list of the first batch of 9 pilot laboratories and 21 incubator laboratories, marking the official state recognition of humanities laboratories. In 2023, the *Measures for the Construction and Administration of Philosophy and Social Science Laboratories (Trial)* issued by the Ministry of Education established humanities laboratories as substantive components of China's university innovation system for philosophy and social sciences. In 2024, the Ministry of Education launched the second round of development for philosophy and social science laboratories, ushering the construction of China's humanities laboratories into a new stage of institutionalization and large-scale development [4]. It is worth noting that the institutional arrangements for China's New Liberal Arts laboratories are not accidental, but an inevitable outcome of the overarching national development strategy to transform research paradigms in philosophy and social sciences. At present, China's humanities laboratories remain in a development phase with multiple missions. Under the overall layout of serving national strategies, the core model through which we uphold humanistic foundations, build an independent Chinese knowledge system, lead transformations in research paradigms and advance interdisciplinary integration remains to be thoroughly explored, so that humanities laboratories can achieve sound development from merely "interpreting the world" to "changing the world."

The rise of humanities laboratories in China is jointly driven by three forces: policy, technology and knowledge, among which national strategies and policy formulation constitute the primary driving force. Top-level designs such as the *Outline for Building a Powerful Education Nation (2024–2035)* clearly stipulate that constructing an independent knowledge system for philosophy and social sciences serves as the fundamental basis for laboratory development. The underlying logic is to propel China's philosophy and social sciences from "following global trends" to "running alongside global peers" and ultimately "taking the lead." The institutional safeguards for China's humanities laboratories originate from top-level design [5], with the integration of government, industry, universities, research institutes and end-users as a core function they undertake [6]. On the technological front, big data, Artificial Intelligence (AI), Virtual Reality (VR) and other technologies are reshaping knowledge production and research paradigms in the humanities, shifting laboratories from theory-driven to data-driven operation and enabling human-machine collaboration to spawn the fifth-generation paradigm (AI4S) [7]. Only in this way can we break through the limitations of traditional research methods, realize dual innovations in laboratories through integrated virtual and physical research paradigms, and achieve transitions from statistical inference to causal inference and from single-discipline research to open network collaboration [8]. Meanwhile, we must guard against challenges brought by the "black box" theory and algorithmic bias, so as to balance the dual effects of humanistic guidance and

technological empowerment [9]. On the knowledge front, national humanities laboratories serve as institutional carriers for the transformation of knowledge production modes from Mode I (discipline-based) to Mode II (problem-oriented) and further to Mode III (open network). It is necessary to build a bridge between academic theories and policy-making through "translating knowledge into evidence" [10]. In addition, regarding knowledge integration pathways, we must clarify the application boundaries of borrowing, consolidation, collaboration and reconstruction models to guarantee the effective operation of experimental scientific paradigms [11]. In recent years, with the rise of environmental psychology, quantitative scientific research on environmental governance has attracted growing academic attention. Since ecological issues form coupled "natural-social" systems, interdisciplinary research models are urgently required to realize in-depth integration at the paradigm level — this constitutes the core research topic of humanities laboratories in the new 15th Five-Year Plan period addressed in this paper.

Therefore, this paper takes the Laboratory of Ecological Civilization and Environmental Governance at Wenzhou University as its core research subject, systematically analyzes the opportunities, challenges and pathways for constructing university humanities laboratories in the new era, and further explores the strategic direction for the development of China's university humanities laboratories. Wenzhou University's humanities laboratory was selected for the first batch of Zhejiang Provincial University Humanities Laboratory construction projects in 2024, and it strives to explore construction pathways for interdisciplinary research platforms, offering unique and enlightening new perspectives for the development of humanities laboratories nationwide.

