DOI: 10.66069/ojspub.27450722

Research on the Dilemmas and Collaborative Mechanisms of Traditional Chinese Medicine Informatization in China

Xiang Cui, Jing Ouyang*

School of Humanities Management and Foreign Languages, Shaanxi University of Chinese Medicine, Xianyang 712046, Shaanxi, China
**Correspondence Author*

Abstract: ***Background**: Traditional Chinese medicine (TCM) informatization in China has progressed from basic hospital information system construction toward regional platforms, data governance, intelligent diagnosis, and digital service integration. However, development remains constrained by fragmented infrastructure, insufficient standardization, weak interoperability, uneven data quality, a shortage of interdisciplinary professionals, and limited integration between artificial intelligence and TCM theory. **Objective**: This focused narrative review aims to analyze the major dilemmas of TCM informatization in China and propose collaborative mechanisms for sustainable and clinically meaningful development. **Methods**: Representative Chinese literature was reviewed across six themes: TCM informatization pathways, digital empowerment of TCM hospitals, regional electronic medical record systems, data governance and security, AI-assisted syndrome differentiation and clinical decision support, and talent development for informatization. **Results**: Four major dilemmas were identified: fragmented infrastructure and uneven capacity, constraints in data standardization and governance, insufficient clinical translation of AI and TCM theory, and organizational and workforce limitations. Correspondingly, four collaborative mechanisms are proposed: policy and institutional coordination; data standardization and secure sharing; clinical knowledge-data-technology co-development; and a mechanism for talent development, evaluation, and feedback. **Conclusion**: TCM informatization should shift from isolated system construction to collaborative digital governance. Future development should strengthen integrated infrastructure, standardized data representation, secure data circulation, theory-grounded AI, multimodal clinical intelligence, interdisciplinary talent cultivation, and continuous evaluation mechanisms.*

Keywords: Traditional Chinese Medicine, Informatization, Digital transformation, Collaborative mechanisms, Data governance, Artificial intelligence, Syndrome differentiation.

1. Introduction

Traditional Chinese medicine (TCM) informatization has become an important part of China's health service modernization and the inheritance and innovation of TCM. Digital technologies, including cloud computing, big data, artificial intelligence, mobile health applications, and intelligent diagnostic devices, have been increasingly applied in TCM hospitals, regional platforms, grassroots institutions, and clinical research, improving service accessibility, clinical efficiency, data governance, and knowledge transmission [1,2].

However, TCM informatization is not merely a process of technological upgrading. It must address distinctive clinical information such as tongue and pulse findings, syndrome differentiation, pathogenesis judgment, herbal prescription logic, constitution identification, and follow-up evaluation. Existing studies show progress in electronic medical records, regional platforms, and AI-assisted diagnosis, but persistent dilemmas remain, including fragmented infrastructure, weak interoperability, uneven data quality, insufficient TCM-specific standards, talent shortages, and limited clinical translation[3].

2. Review Approach and Analytical Perspective

2.1 Review Orientation and Literature Scope

This article adopts a focused narrative review approach. A focused narrative review is appropriate when the objective is to synthesize conceptual developments, identify practical problems, and construct an analytical framework from representative literature. Unlike a systematic review, it does not aim to identify all available studies or conduct a quantitative evidence synthesis. Instead, it emphasizes conceptual integration and problem-oriented analysis, which is suitable for examining the dilemmas and collaborative mechanisms of TCM informatization.

The reviewed literature covers six interrelated themes: TCM informatization pathways under high-quality development, digital empowerment of TCM hospitals, regional electronic medical record systems, data governance and security, AI-assisted syndrome differentiation and clinical decision support, and talent development for informatization. Macro-level studies provide the policy and institutional background of TCM informatization, while hospital-level and clinical-level studies reveal the operational and technical issues that arise in practice. Together, these studies offer a foundation for analyzing both the external governance conditions and the internal clinical and technical constraints of TCM informatization.

