

Digital Technology Empowers the Logic, Challenge and Optimization Path of Grassroots Social Governance Modernization in Frontier Ethnic Areas

Feng Shi

School of Business Administration, Baise University, Baise, Guangxi, China

**Corresponding Author*

Abstract: With the implementation of strategies such as Digital China and Digital Management, digital technology has reshaped the resource allocation, organizational operation and public participation models of grassroots governance, providing a new path to solve the problems such as large governance radius, high costs and weak collaboration in border areas. From the perspective of digital technology empowerment, this paper analyzes the internal logic, practical challenges and optimization paths of its empowerment of the modernization of grassroots governance. The research shows that digital transformation is not merely the application of technology, but a governance transformation that couples multiple logics such as technology, institutions and social values. However, the empowerment of digital technology for the modernization of grassroots governance in ethnic border areas is jointly constrained by multiple factors such as weak infrastructure, insufficient digital literacy, poor institutional collaboration, insufficient cultural adaptation, limited resource investment and increased security pressure. Therefore, to promote the modernization of grassroots social governance in border and ethnic minority areas, efforts should be made in a coordinated manner from aspects such as consolidating the digital foundation, strengthening capacity building, optimizing institutional supply, adhering to cultural adaptation, coordinating development and security, and emphasizing classified advancement, so as to truly integrate digital technology into local governance practices and transform it into sustainable, replicable and scalable governance capabilities.

Keywords: Digital Technology; Border and Ethnic Minority Areas; Grassroots Social

Governance; Governance Modernization; Digital Empowerment

1. Introduction

Grassroots governance is the cornerstone of national governance. The modernization of grassroots governance in ethnic minority areas of border regions is a major strategic issue that concerns national unity, ethnic solidarity, and border stability. Under the digital wave, digital technology is reshaping the governance pattern, providing new opportunities and important paths for solving governance problems in border areas and promoting governance modernization [1].

Due to its special geographical location, complex ethnic composition, diverse cultural traditions, and relatively lagging economic and social development levels, grassroots governance in ethnic minority areas of border regions faces many unique challenges. At the same time, with the acceleration of China's urbanization process and the increase in population mobility, the social structure, interest pattern, and governance demands in ethnic minority areas of border regions are undergoing profound changes, placing higher demands on grassroots governance [2]. The rapid development of digital technology has injected new impetus into the modernization of grassroots governance in ethnic minority areas of border regions. New-generation information technologies, through data-driven, intelligent decision-making, and precise services, are profoundly changing the concepts, methods, and efficiency of grassroots governance [3].

The exploration of digital technology's role in empowering grassroots governance in ethnic minority areas across the country is booming. However, this process has not been smooth sailing. The tensions between technological rationality and local knowledge, standardized governance and ethnic particularity, digital divide and governance fairness, as well as

technological dependence and governance autonomy have become increasingly prominent [2]. In the frontier ethnic areas, the application of technology should not only consider its advanced nature, but also give consideration to the adaptability of national culture, the feasibility of local governance and the acceptance of the masses. Based on the actual needs of the modernization of grassroots governance in ethnic minority areas, this paper takes digital technology empowerment as the entry point and systematically explores the internal logic, practical challenges, and optimization paths of digital technology empowering grassroots governance in ethnic minority areas.

2. Definition of Core Concepts and Theoretical Basis

2.1 Definition of Core Concepts

Digital technology not only possesses functions of information collection, storage, transmission and processing, but also has governance attributes such as data association, intelligent analysis, precise identification, real-time feedback and cross-domain collaboration [4]. In terms of grassroots social governance, the core value of digital technology is not merely "updating of tools", but lies in promoting the transformation of governance methods from experience-based judgment to data-driven, from passive response to proactive early warning, and from fragmented and scattered to collaborative and coordinated [5].

The modernization of grassroots governance in border ethnic areas refers to the process of promoting comprehensive optimization in governance concepts, structures, mechanisms and capabilities in the grassroots fields such as counties, towns, villages (communities) in border ethnic areas, by upholding the leadership of the public sector, basing on the overall requirements of national governance modernization, and coordinating self-governance, rule of law, moral governance and intelligent governance [6].

