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Smart Technologies Empowering Red Culture in China: A Systematic Review of Digital Transformation, Educational Integration, and Cultural Innovation

Yuexing Wu¹, Ting Li^{2*}

School of Civil Engineering, Hunan City University, Yiyang, 413000, China¹

School of Humanities, Hunan City University, Yiyang, 413000, China^{2*}

ABSTRACT: In the era of intelligent technologies, the digital transformation of Red Culture in China has gained unprecedented momentum. This study presents a systematic review of 28 scholarly publications (2024–2025) exploring how smart technologies—such as artificial intelligence (AI), big data, virtual/augmented reality (VR/AR), and cloud computing—have empowered the preservation, dissemination, and innovation of Red Culture. Drawing upon cross-sectoral applications, the review identifies three major domains of integration: digital infrastructure for cultural preservation, smart platforms for ideological and civic education, and creative industry pathways including red tourism, digital heritage, and cultural IP development. The findings reveal that smart technologies not only enhance the accessibility and interactivity of Red Culture but also foster immersive, multi-modal, and youth-oriented engagement. However, several challenges persist, including algorithmic bias, content de-symbolization, regional disparities in infrastructure, and the lack of evaluation metrics in educational integration. To address these issues, the paper calls for the construction of an inclusive, collaborative smart ecosystem grounded in ethical governance, interdisciplinary talent development, and cultural authenticity. This review contributes to the growing body of literature on digital humanities and cultural informatics by offering a comprehensive perspective on how tradition and technology co-evolve in shaping ideological continuity, civic identity, and cultural sustainability in China's digital age.

KEYWORDS: Red Culture, Smart technologies, Digital transformation, Ideological and civic education, Cultural innovation, Intelligent media Virtual heritage.

I. INTRODUCTION

1.1 Background and Significance

Red Culture, a unique ideological and historical construct rooted in China's revolutionary history, represents the spiritual legacy of the Communist Party of China (CPC). It embodies values such as patriotism, collectivism, and the revolutionary spirit of perseverance and sacrifice. In the current era of technological revolution, the preservation and propagation of Red Culture are undergoing transformative changes driven by smart technologies.

China has initiated large-scale digitalization strategies, integrating cultural preservation with cutting-edge technologies such as big data, artificial intelligence (AI), virtual/augmented reality (VR/AR), and cloud computing. This wave of digital innovation provides new momentum for Red Culture to move beyond traditional display models and towards immersive, interactive, and intelligent engagement with the public. Scholars have emphasized that smart empowerment can significantly enhance the communication capacity, symbolic transmission, and youth appeal of Red Culture [1][2]. However, this transformation is not without tensions. The coexistence of educational missions, ideological depth, and technological efficiency raises complex questions about authenticity, ethics, and accessibility [3][4]. The convergence of Red Culture and smart technologies thus emerges as both an opportunity and a challenge for China's cultural governance and value system.

1.2 Research Questions and Objectives

This paper conducts a systematic review of 28 scholarly publications retrieved from CNKI, focusing on the smart empowerment of Red Culture. It aims to address the following research questions:

- RQ1: What types of smart technologies have been integrated into Red Culture-related practices in China?
- RQ2: In what domains—such as education, tourism, creative industries—has this integration manifested?
- RQ3: What are the emerging benefits, dilemmas, and unresolved challenges in this convergence?

By synthesizing existing literature, this paper seeks to map the landscape of Red Culture digitalization, identify key application fields, and propose pathways for sustainable innovation and cultural revitalization in the smart age.

1.3 Methodology of the Review

The review is based on a qualitative content analysis of 28 academic articles retrieved from China National Knowledge Infrastructure (CNKI) using the keywords “Red Culture” and “Smart/Digital Intelligence”. These papers cover a wide range of application areas, from education and cultural tourism to red archives and digital storytelling.

Each article’s title and abstract were extracted and manually coded to identify thematic clusters. Additional techniques such as word frequency analysis and latent topic modeling were applied to reveal the core patterns and innovation models.