2. In-depth dilemmas in the construction of humanities laboratories

The current construction of humanities laboratories faces a series of deep-seated dilemmas concentrated in three dimensions: conceptual cognition, institutional arrangements and capacity building, revolving around three core disputes: (1) Do the humanities truly require laboratories? (2) Are there essential differences between humanities laboratories and science and engineering laboratories? (3) What logic should govern the construction of humanities laboratories? Some scholars have pointed out that prevailing unhealthy tendencies exist in the construction of domestic humanities laboratories, namely "prioritizing hardware over software, prioritizing form over substance, prioritizing application preparation over actual construction." Some laboratories have even degenerated into technology exhibition halls rather than genuine sites for knowledge production. The root of this dilemma lies in the lack of systematic and in-depth understanding among relevant stakeholders of the essential attributes, functional positioning and development laws of national humanities laboratories. Therefore, an in-depth analysis is required from the following dimensions:

2.1. Cognitive dilemma: disputes over the necessity and methodology of humanities laboratory construction

The primary challenge confronting humanities laboratory construction lies in conceptual perceptions, centering on value judgments about whether laboratory frameworks are applicable to humanistic research. Influenced by the long-standing bias prioritizing science over the humanities, some university administrators hold the view that humanities research only requires pen and paper, making laboratory construction dispensable [12]. This perception inherently frames laboratories as exclusive spaces for natural sciences, regards the humanities as naturally isolated from experimental frameworks, and even simplifies humanistic learning to nothing more than library research [13]. This mindset demands fundamental clarification. From the global trend of higher education development, academic circles no longer debate whether the humanities need

laboratories, but instead explore how humanities laboratories can construct unique methodological systems [14]. In China, alongside interdisciplinary advancement, a growing number of scholars have accepted quantitative and empirical experimental methods to advance in-depth disciplinary development. Nevertheless, profound methodological disputes persist within academia, revolving around how to define the "scientific nature" of humanistic research. Experimental methods in natural sciences center on replicability and falsifiability, while research objects in social sciences feature historicity, situationality and subjectivity. Thus, discrepancies between experimental effects and real-world effects constitute fundamental doubts [1]. Critics further argue that over-reliance on experimental methods may lead to scientism, which reduces complex social phenomena to quantifiable variables and ignores deep-seated cultural and historical factors, thereby blurring laboratory positioning and hindering resource integration [15]. Supporters, by contrast, maintain that the very complexity of social phenomena necessitates experimental methods to test theories and accumulate empirical evidence [16]. Overall, broad consensus has been reached on the necessity of humanities laboratories, and their research methodologies can be continuously refined through practice.

2.2. Institutional dilemma: structural contradictions between evaluation systems and resource allocation

The second challenge facing humanities laboratory construction emerges from institutional frameworks, manifested as structural contradictions between evaluation systems and resource allocation. In terms of evaluation systems, single standardized criteria clash with diversified multi-modal research outputs. The prevailing mechanism centered on academic papers fails to effectively measure diversified outputs including datasets, tool development and policy briefs, creating a mismatch between multi-modal deliverables and unitary evaluation standards [17]. This stems from the absence of mature, specialized and systematic evaluation criteria. In terms of resource allocation, fragmented resources conflict with demands for interdisciplinary collaboration. Given the difficulty in quantifying outputs and long conversion cycles, humanities laboratories are disadvantaged under performance-oriented management models, suffering from incomplete basic databases, structural equipment imbalances and the tendency to "prioritize hardware over software" [3]. Additionally, the industry witnesses a widespread tendency to "prioritize equipment procurement over utilization" [18], and disciplinary barriers have led to a lack of resource sharing platforms, further exacerbating mismatches between evaluation and resource distribution [19]. Gao and Wei further note that domestic humanities laboratories lag far behind their international counterparts in teams, projects and funding, while institutional inertia in personnel systems conflicts with demands for transformed research paradigms [20]. Furthermore, most faculty assigned to humanities laboratories hold dual teaching and research positions, with no dedicated experimental technical staff, resulting in data shortages and related issues. Though these structural contradictions exist objectively, they can be gradually resolved through enhanced management and improved research capabilities.