The review pays particular attention to the distinction between informatization and collaborative digital transformation. Informatization often refers to the construction of information systems and the digitization of administrative or clinical processes. Collaborative digital transformation goes further. It requires data to flow across institutions, standards to be applied consistently, clinical knowledge to be translated into computable forms, AI models to be explainable and clinically

usable, and organizational mechanisms to support continuous learning. This distinction is important because many current problems are not caused by the absence of information systems, but by weak coordination among systems, data, knowledge, personnel, and governance.

2.2 Analytical Perspective: Dilemmas and Collaborative Mechanisms

In this paper, "dilemma" refers to a structural problem that cannot be solved by a single technology, institution, or professional group. For example, the problem of heterogeneous TCM data is not only a technical issue of database integration; it also involves terminology standards, clinical documentation habits, data quality control, privacy protection, intellectual property governance, and incentives for data sharing. Similarly, the limited clinical application of AI-assisted syndrome differentiation does not stem solely from algorithmic limitations; it is also related to the complexity of TCM reasoning, the lack of high-quality datasets, weak model interpretability, insufficient clinical validation, and limited trust among clinicians.

The concept of a collaborative mechanism is therefore central to this review. It refers to a set of institutional, technical, clinical, and organizational arrangements through which multiple actors coordinate their actions to advance TCM informatization. These mechanisms include policy coordination, data standardization and sharing, knowledge-data-technology co-development, interdisciplinary talent cultivation, cybersecurity governance, clinical evaluation, and feedback-based improvement. A collaborative mechanism is not a single administrative measure but a multi-level governance structure that enables fragmented resources to become an integrated digital ecosystem.

Based on the reviewed literature, this paper proposes a four-dimensional analytical structure. The first dimension is infrastructure collaboration, which concerns the integration of hospital information systems, regional platforms, cloud services, and intelligent diagnostic devices. The second dimension is data governance collaboration, which concerns standards, interoperability, quality control, secure sharing, and data reuse. The third dimension is clinical-intelligence collaboration, which concerns AI-assisted syndrome differentiation, multimodal data from the four diagnostic methods, knowledge representation, and TCM theory. The fourth dimension is organizational collaboration, which concerns talent, management, incentives, evaluation, and institutional responsibility.

3. Major Dilemmas of TCM Informatization in China

3.1 Fragmented Infrastructure and Uneven Service Capacity

The first dilemma is the fragmentation and uneven development of information infrastructure. Many TCM hospitals have established basic information systems for registration, billing, pharmacy management, electronic medical records, and hospital administration. These systems have improved work efficiency, but they are often developed according to general hospital management logic rather than TCM clinical logic. As a result, they may not fully support tongue diagnosis records, pulse information, syndrome elements, individualized prescription reasoning, constitution assessment, or continuous therapeutic evaluation [3].

Regional platforms and cloud-based electronic medical records provide a useful direction for overcoming institutional fragmentation. The construction of a TCM outpatient electronic medical record cloud in Xiamen, for example, linked grassroots healthcare institutions with TCM hospitals and supported electronic medical record documentation, quality management, TCM diagnosis and treatment reporting, intelligent diagnostic support, and regional collaborative care [4]. This type of platform demonstrates that TCM informatization can support not only intra-hospital management but also regional service collaboration.

Nevertheless, the infrastructure gap remains significant. County-level and grassroots TCM institutions may face inadequate hardware, insufficient technical teams, limited funding, and weak capacity to maintain or upgrade systems. Even when information systems are installed, they may not be deeply embedded into clinical workflows. Some systems become administrative tools rather than clinical decision-support tools. In addition, isolated platforms reduce the value of regional collaboration because data cannot easily flow across institutions, departments, and clinical scenarios. This dilemma suggests that infrastructure construction must shift from isolated deployment to integrated architecture.