To ensure representativeness and analytical rigor, the review focused on:

- Peer-reviewed journal articles published between 2024–2025;
- Content that explicitly integrates both Red Culture and smart technology;
- Discursive materials related to cultural innovation, educational practice, and digital governance.

II. SMART TECHNOLOGIES IN RED CULTURE DIGITAL TRANSFORMATION

2.1 Core Technologies and Technical Frameworks

The smart transformation of Red Culture in China is fundamentally enabled by the convergence of emerging digital technologies, including artificial intelligence (AI), big data, cloud computing, VR/AR, and interactive platforms. These technologies offer scalable capabilities for the storage, processing, visualization, and interactive dissemination of cultural content.

For instance, big data allows for the aggregation and classification of fragmented Red Culture resources, facilitating integrated databases that overcome the “information silos” problem [1]. AI-driven algorithms support intelligent tagging and recommendation systems that match content with audience preferences, especially for younger users [3]. Meanwhile, VR/AR technologies are widely used to reconstruct revolutionary scenes, enabling immersive educational and experiential environments [5].

The general technical framework observed across multiple applications can be summarized as follows:

- Data acquisition from archives, museums, and oral histories;
- Content modeling and structuring, often using metadata standards and AI-assisted annotation;
- Multi-platform deployment, including mobile apps, social media, and metaverse environments;
- User feedback loops through data analytics and interaction tracking.

This layered architecture transforms Red Culture from static narratives into dynamic, multi-sensory experiences tailored for diverse audiences.

2.2 Use Cases: Museums, Archives, and Virtual Experiences

Red Culture digitalization is most prominently applied in museums, memorial halls, and thematic exhibition centers across revolutionary sites such as Yan’an, Jinggangshan, and Yimeng.

Digital museums now incorporate:

- Virtual exhibition halls accessible via mobile or web [6];

- AI-powered virtual docents offering real-time narration and interaction [7];
- 3D modeling and reconstruction of historical battlefields or iconic moments in CPC history [8];
- Red archives featuring intelligent search, sentiment-tagged documents, and crowd-sourced oral history platforms [9].

For example, the *Red Ribbon Digital Art Hall* in Guiyang integrates projection mapping and AI-generated storyboarding to create immersive storytelling experiences [10]. Another case from Sichuan involves parametric design + AR rendering to activate traditional revolutionary patterns as modern cultural symbols in digital platforms [11].

These cases collectively reflect the transition from physical preservation to emotive participation, enabling Red Culture to resonate with a broader audience through digitally mediated experiences.

2.3 Infrastructure Constraints and Technical Challenges

Despite these achievements, several technical and infrastructural barriers persist:

- Low interoperability across different cultural databases and archives, leading to redundancy and inefficiency [12];
- Lack of standardization in content encoding, tagging, and metadata schema for Red Culture resources [1];
- Overreliance on third-party platforms for content dissemination, raising concerns over sovereignty and algorithmic control [13];
- Digital divide in rural/ethnic regions, where Red Culture is rich but technological penetration is weak [14].

Moreover, some scholars caution against the aesthetic flattening caused by excessive virtualization. While immersive scenes can impress, they may dilute the ideological depth and narrative seriousness central to Red Culture [4].

To address these issues, recommendations include:

- Development of national-level digital culture infrastructure;
- Promotion of open standards and inter-platform APIs;
- Strengthening cyber-sovereignty awareness in Red Culture digital projects;
- Building multi-disciplinary teams of technologists, historians, and educators.

III. INTEGRATION WITH IDEOLOGICAL AND CIVIC EDUCATION

3.1 Smart Red Culture in the “Big Ideological Classroom”

The concept of the “Big Ideological Classroom” (*da sixiang zhengzhi ke*) has become a central pillar of ideological education reform in China. Within this framework, Red Culture plays a crucial symbolic and content-rich role. Smart technologies—such as AI-powered educational platforms, virtual simulations, and data-driven teaching design—have been actively integrated to enhance ideological education's relevance, interactivity, and value transmission power [15]. Several studies have documented successful use cases where digitized Red Culture content is embedded into university and secondary school curricula. For instance:

- The construction of multi-terminal smart classrooms incorporating Red-themed VR materials [16];
- The building of Red Culture resource libraries accessible via cloud platforms and WeChat mini-programs [17];
- Region-specific integration strategies such as Sichuan’s “one body, three levels” ideological integration model from primary to university education [18].