2.3. Capacity dilemma: tensions between technological empowerment and humanistic persistence

The third challenge for humanities laboratory construction lies in capacity gaps, concentrated in imbalances between instrumental rationality and value rationality, disparities between technical thresholds and humanistic literacy, and conflicts between data-driven research and meaning construction. As a "double-edged sword," technological tools expand research boundaries yet risk technological alienation, leading researchers to overemphasize "what technologies can accomplish" while neglecting "what research questions ought to be addressed." On the dimension of value rationality, the black-box nature of deep learning models and data bias

challenge the interpretive traditions of the humanities [7]. Humanities laboratories must overcome technological hegemony [21], uphold the subjectivity of humanistic research, and calibrate technological applications toward value-oriented research through humanistic critical thinking [14], seeking integration between technical capacity and humanistic judgment to ensure research tools serve inquiry into core problems. Concerning capacity gaps between disciplines, most administrators of humanities laboratories lack proficiency in operating sophisticated equipment, creating a capacity divide between technological empowerment and humanistic research [22]. Skill requirements such as programming and data analysis have sparked concerns that humanities education is becoming overly engineering-oriented, marginalizing the cultivation of humanistic spirit. Therefore, under the data-driven paradigm, research questions often derive from patterns uncovered within data — this shift risks diverting academic research from the pursuit of meaning toward mere correlation mining, and diluting value concern into instrumental rationality. Accordingly, technological tools should be viewed as new-era expressions of humanistic spirit. A core task for humanities laboratories is to construct a competency model for humanistic researchers and form training pathways for interdisciplinary compound talents.

2.4. Integration challenges: exploring interdisciplinary collaboration in humanities laboratories

Based on the above analysis, the construction of the Laboratory of Ecological Civilization and Environmental Governance at Wenzhou University reflects the integrated manifestations of the threefold dilemmas in practical operation. At the cognitive level, the laboratory faces challenges in identity definition. As a university humanities laboratory, it relies on ecology as its flagship discipline while integrating psychology, economics, Marxist theory, architecture, computer science and other fields. This interdisciplinary structure raises questions about disciplinary evaluation standards: should it be assessed under criteria for humanities laboratories or science and engineering laboratories? The authors argue that as a provincial humanities laboratory approved by Zhejiang Provincial Department of Education, it is fully capable of exploring integrated liberal arts-science pathways to resolve disciplinary positioning issues. At the capacity level, the laboratory grapples with balancing technological application and theoretical innovation. For instance, the research team has achieved remarkable technical outcomes in cyanobacterial bloom control and water quality monitoring, yet exploration continues into how to better serve interdisciplinary talent cultivation systems for ecological civilization. At the resource and institutional level, amid nationwide university staffing contractions, the laboratory plans to recruit high-level interdisciplinary talents proficient in ecology, sociology and technological development. To this end, the laboratory has jointly established a postdoctoral workstation with the Training Center of the Chinese Academy of Social Sciences, which will strongly facilitate the recruitment of interdisciplinary researchers. Clear standards for talent development and in-depth exploration of recruitment for young technical staff remain required for existing personnel training systems. It should be emphasized that the above challenges are not unique to Wenzhou University's humanities laboratory, but represent common problems plaguing humanities laboratory construction nationwide. Resolving these challenges demands exploration of development pathways suited to China's national conditions, grounded in a thorough understanding of the essential attributes of humanities laboratories.

3. Theoretical reconstruction for talent development in humanities laboratories

Building on the preceding discussion, this section focuses on theoretical inquiries into talent development from four dimensions.