3.2 Standardization, Interoperability, and Data Governance Constraints

The second dilemma lies in data standardization, interoperability, and governance. TCM data are highly complex and may be derived from classical literature, electronic medical records, tongue images, pulse waveforms, inquiry records, herbal prescriptions, syndrome scales, follow-up information, patient-generated health data, and real-world clinical practice. These data are multi-source, heterogeneous, and often recorded in free text, making them difficult to integrate, compare, reuse, or transform into machine-readable knowledge.

Electronic medical records are a primary source of real-world TCM clinical data, but their value depends on whether they can represent TCM-specific information in a structured and standardized way. If syndrome names, symptom descriptions, pulse findings, tongue images, treatment principles, and prescriptions are recorded inconsistently, the resulting data cannot effectively support quality control, knowledge mining, clinical decision support, or real-world evidence generation. Therefore, TCM informatization requires standardized electronic records that reflect both biomedical information and TCM diagnostic logic.

Data governance is also linked to security and trust. The rise of large language models and multimodal AI has increased the strategic value of TCM data. Intelligent diagnosis requires large-scale, high-quality, and clinically meaningful datasets, but data sharing must be balanced with privacy protection,

cybersecurity, intellectual property protection, and ethical oversight. TCM diagnostic data may contain sensitive patient information as well as the accumulated experience of senior TCM physicians. If governance mechanisms are weak, data circulation may generate legal, ethical, and security risks [8].

3.3 Insufficient Clinical Translation of AI and TCM Theory

The third dilemma is the insufficient integration between AI models and TCM clinical theory. AI-assisted syndrome differentiation has developed from expert systems and knowledge-based reasoning to machine learning, deep learning, knowledge graphs, and large language models. These technologies have expanded the technical possibilities for intelligent diagnosis, but the clinical utility of such systems depends on whether they can reflect TCM reasoning rather than merely produce statistical predictions [5].

Several technical and clinical challenges remain. Public datasets are limited, and the quality of available data varies across institutions. Many models are designed for specific diseases, specific departments, or narrow clinical scenarios, resulting in weak generalizability. Deep learning models may achieve acceptable prediction performance but lack interpretability. This is especially problematic in TCM because clinical reasoning depends on the relationships among symptoms, syndrome elements, disease location, disease nature, pathogenesis, treatment principles, and prescription formulation. A model that cannot explain these relationships is unlikely to gain sustained clinical trust [6].

The challenge is not to replace TCM physicians with algorithms but to build theory-grounded clinical intelligence. One promising approach is to develop intelligent platforms centered on pathogenesis, using TCM theory as the organizing core for clinical data, knowledge graphs, deep learning models, decision support, treatment-response prediction, and evidence generation [7]. Such platforms may help transform tacit clinical reasoning into computable knowledge without reducing TCM practice to mechanical classification.

3.4 Organizational and Workforce Limitations

The fourth dilemma concerns organizational capability and workforce development. TCM informatization requires interdisciplinary professionals who understand information technology, TCM theory, clinical medicine, data governance, hospital management, and cybersecurity. However, studies of TCM hospitals indicate that informatization departments still face problems such as insufficient personnel, uneven staff distribution, an imbalanced professional composition, and limited research capacity caused by heavy routine maintenance work [12].

This workforce dilemma has direct consequences for digital transformation. Without skilled professionals, hospitals may be able to purchase software but be unable to optimize workflows, control data quality, evaluate AI applications, or maintain cybersecurity. Clinicians may also lack the digital literacy needed to use intelligent systems critically. Conversely, technical staff may lack sufficient understanding of TCM concepts, making it difficult to translate clinical logic into computable structures. This gap between clinical knowledge and technical implementation weakens the sustainability of TCM informatization.

Organizational mechanisms are equally important. Some hospitals lack clear leadership structures for digital transformation, such as a chief information officer role, a cross-departmental data governance committee, or a clinical evaluation system for digital applications. Without institutional coordination, digital projects may remain isolated, duplicated, or unsustainable. Therefore, the workforce dilemma is not merely a problem of personnel quantity; it is a governance problem that requires coordinated institutional design. In addition, many digital projects lack continuous evaluation and feedback mechanisms, making it difficult to assess clinical usability, patient experience, data quality, and long-term service value.