These efforts highlight the transformation from unidirectional ideological preaching to interactive value co-creation, enabling Red Culture to engage youth in a more experiential, participatory, and contextualized manner.

3.2 Pedagogical Innovation and User Experience

Smart Red Culture education redefines not only content but pedagogy. Teaching strategies shift from static classroom lectures to multi-sensory engagement, using:

- AR simulations of historical battles or revolutionary events;
- Gamified mobile apps based on Red IPs and role-playing;
- Red short videos deployed via TikTok (Douyin), Bilibili, or university LMS [19].

The pedagogy emphasizes student-centered learning, encouraging learners to explore, interpret, and even co-create Red narratives. One notable innovation is the use of AI-generated storytelling, allowing students to dialogue with virtual revolutionaries or simulate historical decision-making scenarios [8].

Moreover, learning analytics and engagement dashboards help teachers evaluate ideological resonance, fostering “intelligent reflection” on civic identity formation [20].

3.3 Challenges in Value Interpretation and Content Governance

Despite the promising integration, researchers also point to normative, operational, and ethical risks:

- Content de-symbolization: Over-gamification and entertainment-led short videos risk trivializing revolutionary content [13];
- Algorithmic misguidance: Recommendation systems may privilege emotionally charged or simplified narratives over historically nuanced ones [3];
- Evaluation ambiguity: There is a lack of standardized metrics to assess educational impact, ideological reception, and digital engagement [17].

Additionally, concerns arise over intergenerational disconnect, as Red Culture’s moral codes may not always align with Gen Z’s discourse habits and digital identities [21]. Some scholars propose establishing ethics review committees, content supervision protocols, and algorithm audits for Red Culture education platforms [4].

These issues highlight the tension between technical innovation and value fidelity, suggesting the need for balanced design thinking that safeguards historical gravity while embracing digital transformation.

IV. RED CULTURE–DRIVEN CULTURAL INNOVATION AND INDUSTRY APPLICATIONS

4.1 Red Cultural Tourism and Digital Heritage

Red Culture has become a crucial pillar of China’s integrated cultural and tourism strategy. In the digital age, smart technologies play a vital role in revitalizing historical landscapes, deepening visitor engagement, and rebranding revolutionary heritage as participatory experiences.

Key examples include:

- Immersive red tourism using AR/VR to simulate key revolutionary events, such as the Long March and the Yan’an period [22];
- Smart scenic area construction, where digital signage, mobile guides, and sentiment-based route recommendations personalize tourist experiences [23];
- Geo-located storytelling combining mobile apps with AI narrators to contextualize history at physical sites [7].

Case studies such as Yimeng, Guiyang, and Daqing demonstrate the potential of digital twin scenic design and data-driven crowd management in red-themed tourism planning [10][24].

These approaches transcend passive sightseeing, inviting visitors to engage emotionally and cognitively with revolutionary history through immersive, participatory, and context-aware interfaces.

4.2 Red Cultural Creative Industries

Smart technologies also enable the growth of Red Cultural Creative Industries, transforming ideological symbols into marketable cultural IPs and consumer-facing products. Typical innovations include:

- Digitally designed red-themed souvenirs, mascots, fashion elements;
- AI-generated art and NFTs based on Red Culture motifs;
- Interactive exhibitions and gamified installations in public spaces and memorial sites [25][26].

In Sichuan and Guizhou, researchers have advocated for the use of parametric design systems, allowing traditional revolutionary visual elements to be modularized and recombined in modern design contexts [11].

Furthermore, the internationalization of Red Culture through digital platforms and multilingual interfaces has begun to gain traction, marking the transition from internal value reinforcement to soft power projection [27].

