



Digital Intelligence Empowers Rural Aging Human Resource Development: DST Model Construction and Path Design

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Abstract. Activating rural aging human resources is crucial for addressing labor shortages in rural areas and supporting rural revitalization. Under the digital-intelligent transformation context, developing this demographic faces structural challenges such as organizational fragmentation and supply-demand mismatches. Based on digital empowerment and diffusion theory, this study examines the practical needs and obstacles in digital-intelligent development for rural elderly workers using Sichuan Province as a case study. It proposes a three-dimensional DST development model integrating Digital Platform (D), Targeted Training (S), and Skill Transfer (T). The model resolves organizational challenges through cross-sector collaborative platforms, implements differentiated training via demographic profiling, facilitates localized skill dissemination through rural social networks, and achieves dynamic optimization via feedback loops. The DST model provides a systematic theoretical framework for enhancing rural human capital quality in the digital economy era, while offering actionable pathways for activating aging workforce potential and empowering rural revitalization in central and western China.

Keywords: Rural revitalization; Rural aging human resources; Digital intelligence; DST development model

1 Introduction

Against the backdrop of deep integration between the digital economy and the rural revitalization strategy, enhancing the digital and intelligent development level of elderly human resources in rural areas can not only help the aging population bridge the digital divide but also inject endogenous momentum into the sustainable development of the rural economy.[1] However, effective development of this demographic still faces numerous challenges.

The academic community has conducted extensive discussions on this topic. Firstly, regarding practical challenges, research primarily focuses on three structural constraints: First, the mismatch between workforce competency and supply capabilities—

elderly populations exhibit low digital literacy and diverse needs, yet training programs remain limited in scope [2]. Second, barriers stemming from objective environments and organizational systems—the urban-rural digital infrastructure gap and lack of grassroots coordination mechanisms lead to high collaborative development costs [3]. Third, in terms of implementation approaches, scholars propose leveraging artificial intelligence for precise talent matching [4] or designing training content aligned with regional industrial characteristics [5]. Finally, theoretical frameworks include digital empowerment theory [6], which highlights technology's potential to reduce learning barriers, and diffusion-of-communication theory [7], providing logical foundations for innovative models.

While existing research has laid a solid foundation, it remains limited in focusing primarily on single-stage optimization rather than developing a comprehensive model to systematically address challenges such as decentralized personnel management and unsustainable knowledge dissemination. Particularly lacking are studies tailored to the complex rural environments of central and western China. Building on this gap, this study examines rural areas in Sichuan Province and employs digital empowerment and diffusion theory to construct a DST development model specifically designed for rural aging populations. Through systematic integration of platform support, targeted cultivation, and knowledge diffusion mechanisms, the model aims to resolve three critical challenges: organizational structure, empowerment strategies, and operational efficiency. This approach provides both theoretical frameworks and practical benchmarks for enhancing rural human resource quality and productivity.

2 Connotation Definition of Aging Human Resources in Rural Areas

According to academic definitions and research frameworks on rural human resources (Luo Hui, 2025; Liu Haoxing et al., 2016), rural aging workforce specifically refers to elderly individuals aged 60-75 in rural areas who possess labor capacity and willingness to participate in work. These individuals maintain strong ties with local communities and are familiar with regional production patterns. However, constrained by Sichuan Province's complex terrain featuring alternating plains, hills, and mountainous regions, their geographic dispersion poses significant organizational challenges. The notable heterogeneity among individuals in terms of age, health status, educational background, and skills has led to diverse labor demands. Data from Sichuan's Seventh National Population Census reveals that rural populations aged 60+ account for 21.7% of the total, with an aging rate reaching 27.3%. Certain regions still face structural constraints such as inadequate infrastructure, a situation that aligns closely with common challenges in rural areas across central and western China. Under these circumstances, traditional development models have become inadequate, necessitating breakthroughs through digital and intelligent technologies to unlock the labor potential of the aging population.

3 Problems and Causes Analysis in Rural Aging Human Resource Development in Sichuan Province

(1) Organizational Challenges: Highly Dispersed Personnel Distribution and Weak Grassroots Mobilization Systems

The “local-based” production and living patterns of rural aging workers remain a primary constraint on development initiatives. Survey data from this study—collected across 10 counties (districts) in Sichuan Province in 2024, with a sample of 2,500 rural residents aged 60–75—reveal that over 82,000 aging workers are distributed across more than 2,300 administrative villages, exhibiting a pattern of “wide geographical coverage with uneven density.” Mountainous and hilly regions account for 58% of this population, resulting in highly fragmented distribution. This spatial pattern renders traditional centralized training programs costly, with low coverage and marginal returns.

The underlying causes include: (1) household-based production units that limit the time and motivation of aging individuals to participate in collective activities; (2) geographic and physiological constraints, such as inconvenient transportation and declining physical function, which hinder long-distance travel; and (3) grassroots organizations lacking specialized functions and professional capacity to establish effective mobilization networks.