3.1. From "instrumental research platform" to "innovative academic cluster"

The traditional instrumental perspective frames humanities laboratories as technical platforms providing data, equipment and methodological support, overlooking their organizational identity as innovative academic clusters. Experiences from world-class university humanities laboratories demonstrate that successful laboratories are essentially academic communities composed of supervisors, students and technical staff united by shared research interests [12]. From an organizational evolution perspective, contemporary open networked laboratories feature decentralized, flat management and form innovative academic clusters centered on co-creation of knowledge [8]. Laboratory governance models have shifted from centralized to flat and networked management [23], representing a transition from isolated academic silos to innovation hubs. This transformation manifests in three features: first, at the organizational level, a shift from hierarchical administration to flat dynamic collaboration; second, at the functional level, a transition from single technical support to integrated multi-objective operations covering knowledge co-creation, talent cultivation and social services; third, at the cultural construction level, a move from task-oriented operations to value community building centered on shared vision and inclusive openness [24]. Accordingly, laboratory construction priorities should shift toward building open academic ecosystems, evaluation criteria should focus on community vitality (i.e., capacity to attract outstanding talent, generate high-quality outcomes and cultivate innovative researchers), and management models should shift from administrative dominance to academic self-governance.

3.2. From "discipline-dependent" to "problem-oriented"

Traditional laboratories are mostly built around single disciplines. While this discipline-dependent model facilitates access to disciplinary resources, it limits capacity to address complex real-world problems. The rise of humanities laboratories has driven a paradigm shift from discipline-based to problem-oriented research, whose core lies in reconstructing the driving mechanism of knowledge production: research is no longer solely driven by internal disciplinary logic, but jointly guided by real social demands and national strategic priorities. Notably, ecological civilization laboratories serve as practical sites for problem-oriented Mode II/III knowledge production [17], requiring laboratories to transcend single-discipline development logic and prioritize external logics centered on environmental governance demands, thereby realizing a transition from disciplinary development logic to problem-solving logic. Its logical starting point lies in responding to major real-world demands through scientific and technological thinking, and advancing the translation of knowledge accumulation into scientific evidence. It should be clarified that problem-oriented research does not negate disciplinary value; rather, it demands disciplinary integration in the process of solving practical problems. This requires humanities laboratories to operate as independent physical entities with autonomous authority over human, financial and material resources. The Ministry of Education has long stipulated that national humanities laboratories should in principle function as relatively independent institutional research bodies within universities, endowed with independent authority over personnel, funds, materials and technical route decision-making [4], a provision that further defines the institutional boundaries of humanities laboratories.

3.3. From "physical space" to "meaningful field"

The third theoretical question concerning humanities laboratory construction concerns understanding the essence of experimental research. Experiments within humanities laboratories encompass controlled experiments, policy simulation, social experiments, action-oriented research and other forms, which means they cannot simply replicate the physical spatial models of science and engineering laboratories, but must expand beyond enclosed campus boundaries. Currently, humanities laboratories are breaking free from narrow

definitions confined to physical premises, evolving into meaningful fields that carry knowledge production, value consensus and identity recognition. These fields encompass not only physical spaces but also interpersonal interactions and collaborative methodologies, forming research environments integrating empirical experience, theoretical inquiry and intelligent simulated modeling [7]. Further exploration reveals their core lies in constructing social networks, trust mechanisms and shared values, extending far beyond physical spatial expansion [15]. In terms of functional boundaries, the experimental premises of humanities laboratories constitute broad spaces for generating meaning. Within humanistic experiments, researchers from diverse disciplines generate problem awareness through dialogue, and convert diverse information into policy proposals through interactive research, forming central hubs for information production and translation [25]. This inherently requires laboratories to break closed single-function structures and design open fields supporting collaborative interaction.

3.4. Foundational insights from ecological civilization humanities laboratories

The three dimensions of theoretical reconstruction outlined above provide clear theoretical guidance and practical pathways for constructing laboratories focused on ecological civilization and environmental governance. Accordingly, this laboratory adheres to a construction model of "leading talent, integrated liberal arts and sciences, joint innovation, global orientation," forming a three-tier functional positioning as an "ecological environment research base," "ecological civilization talent center," and "new-type ecological civilization think tank," evolving from a traditional instrumental platform toward an innovative academic cluster. Tied together by shared research interests, it unites multiple stakeholders including research institutes, government agencies, enterprises, public institutions and social organizations, leveraging flat collaborative mechanisms to stimulate innovation among participants and strive to build highly cohesive academic communities.