4.3 Public Engagement and Community Co-Creation

A major trend in recent literature is the rise of community-driven co-creation models, where Red Culture is no longer a top-down ideological delivery system but rather an interactive, socially constructed symbolic space.

This is particularly visible in:

- Short video platforms (e.g., Douyin, Bilibili), where users remix revolutionary stories through personal narratives [19];
- Youth-focused participatory campaigns, such as Red-themed TikTok challenges, avatar-based cosplay, and digital red stamps [13];
- Interactive live-streamed visits to historical sites, where remote audiences can vote on where to go, what to ask, or leave bullet-screen comments in real time [6].

Scholars note that such grassroots participation reshapes the narrative logic, transitioning from monologue to dialogue, and facilitates the construction of a "youth-coded red identity" in digital space [3].

Nonetheless, this participatory culture also carries risks: algorithmic misalignment, cultural de-contextualization, and aesthetic over-commercialization. Thus, several researchers call for ethical co-creation guidelines and content resonance evaluation systems [4].

V. CHALLENGES AND GAPS IN SMART EMPOWERMENT

5.1 Algorithmic Risks and Cultural Misrepresentation

One of the most commonly cited concerns in the reviewed literature is the algorithmic logic embedded in smart platforms, especially recommendation systems used in short videos and interactive content. While personalization and user engagement are key benefits, they also pose serious risks to the integrity and ideological depth of Red Culture content.

Researchers highlight that algorithm-driven platforms often prioritize:

- Entertainment-first content that favors emotional immediacy over historical authenticity;
- Viral formats that trivialize revolutionary symbols through oversimplified memes or gamification;
- "Algorithmic narrowing" which reinforces cognitive biases and restricts diverse interpretations [13].

In such environments, Red Culture may be reduced to spectacle, losing its critical function as a carrier of political memory and national identity. This phenomenon is referred to as "cultural desymbolization", where the sacred is rendered mundane, and the pedagogical is displaced by the performative [21].

5.2 Regional Disparities and Infrastructure Limitations

Despite national-level promotion of cultural digitalization, there exists a marked imbalance in regional infrastructure and resource deployment. Revolutionary base areas (e.g., rural parts of Shaanxi, Guizhou, Gansu) often house rich Red Culture legacies but lack:

- Stable high-speed internet or smart terminal access;
- Localized content production capacity;
- Skilled personnel to operate or maintain digital systems [14].

Consequently, while urban centers and key memorial sites have embraced immersive exhibitions and smart museums, many rural heritage locations still rely on outdated exhibition formats or physical-only archives.

Scholars argue for targeted investments and public-private partnerships to address this "last-mile problem" in Red Culture digital dissemination [23].

5.3 Pedagogical and Evaluation Challenges in Education Integration

The integration of smart Red Culture into ideological education, though transformative, faces three key challenges:

- (1) Content–curriculum mismatch: Digitized resources are often not aligned with textbook narratives or exam requirements.
- (2) Unclear educational metrics: There is no standardized framework to evaluate the ideological impact of smart tools (e.g., how to quantify “patriotic affect”?).
- (3) Educator readiness: Many teachers lack the technical skills and pedagogical literacy to use AI/VR tools effectively [20].

Moreover, the oversaturation of Red Culture content—often deployed without audience research—may result in aesthetic fatigue and cognitive disengagement, especially among Gen Z learners.

5.4 Interdisciplinary Fragmentation and Talent Gaps

The construction of a smart Red Culture ecosystem demands cross-sectoral collaboration among technologists, educators, historians, designers, and policymakers. Yet current research and practice reveal:

- A shortage of interdisciplinary professionals capable of “bridging code and culture” [6];
- Institutional silos separating ideological content development from digital platform design;
- Policy gaps in terms of ethics review, data governance, and IP management [7].

Without robust talent pipelines and collaborative infrastructure, digital Red Culture projects risk falling into superficial showcases, lacking sustainability or strategic alignment.

Several studies call for national-level interdisciplinary capacity-building programs and academic-industry-government consortia focused on cultural AI and digital heritage [27].