(2) Empowerment Challenges: Group Capability Heterogeneity and the Digital Literacy Gap

Significant heterogeneity and digital literacy gaps among the aging population undermine the effectiveness of standardized empowerment models. According to the same survey, 18.3% of respondents are in a state of “digital isolation,” 45.7% possess only basic communication skills, and only 9.5% demonstrate productive competencies such as operating intelligent agricultural machinery or engaging in agricultural e-commerce.[8]

This situation results from multiple factors: declining fluid intelligence leads to technological anxiety; rural digital infrastructure lags behind urban areas, and elderly-friendly terminal design is inadequate; and the outmigration of younger adults disrupts family-based “digital reverse mentoring,” thereby reinforcing the digital divide.

(3) Performance Dilemma: Misalignment Between Training Supply and Actual Needs, Hindering Skill Outcomes Dissemination

Even with resource allocation, the ultimate effectiveness of development initiatives remains constrained by supply-demand mismatches and rigid outcome frameworks. Research indicates that 70.8% of surveyed participants have never received systematic digital intelligence training, with existing programs predominantly focused on policy dissemination that remains disconnected from practical production scenarios like smart agricultural machinery and e-commerce operations. This highlights fundamental systemic barriers: the supply side adheres to top-down administrative logic without precise mechanisms to capture decentralized demands, while the dissemination side lacks skill-sharing incentives and fails to leverage rural “knowledge-sharing networks” for knowledge spillover and diffusion.[9]

4 Construction, Operation and Promotion of DST Development Model for Rural Aging Human Resources

4.1 Core Connotation of DST Development Model

The DST Development Model is grounded in Digital Empowerment Theory and Diffusion of Communication Theory. Addressing structural challenges in rural aging workforce digitalization—including fragmented organizational supply chains, high mobilization costs, mismatched training programs due to significant demographic diversity, inadequate coverage, and limited knowledge transfer—the model establishes a systematic framework integrating platform support, targeted training, and knowledge diffusion. Designed to enhance organizational efficiency, supply-demand alignment, and outcome conversion rates, it implements institutionalized mechanisms for coordinated management of participants, training content, and implementation processes. This approach facilitates sustained competency development and scalable knowledge dissemination among senior workforce members.

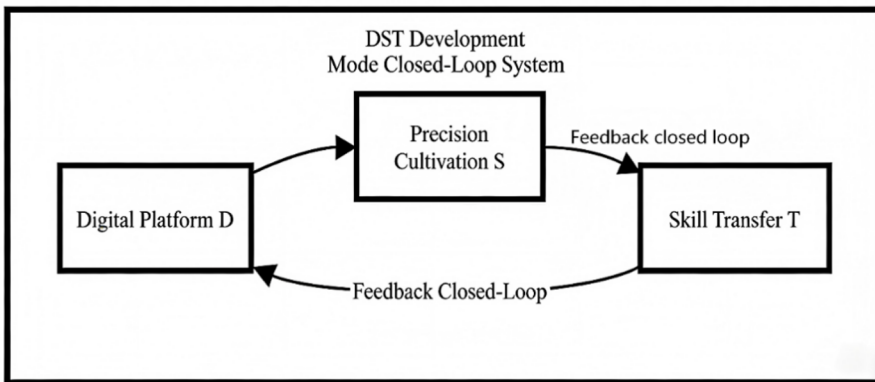


Fig. 1. Framework diagram of DST development model

As illustrated in Figure 1, the DST development model operates as a closed-loop system. The digital platform (D) serves as the foundational organizational framework and governance tool, responsible for demand collection, resource integration, and process management while providing informational and resource support for subsequent stages. Precision training (S) leverages platform-generated demand data and demographic profiles to implement tiered, targeted training programs and scenario-based exercises, enhancing skill acquisition quality and transferability. Skill transmission (T) utilizes rural social networks and peer learning mechanisms to convert mastered skills into a cascading process of knowledge dissemination, enabling the expansion of training outcomes from individual levels to broader rural communities. Simultaneously, the model employs feedback loops to transmit information on skill application effectiveness, transmission outcomes, and emerging demands back to the platform. This feed-

back mechanism drives dynamic adjustments and iterative optimization of training content, participant stratification, and resource allocation, establishing a continuous improvement cycle.

4.2 Digital Platform (D): Organizational Support Module for Cross-Entity Collaboration

To address the challenges of dispersed elderly workforce distribution and high organizational costs, a unified digital platform serves as the foundational infrastructure. This platform establishes a collaborative ecosystem integrating government agencies, enterprises, training institutions, and workers, fulfilling three core functions: First, precise demand capture through multi-channel skill requirement databases; Second, end-to-end implementation by providing age-friendly online courses and remote guidance; Third, dynamic evaluation and feedback mechanisms to monitor outcomes in real-time and optimize resource allocation.

In line with Sichuan's practical conditions, the platform construction adopts a "dual-track parallel" strategy: on one hand, a regional integrated management portal (Web-based) is established under government-led supervision to oversee resource allocation; on the other hand, elderly-friendly mobile terminals (App/mini-program interface) are developed, featuring simplified interfaces, large font sizes, and voice navigation to reduce user accessibility barriers.