4. Collaborative Mechanisms for Advancing TCM Informatization

4.1 Policy and Institutional Coordination Mechanism

The first collaborative mechanism is policy and institutional coordination. TCM informatization involves multiple levels of governance, including national and provincial health authorities, TCM administrative departments, hospitals, regional platforms, research institutions, and technology enterprises. A coordinated policy mechanism should clarify responsibilities, define development priorities, allocate resources, and promote consistency across regions and institutions. It should also prevent duplicative system construction, fragmented procurement, and technology-driven expansion without clinical value.

Policy coordination should be linked to high-quality development. The purpose of TCM informatization is not only to build systems, but to improve service quality, clinical efficiency, equity, safety, and governance capacity. Therefore, digital projects should be evaluated according to whether they improve clinical workflow, support grassroots services, strengthen data quality, enhance patient experience, and contribute to TCM inheritance and innovation. This requires an institutional shift from project-based construction to continuous digital governance.

At the hospital level, leadership structures should be strengthened. TCM hospitals may establish a chief information officer role, an interdisciplinary digital transformation committee, and a data governance working group. These bodies can coordinate clinicians, managers, information technology departments, data security officers, and external technology providers. Their task is to ensure that digital systems are aligned with clinical needs and institutional goals rather than existing as isolated technical assets.

4.2 Data Standardization and Secure Sharing Mechanism

The second collaborative mechanism is data standardization and secure sharing. TCM data cannot become a strategic resource unless it is standardized, interoperable, and

trustworthy. A collaborative data mechanism should include standardized terminology systems, structured electronic record templates, data element standards, quality control procedures, metadata management, and interoperability protocols. These standards should cover both general medical information and TCM-specific information such as symptoms, syndrome elements, tongue and pulse findings, pathogenesis judgment, treatment principles, prescriptions, and therapeutic outcomes.

Secure sharing is equally important. TCM data governance should establish rules for consent management, de-identification, access control, audit trails, data ownership, intellectual property protection, and risk assessment. Because TCM diagnostic data may embody both patient information and physicians' clinical experience, data-sharing mechanisms must protect privacy and professional knowledge while enabling legitimate research and clinical use [8]. A balance is needed between data openness and data security.

Regional collaboration can provide a practical setting for data sharing. Regional platforms can support standardized electronic medical records, shared prescription services, remote diagnosis, referral management, and quality control. For grassroots institutions, shared cloud-based systems may reduce technical burdens and improve access to TCM expertise. For tertiary TCM hospitals, regional platforms may generate larger and more diverse real-world datasets, supporting clinical research, AI model development, and service evaluation.

4.3 ClinicalKnowledge-Data-Technology Co-development Mechanism

The third collaborative mechanism is the co-development of clinical knowledge, data, and technology. AI-assisted TCM diagnosis should not be driven by algorithms alone. It requires TCM clinicians to define meaningful clinical problems, informaticians to structure data, AI researchers to design models, and administrators to support implementation and evaluation. This collaborative process can reduce the risk that AI systems become technically sophisticated but clinically irrelevant.

Knowledge representation is a key task. TCM theory contains rich conceptual relationships among symptoms, syndrome elements, disease nature, disease location, pathogenesis, treatment principles, formulas, herbs, and therapeutic effects. Knowledge graphs, syndrome-element models, pathogenesis-centered platforms, and hybrid knowledge-data methods may help formalize these relationships and improve model interpretability [7]. In this way, AI can become a tool for representing and extending TCM reasoning rather than replacing it.