Guided by problem-oriented research, the humanities laboratory centers on "ecological civilization and environmental governance," integrates liberal arts and science disciplinary resources within the university, and constructs a three-tier research framework of "ecological monitoring – environmental psychology – intelligent governance," realizing deep integration between disciplinary development and national strategies. At the level of meaningful fields, the laboratory leverages Wenzhou's abundant natural resources to extend research scenarios beyond traditional laboratory premises to real ecological environments, enabling direct application of research outcomes to environmental governance practices. This linkage model of "experiment – natural environment – society" breaks the boundaries of physical space and transforms the laboratory into an expansive meaningful field connecting knowledge production and social application.

4. Institutional safeguards for the sustainable development of humanities laboratories

Following the theoretical reconstruction of talent development frameworks for humanities laboratories, further exploration of institutional safeguard requirements is necessary, analyzed across three dimensions: top-level design, operational mechanisms and evaluation reform.

4.1. Three-tier linked top-level design: state, local and university

Top-level governmental design plays a pivotal role in the development of humanities laboratories. Drawing on international experience, the U.S. federal government funds social science laboratories at numerous universities through the National Science Foundation (NSF), while the United Kingdom guides universities to

increase investment in liberal arts infrastructure via the Research Excellence Framework (REF). Building on these precedents, China can develop a three-tier linked construction system for humanities laboratories spanning "state – local government – university." At the national level, the Ministry of Education has selected two batches of philosophy and social science laboratories starting from 2021, and issued the *Measures for the Construction and Administration of Philosophy and Social Science Laboratories (Trial)* to clarify construction standards and operational norms. At the local level, Zhejiang, Shandong, Sichuan and other provinces have launched selection processes for provincial philosophy and social science laboratories, initially forming a gradient development pattern led by national-level laboratories and supported by local counterparts. As one of the first approved provincial university humanities laboratories, Wenzhou University's Laboratory of Ecological Civilization and Environmental Governance directly benefits from this institutional system and generates China-specific practical experience.

At present, Wenzhou University's humanities laboratory adopts a top-down and bottom-up integrated institutional design. Top-level design addresses two core issues: first, multi-stakeholder collaborative linkage. As a provincial laboratory, it actively engages the Zhejiang Provincial Department of Ecology and Environment, Zhejiang Provincial Department of Education, Zhejiang Federation of Social Sciences and other authorities to obtain development information, while coordinating relations with internal science and engineering laboratories across the university. Second, response mechanisms for dynamic adjustment. The Ministry of Education and Zhejiang Provincial Department of Education have defined fixed construction cycles for laboratories, with post-cycle assessment evaluations providing an institutional foundation for dynamic management. This framework constitutes both a test for laboratory development and a reference model for other provincial-level laboratories nationwide.

4.2. Collaborative allocation operational mechanisms for personnel, finance and assets

The sustainable development of humanities laboratories relies on sound operational mechanisms. Drawing on practical experience from Wenzhou University's Laboratory of Ecological Civilization and Environmental Governance, three core mechanism constructions are highlighted below. In terms of personnel mechanisms, a talent development system combining recruitment and internal cultivation has been established. On one hand, national leading talent programs recruit high-level academic leaders from home and abroad; on the other, young talent programs cultivate promising early-career scholars within the laboratory. Meanwhile, full-time researcher and experimental technician positions are gradually formalized, addressing staffing and professional title evaluation issues for experimental technical staff to stimulate research enthusiasm. In addition, new professional title evaluation systems aligned with product transformation and patent application outcomes are being explored to foster a supportive development ecosystem for researchers. In terms of financial mechanisms, a dual funding guarantee model of "stable base funding + competitive project funding" has been constructed. Stable funding derives from regular university and government appropriations to cover basic laboratory operations, while competitive funding originates from research projects and social service revenues to support targeted research activities. Sustained input from both funding streams provides baseline security for stable laboratory operation. In terms of asset mechanisms, open shared equipment management frameworks have been explored. Given the relatively limited equipment investment in humanities laboratories, resource sharing platforms boost utilization efficiency. The laboratory collaborates with the university library to provide data resources, partners with the School of Computer and Artificial Intelligence to optimize algorithm research, and relies on the university's Information Center to supply computing power, delivering one-stop research services to researchers. For the Laboratory of Ecological Civilization and Environmental Governance, coordinated linkages with municipal and provincial environmental authorities and internal