4.3 Precision Cultivation (S): Core Implementation Module for Differentiated Empowerment

The precision cultivation module leverages platform big data profiling technology to conduct multidimensional profiling of elderly workers, establishing a differentiated development system that achieves precise supply-demand matching. Implementation strategies require dual adaptation through individual stratification and industrial categorization: At the individual level, advanced courses such as intelligent agricultural machinery operation are offered to younger healthy participants, while basic skills like information acquisition are emphasized for frail elderly individuals. At the industrial level, plain agricultural regions prioritize smart irrigation systems and digital monitoring technologies, whereas mountainous cultural tourism villages focus on cultivating digital management skills for homestays and online content dissemination capabilities.[10]

Based on this, a dual cultivation system integrating foundational digital literacy and industry-appropriate skills is constructed: the former encompasses life skills such as terminal operation, application interaction, and security prevention; the latter includes smart agricultural production, digital marketing of agricultural products, and digital-intelligent transformation of rural services, ensuring that elderly workers can both "access these technologies" and "affordably utilize them."

4.4 Skill Transfer (T): Transformation Module of Localization Diffusion Outcomes

Skill transfer refers to the process where elderly workers who have mastered digital and intelligent skills assume the role of peer instructors, disseminating knowledge and skills to untrained peers through verbal explanations and situational demonstrations. Considering the social structural characteristics of close neighborhood interactions in rural Sichuan, skill transfer demonstrates feasibility and cost-effectiveness advantages.

To enhance the stability of knowledge transmission, outstanding trainees may be selected during the cultivation phase as potential transmitters, supported by incentive measures such as skill certification, commendations, rewards, and lost-work allowances. Transmission service points can be established through village-level organizations to form a fixed transmission network. Digital platforms provide process support, including recording transmission outcomes, showcasing exemplary cases, creating discussion forums, and offering online Q&A services.

4.5 Implementation Pathway for Promoting the DST Model

The DST model is applicable to diverse geomorphological regions in central and western China, rural areas dominated by characteristic industries, and regions with underdeveloped digital infrastructure. Its implementation requires adherence to the following pathways:

(1) Platform Adaptation: Establishing Regional Digital Infrastructure. Regions with robust network infrastructure should develop regional integrated platforms; underdeveloped areas should prioritize lightweight applications or mini-programs, enhancing elderly-friendly features such as offline caching and voice interaction.

(2) Precision Profiling: Developing Differentiated Cultivation Plans. Leveraging platform data and integrating local industrial structures with demographic characteristics, content is dynamically optimized to achieve targeted empowerment through "one-person-one-policy" or "one-category-one-policy" approaches.

(3) Network Activation: Establishing a localized transmission system. Select and incentivize "skill transmitters", establish "service delivery points" through village-level organizations, and achieve secondary skill dissemination via on-site field instruction.

(4) Multi-party collaboration: Establishing a regularized safeguard mechanism. A framework of "government guidance, market operation, and multi-party participation" should be formed, where the government is responsible for policy formulation and infrastructure investment, enterprises provide technical support, grassroots organizations undertake mobilization efforts, and research institutions conduct optimization evaluations.

(5) Closed-loop optimization: Implementation of dynamic evaluation and feedback. Through platform data monitoring and offline follow-ups, opinions from multiple stakeholders are collected to dynamically adjust platform functions, curriculum development, and incentive measures, thereby forming a virtuous cycle of "promotion-evaluation-optimization".

5 Conclusion

This study takes the digital-intelligent empowerment of rural aging human resources as the core research orientation, takes Sichuan Province as the empirical research area, and constructs the DST development model integrating Digital Platform, Targeted Training and Skill Transfer based on digital empowerment theory and communication diffusion theory. The research finds that the development of rural aging human resources in Sichuan is restricted by three core dilemmas: organizational fragmentation caused by scattered population distribution, empowerment inefficiency caused by group heterogeneity, and transformation difficulty caused by supply-demand mismatch. The DST model takes cross-departmental digital collaboration platform as the organizational support, big data profiling and differentiated training as the core empowerment path, and rural social network-based skill transfer as the effect diffusion mechanism, forming a closed-loop operation system of "collection-training-dissemination-feedback-optimization", which can effectively solve the structural problems in the development of rural aging human resources.

In practice, the DST model can be adapted to the terrain characteristics and industrial differences of central and western China, and realize the low-cost, wide-coverage and sustainable development of rural aging human resources through platform lightweight transformation, group precise stratification, localized skill transmission and multi-party collaborative guarantee. In theory, this study enriches the research system of digital empowerment and rural human resource development, and provides a new analytical framework for solving the problem of rural labor shortage under the background of aging. In the future, with the continuous improvement of rural digital infrastructure and the deepening of intelligent technology application, the DST model can be further optimized in combination with emerging technologies such as artificial intelligence and the Internet of Things, and expand the application scenarios in rural characteristic industries, so as to provide stronger talent support for rural revitalization and high-quality agricultural development.

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