Multimodal data fusion should also be developed collaboratively. TCM clinical practice relies on inspection, auscultation and olfaction, inquiry, and palpation. Intelligent image processing has been used in tongue image analysis, facial complexion analysis, herbal identification, and digital meridian visualization, but it still faces problems such as a lack of standardized datasets, inconsistent acquisition conditions, weak annotation, poor interpretability, and overreliance on single-modality data [9]. Future systems should integrate image data with text, voice, pulse waveforms, laboratory indicators, and follow-up outcomes.

Clinical evaluation should be embedded into model development. Syndrome scales may provide a bridge between subjective clinical judgment and quantitative assessment. When combined with AI, structured syndrome scales may support a closed-loop model of syndrome differentiation, diagnosis, treatment, and evaluation [10]. TCM preventive-treatment knowledge service systems also show that TCM theory can be digitized, structured, and transformed into health management services [11]. These examples suggest that clinical intelligence should support not only diagnosis but also evaluation, prevention, rehabilitation, and long-term health management.

4.4 Talent, Evaluation, and Feedback Mechanism

The fourth collaborative mechanism is talent cultivation, evaluation, and feedback. TCM informatization requires a new type of interdisciplinary workforce. This workforce should include digital physicians, medical engineers, clinical informaticians, data managers, AI engineers, knowledge engineers, cybersecurity professionals, and specialists capable of translating TCM knowledge into computable structures. Universities, TCM hospitals, research institutes, and enterprises should jointly design training programs that combine TCM theory, clinical practice, data science, AI, hospital management, and ethics [12].

Evaluation mechanisms should also be collaborative. Digital transformation should not be assessed only by the number of systems installed or the amount of investment. More meaningful indicators include interoperability, data quality, clinical usability, patient experience, decision-support effectiveness, operational efficiency, cybersecurity, clinician acceptance, and contribution to TCM inheritance and innovation. Pilot projects should be evaluated through real-world data, multicenter validation, clinician feedback, and patient-centered outcome indicators.

Feedback mechanisms are essential for sustainable development. Data generated in clinical practice should feed back into model optimization, knowledge updating, service improvement, and policy adjustment. Clinicians should be able to report errors, refine rules, and explain why a recommendation is or is not clinically appropriate. Patients' outcomes and experiences should also be incorporated into system evaluation. Through continuous feedback, TCM informatization can move from one-time system construction to a learning digital ecosystem.

5. Discussion, Limitations and Conclusion

5.1 Discussion: From Isolated Informatization to Collaborative Governance

The analysis above shows that the main obstacles to TCM informatization are not isolated technical defects but systemic coordination problems. Infrastructure fragmentation reflects weak coordination among institutions and platforms. Data standardization problems reflect weak coordination among

clinical terminology, documentation habits, governance rules, and technical standards. The limited clinical translation of AI reflects weak coordination among TCM theory, data resources, algorithm design, interpretability, and validation. Workforce limitations reflect weak coordination among education, hospital management, career development, and interdisciplinary collaboration.

For this reason, the future of TCM informatization should be understood as collaborative governance. Technology remains important, but it should be embedded in institutional arrangements, clinical logic, data governance, and continuous evaluation. A collaborative governance perspective can also help prevent two common misunderstandings. The first is technological determinism, which assumes that introducing advanced technologies automatically improves TCM services. The second is conservative isolationism, which treats TCM theory as incompatible with digital methods. A more productive approach is to use digital technologies to represent, test, refine, and extend TCM knowledge while respecting its clinical logic.

The proposed collaborative mechanisms can support this transition. Policy coordination provides institutional direction. Data standardization and secure sharing provide the foundation for trustworthy reuse. Clinical knowledge-data-technology co-development ensures that AI systems remain aligned with TCM reasoning. Talent and evaluation mechanisms ensure sustainability. Together, these mechanisms can transform fragmented informatization projects into an integrated system that supports clinical service, research, prevention, and governance.