university schools enable shared access to environmental monitoring data, geographic information systems and other resources.

4.3. Quality-oriented evaluation reform with diversified standards

Evaluation reform acts as the "baton" for resource allocation and constitutes a critical constraint on humanities laboratory development. Currently, domestic humanities laboratories face widespread mismatches between diversified laboratory outputs (such as policy reports, databases and software tools) and unitary paper-centric evaluation standards. The strategy adopted by Wenzhou University's humanities laboratory to resolve this contradiction lies in developing a quality-oriented evaluation system with diversified assessment criteria. In terms of evaluation content, policy impact, social benefits and technological innovation are integrated into indicator frameworks, fundamentally reversing the "paper-only" bias. In terms of evaluation methods, representative output systems and peer review mechanisms are introduced, prioritizing substantive contributions over quantitative output volume. In terms of evaluation cycles, the long-term nature of humanistic research is fully acknowledged through extended evaluation cycles, avoiding suppression of innovative activities by short-term performance assessments. For applied fields such as ecological civilization and environmental governance, capacity to translate research outcomes into environmental policies and support local ecological governance should serve as core evaluation criteria for laboratories. Accordingly, the laboratory establishes "capacity to solve practical problems" as the core benchmark for evaluating research outcomes, adopting an evaluation orientation that "judges research merit by real-world application." The fundamental logic underpinning this evaluation reform is that the ultimate test of scientific research lies in its capacity to drive the transition from merely "interpreting the world" to "changing the world."

5. Practical management insights from Wenzhou University's laboratory construction

In its construction process, the Laboratory of Ecological Civilization and Environmental Governance at Wenzhou University has formed replicable practical insights spanning six dimensions: interdisciplinary organizational mechanisms, technological empowerment pathways, talent cultivation model transformation, breakthroughs in scientific research, expansion of social service functions, and concrete practices for cultural innovation.

5.1. Organizational mechanisms for interdisciplinary collaboration

Systematic exploration of interdisciplinary collaboration at Wenzhou University's humanities laboratory has yielded key progress across disciplinary layout, organizational structure and staffing allocation. In terms of disciplinary layout, a three-tier "core – supporting – radiating" system has been constructed: ecology serves as the core discipline, supported by psychology, Marxist theory and computer science, while economics, sociology and education form foundational fields, creating a complete research chain spanning basic research to applied translation. In terms of organizational structure, a matrix framework combining vertical research fields and horizontal methodological platforms has been established, breaking traditional segmented disciplinary silos to facilitate collaborative innovation. In terms of staffing allocation, a flexible personnel mechanism combining dual-appointment for core researchers and temporary mobility for project-based staff balances team stability and operational flexibility, supplemented by dynamic safeguards of "structural empowerment, standardized linkage and internalized trust" to achieve the development goals of "openness, mobility, collaboration and competition."