VI. FUTURE PROSPECTS AND RESEARCH DIRECTIONS

6.1 Towards a Smart Red Culture Ecosystem

As smart technologies continue to evolve, the future of Red Culture digitization must move beyond isolated use cases toward a systemic, collaborative, and data-driven ecosystem. This ecosystem should integrate four interdependent components:

- Content development: grounded in ideological authenticity and regional heritage;
- Technical platforms: interoperable, secure, and adaptive;
- User communities: diverse, participatory, and intergenerational;
- Governance mechanisms: ethical, evaluable, and policy-aligned.

Several scholars propose the notion of a “smart Red Culture ecological loop”, linking content producers, platform operators, educators, policymakers, and users in a feedback-enhanced system [28]. Only through such structural integration can the full potential of smart technologies in cultural transmission be realized.

6.2 Bridging the Theory–Practice Gap

Although many local governments and institutions have launched digital Red Culture projects, the field still suffers from a disconnect between theoretical frameworks and practical implementations:

- Most projects remain empirically under-evaluated, lacking impact assessment tools or theoretical anchoring [16];
- Few studies systematically model value perception, youth identity formation, or behavioral outcomes in smart Red Culture environments;
- There is an over-reliance on visual immersion, with limited exploration of affective computing, behavioral gamification, or interactive narrative design [19].

Future research should build:

- Multi-dimensional evaluation systems, integrating cognitive, emotional, and behavioral metrics [20];
- Mixed-method approaches, combining qualitative field studies with algorithmic modeling;
- Theoretical typologies to categorize types of smart cultural experiences (e.g., informative vs. transformative; symbolic vs. embodied).

6.3 From “Digital Preservation” to “Cultural Empowerment”

The role of smart technologies in Red Culture is evolving from preservation-focused archiving to empowerment-centered innovation. Future projects should:

- Embed Red Culture into daily digital life, via smart wearables, intelligent assistants, and ambient computing;
- Enable co-creative authoring, allowing youth to remix history in meaningful yet respectful ways;
- Explore transmedia storytelling, using gamification, animation, and AI-generated dialogue to cultivate deeper cultural engagement [21].

Moreover, policy design should shift toward long-term cultural capacity building:

- Establishing cultural tech innovation zones (e.g., Red Culture + AI labs);
- Supporting open data platforms for Red Culture resources;
- Incentivizing interdisciplinary research that bridges political communication, cognitive science, and smart design [18].

VII. CONCLUSION

This review has systematically examined how smart technologies are reshaping the preservation, transmission, and innovation of Red Culture in contemporary China. Drawing upon 28 recent studies (2024–2025), we identified three major application domains—digital transformation, educational integration, and cultural innovation—that reflect the evolving synergy between technological capability and cultural mission.

Smart technologies such as artificial intelligence, virtual/augmented reality, big data, and cloud computing have provided Red Culture with new expressive tools and participatory channels. From immersive virtual museums and algorithm-driven storytelling to intelligent ideological education platforms, these innovations have contributed to making Red Culture more accessible, interactive, and emotionally resonant, especially among younger audiences.

However, this smart empowerment is not without tensions. Key challenges include:

- Algorithmic risks that distort ideological integrity and historical meaning;
- Regional and infrastructural disparities that hinder inclusive cultural digitization;
- Pedagogical limitations in education settings and weak evaluation mechanisms;
- Fragmented collaboration across disciplines and institutions.

To address these gaps, future efforts must shift from isolated digital showcases to coherent ecosystem building, with attention to content authenticity, technological ethics, user agency, and intergenerational communication. Cross-sector collaboration—spanning cultural scholars, educators, technologists, and policymakers—is crucial for constructing a sustainable model of Red Culture in the digital age.

Ultimately, the integration of smart technologies and Red Culture represents more than a technical upgrade—it is a strategic endeavor to translate historical memory into future-facing civic identity, to empower cultural continuity in a time of algorithmic acceleration, and to reaffirm collective values through intelligent innovation. In this regard, China’s Red Culture digitalization offers a unique model for exploring how tradition and technology may co-evolve to serve social cohesion, national narrative, and cultural self-confidence in the 21st century.

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