5.2 Limitations

This review has several limitations. First, it is a focused narrative review rather than a systematic review, and therefore it did not involve an exhaustive database search or quantitative evidence synthesis. Second, most of the reviewed studies are Chinese-language publications, which may limit international generalizability. Third, the proposed framework is conceptual and requires further validation through empirical studies, multicenter investigations, real-world data analysis, clinical usability testing, and outcome-based evaluation. Fourth, AI technologies are developing rapidly, and the dilemmas and collaborative mechanisms discussed here may need to be updated as new technical and regulatory conditions emerge.

5.3 Conclusion

TCM informatization in China has entered a stage in which the main task is no longer simple system construction but collaborative digital governance. Current development faces multiple dilemmas, including fragmented infrastructure, insufficient standardization and interoperability, weak data governance, limited integration between AI and TCM theory, and a shortage of interdisciplinary professionals. These problems cannot be solved by technology deployment alone. Future development should build collaborative mechanisms among policy, institutions, data, clinical knowledge, technology, talent, and evaluation. Specifically, TCM informatization should prioritize integrated infrastructure, standardized electronic records, secure data sharing, theory-grounded AI, multimodal data fusion across the four diagnostic methods, pathogenesis-centered knowledge representation, human-machine collaborative workflows, interdisciplinary talent cultivation, and continuous feedback-based evaluation. Through these mechanisms, TCM informatization can better support high-quality service delivery, clinical decision-making, evidence generation, preventive health management, and the modernization of TCM.

References

[1] Xiao Yong, et al. “Study on the implementation path of TCM informatization construction in China under high-quality development.” Lishizhen Medicine and Materia Medica Research 33.11 (2022): 2809-2811.

[2] Zhang Jingyi, et al. “Connotation and thought of high-quality development of Traditional Chinese Medicine hospital under the empowerment of digital technology.” Chinese Hospital Management 42.6 (2022): 13-15.

[3] Zhang Junfeng. “Some thoughts on information construction of Traditional Chinese Medicine hospital.” *China Health Standard Management* 13.20 (2022): 6-10.

[4] Liu Hui, Xu Leqin, and Chen Shaomei. “The construction and application of TCM electronic medical record cloud in Xiamen.” Chinese Journal of Health Informatics and Management 16.6 (2019): 690-694.

[5] Wen Zhihua, et al. “Discussion on the evolution and problems of intelligent syndrome differentiation diagnosis technology in Traditional Chinese Medicine.” Modernization of Traditional Chinese Medicine and Materia Medica-World Science and Technology 23.11 (2021): 4297-4303.

[6] Song Yijie, et al. “AI-assisted TCM syndrome differentiation: key issues and technical challenges.” Strategic Study of Chinese Academy of Engineering 26.2 (2024): 234-244.

[7] Shi Zhaofeng, et al. “Constructing a pathogenesis-core intelligent information platform for TCM in the context of individualized research.” Modernization of Traditional Chinese Medicine and Materia Medica-World Science and Technology 26.1 (2024): 429-436.

[8] Gao Yuan, et al. “Thoughts on data issues in intelligent diagnosis research of TCM prompted by ChatGPT.” Journal of Hunan University of Chinese Medicine 43.7 (2023): 1319-1323.

[9] Zhao Zijuan, et al. “Application and challenges of intelligent image processing in Traditional Chinese Medicine.” Journal of Taiyuan University of Technology 53.3 (2022): 405-419.

[10] Chen Zhihui, et al. “Discussion on establishing the intelligent TCM clinical decision-making and curative effect evaluation model based on the TCM pattern scale.” Liaoning Journal of Traditional Chinese Medicine 48.3 (2021): 221-225.

[11] Kuang Xiuying, et al. “Construction of a TCM preventive treatment knowledge service and clinical application system based on big data convergence.” Modernization of Traditional Chinese Medicine and

Materia Medica-World Science and Technology 26.1 (2024): 236-241.

[12] Zhang Kui, Xiao Yong, and Shen Shaowu. “Current situation and thoughts on talents cultivation for IT-application in Hubei Provincial TCM Hospital.” China Digital Medicine 19.4 (2024): 70-77.