5.2. Realization pathways for technological empowerment

Technological empowerment constitutes a core function of humanities laboratories. Wenzhou University's humanities laboratory has explored three primary pathways for constructing technological platforms. First, transformation of research paradigms: multi-source data and machine learning algorithms support water quality prediction models, shifting ecological research from descriptive to predictive paradigms. Second, innovation of experimental methodologies: virtual simulation systems have been developed to simulate environmental governance outcomes under alternative policy scenarios, expanding methodological frameworks for policy research. Third, innovative research models: AI technology enables automated integrated collection, analysis and early warning of technical data. Examples include cyanobacterial control vessels and AI psychological assessment robots that deliver preemptive environmental intervention and risk mitigation. In terms of technological logic, the laboratory prioritizes technology transplantation and situational reproduction, with strict attention to ethical compliance and technological legitimacy. In terms methodological systems, it integrates micro-level individual data analysis, group simulation modeling and human-machine hybrid 360° feedback radar visualization, realizing integrated virtual-physical research and paradigm innovation. In terms of infrastructure, a four-tier technological framework of "sensing – connectivity – computation – feedback" has been established, supported by one-stop services from the university's Smart Information Center to enable assessment visualization and demonstration of research outcomes for social stakeholders.

5.3. Transformative models for talent cultivation

Talent cultivation represents a core mission of national humanities laboratories. Wenzhou University's humanities laboratory has developed a three-in-one talent cultivation model of "project-driven learning, industry-university integrated training, and cross-disciplinary experiential learning." For project-driven learning, authentic research projects are converted into teaching resources, with students deeply participating in water quality monitoring, ecological surveys and field practice, achieving outstanding performance in disciplinary competitions. For industry-university integration, collaborative partnerships with enterprises support digitalized curriculum systems and dual-qualified faculty teams, enabling two-way talent mobility and aligning training programs with industrial development demands to ground research in real-world practice. For cross-disciplinary experiential learning, open humanities laboratories facilitate integration between ecological civilization research and engineering, agriculture and medical disciplines. Partnerships with the School of Computer Science cultivate compound "humanities + AI" talents, significantly boosting the social recognition of humanities laboratories. Furthermore, case simulation and virtual simulation courses strengthen students' practical capacities to identify, analyze and resolve complex problems. The laboratory expands open access, establishes a campus-wide service ethos supporting teaching and research, and co-constructs ecological environmental party-building alliances with social stakeholders to fully implement the fundamental task of fostering virtue through education.

5.4. Innovative breakthroughs in scientific research

Scientific research constitutes the core mission of national humanities laboratories. Wenzhou University's humanities laboratory has delivered multiple groundbreaking advances in ecological civilization and environmental governance research, with specific achievements as follows: Professor Zhao Min's team pioneered purely physical in-situ algae control technology and developed the Feilian algae control vessel to industrialize ecological algae management [26]; Professor Xiao's team discovered that microplastic pollution enhances methanogenic bacterial activity and weakens mangrove carbon sequestration capacity, revealing the

urgency of targeted pollution governance [27]; research teams developed a bionic conservation ark for the critically endangered *Echinotriton chinhaiensis*, providing replicable species protection solutions [28]; Professor Jing's team facilitated three international joint research projects and six inter-university cooperation agreements via Sino-Japanese collaboration, co-developing LED-illuminated bamboo ecological restoration reef equipment to drive technological commercialization [29]; Professor Shi's team constructed a theoretical framework for environmental psychology in ecological civilization covering six core themes: crisis management, risk perception, emotional guidance, resilience development, crisis decision-making, filling domestic theoretical gaps in this interdisciplinary field [30]. The above research outcomes demonstrate that Wenzhou University's humanities laboratory has formed a complete research chain of "theoretical construction – mechanism revelation – tool development – technological intervention – applied promotion," advancing disciplinary innovation through integrated liberal arts and science collaboration.

5.5. Expanded functions for social service delivery

The ultimate mission of humanities laboratories lies in serving society. Research outcomes generated by Wenzhou University's humanities laboratory fall into three categories: academic, service-oriented and technical deliverables, translated through government procurement, university-industry cooperation and independent development channels. At the government service level, the laboratory has established a three-in-one service system of "decision-making consultation, technology transformation and science popularization education." For decision-making consultation, it leverages think tank functions to strengthen the scientificity of governmental policy-making via data analysis and policy simulation, while conducting public psychological and behavioral analysis to support administrative decision-making. For technology transformation, an integrated government-industry-university-research-end-user platform advances industrialization of research outcomes. For instance, cyanobacterial bloom control technology was successfully applied to the dragon boat competition waters of the Hangzhou Asian Games, realizing effective translation from theoretical research to practical application. For science popularization education, carriers including the Sanyang Wetland Research Institute deliver public ecological civilization education via simulated modeling and immersive narrative experiences. In summary, technological services extend laboratory outreach to urban and rural grassroots communities, industrial parks and nature reserves for field research and scientific support, raising public environmental awareness and expanding the social influence of humanities laboratories.

5.6. Practical implementation of cultural innovation

Cultural inheritance and innovative promotion serve as the spiritual bond of humanities laboratories. Within the field of ecological civilization and environmental governance, Wenzhou University's humanities laboratory systematically advances ecological cultural construction through institutionalized cultural development and educational inheritance via three pathways. First, constructing ecological values through themed activities and curricula. On Earth Day, environmental handicraft workshops help the public re-evaluate the value of waste materials; social practice teams deliver game-based ecological bottle courses to rural primary schools; environmental fairs are organized in low-carbon pilot villages to translate governance knowledge into cultural interaction and foster community environmental awareness. Second, constructing spatial narrative platforms through venue design. Relying on an aerial micro-farm platform operated by the School of Education, the laboratory reconstructs human-nature relationships on rooftop spaces, embodying the educational efficacy of viewing physical spaces as living curricula. During architectural design weeks, themed sessions focus on urban resilience construction to integrate ecological and cultural dimensions, rendering the built environment a "silent educator." Third, constructing low-carbon institutional frameworks through management mechanisms.

A student self-managed energy conservation model for water and electricity consumption has been implemented within the laboratory, reducing carbon emissions while cultivating students' thinking aligned with new productive forces, internalizing resource conservation as campus culture. Collectively, these initiatives embed ecological concepts within cognition, materialize them through spatial design, and institutionalize them via management rules, systematically advancing comprehensive construction of ecological culture.

6. Conclusion

Taking Wenzhou University's humanities laboratory as a case study, this paper systematically explores the opportunities, challenges and development pathways for constructing university humanities laboratories during the 15th Five-Year Plan period. Research findings indicate that three core tensions hinder the construction of humanities laboratories in practice: the cognitive tension between disciplinary logic and problem-oriented logic, the value tension between technological empowerment and humanistic persistence, and the institutional tension between short-term performance evaluation and long-term research accumulation. The key to resolving these tensions lies in realizing a paradigm leap from instrumental technological configuration at the material level, to institutional mechanism innovation at the organizational level, and ultimately to cultural ecological construction at the cultural level. Accordingly, university humanities laboratories should adhere to the development orientation of "interdisciplinary integration, data-driven research, virtual-real integration and open sharing." By refining top-level design, innovating operational mechanisms, reforming evaluation systems and reinforcing supporting conditions, we can drive laboratories to evolve from "physical spaces" to "meaningful spaces" and from "experimental platforms" to "ecological spaces," providing solid institutional support and practical foundations for constructing an independent knowledge system of Chinese philosophy and social sciences. More importantly, against the backdrop of deep integration between digital intelligence technologies and humanistic spirit, humanities laboratories are poised to become critical bridges connecting technology and humanity, knowledge and action, China and the world, contributing Chinese academic discourses, practical solutions and intellectual resources to the advancement of human civilization. It should be particularly noted that domestic humanities laboratories feature diverse typologies. While Wenzhou University's practical experience has achieved notable progress in generalizability, cross-regional and cross-cultural comparative research remains required to further test its universal applicability. Future theoretical exploration and practical verification of humanities laboratories should adopt international comparative perspectives to conduct effect evaluation, benchmarking and model analysis, further testing and enriching the effectiveness of the theoretical framework and practical pathways developed by Wenzhou University's humanities laboratory.

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