Digital technology empowerment means transforming previously scattered and implicit governance resources into identifiable, schedulable and collaborative real governance capabilities through technology embedding, process reengineering, resource integration and capability enhancement [7]. Specifically in the

grassroots governance of border ethnic areas, digital technology empowerment mainly manifests in four aspects. First, it breaks through spatial limitations such as mountainous areas, borders and scattered villages, and enhances the reach of governance [8]. Second, it improves the accuracy of public service provision and risk governance through data integration and intelligent analysis [9]. Third, it connects the public sector, village-level organizations, social organizations and the public through platforms, enhancing the collaborative governance capabilities of multiple entities [10]. Fourth, it improves governance transparency, credibility and public participation through online feedback, visual public disclosure and closed-loop handling [11]. Therefore, digital technology empowerment is essentially a governance empowerment process supported by technology, guaranteed by systems, and aimed at enhancing capabilities.

2.2 Theoretical Basis

The theory of national governance modernization provides the macro value goals and overall analytical framework for this article. From this theoretical perspective, the introduction of digital technology must be subordinate to and serve the goal of national governance modernization, promoting the renewal of governance concepts, the optimization of governance structures, and the enhancement of governance efficiency in border ethnic areas [11]. The theory of digital governance emphasizes that new technological elements are profoundly changing the operational logic of public governance. For border ethnic areas, the theory of digital governance reveals how technology breaks through information barriers and promotes the transformation of governance models from "post-event handling" to "pre-warning" and from "coarse management" to "precise governance" [9]. The theory of collaborative governance holds that in the face of complex public affairs, a cooperative pattern involving the public sector, grassroots organizations, social organizations, market entities, and the public must be adopted [12]. The grassroots governance of border ethnic areas involves multiple tasks such as ethnic affairs, public services, social stability, cultural inheritance, and risk prevention, and is highly complex and comprehensive. In particular, it is necessary to build a governance pattern with

multiple participants and vertical and horizontal linkage. The theory of technology-society system emphasizes that the effectiveness of technology depends on the degree of matching between the technology system and organizational structure, institutional arrangement, cultural environment, and behavioral habits [13]. If digital governance overly pursues standardization, homogeneity, and rigidity, it is prone to problems such as "few people who can use it, few people who are willing to use it, and limited scenarios where it is used well", and even trigger real-world dilemmas such as "few people who can use it, few people who are willing to use it, and limited scenarios where it is used well".

3. Digital Technology Empowers the Internal Logic of Grassroots Social Governance Modernization in Frontier Ethnic Minority Areas

Digital technology empowering grassroots social governance modernization in frontier ethnic areas is not a simple technology superposition or tool substitution, but a deep coupling and system reconstruction of technical logic, institutional logic and social logic under specific spatio-temporal situations.

3.1 Technological Empowerment Logic

The primary logic behind the empowerment of digital technology lies in the governance-enhancing effect inherent in the technology itself. Traditional grassroots governance is often constrained by information asymmetry, spatial barriers, and resource dispersion. However, digital technology, through data aggregation, intelligent analysis, and platform connection, has achieved a systematic improvement in governance capabilities [14]. Technologies such as big data and cloud computing have shifted grassroots governance from an experience-based judgment model to a data-driven one. In frontier ethnic minority areas, by integrating multi-source data such as population, geography, economy, and society, visual governance platforms such as "population map" and "resource map" are constructed, which can accurately identify governance needs, dynamically monitor governance processes, and scientifically evaluate governance effects [15]. Artificial intelligence and the Internet of Things have endowed grassroots governance with the ability for proactive early warning and rapid

response [11]. By deploying intelligent sensing devices and establishing risk early warning models, border ethnic areas can achieve real-time monitoring and early intervention of risks such as natural disasters, social conflicts, and public safety. Digital platforms have broken through the hierarchical barriers and departmental divisions in traditional governance, achieving horizontal integration and vertical connection of governance resources.

3.2 Institutional Reconstruction Logic

Digital technology empowerment not only changes governance tools, but also profoundly influences the structure and operational logic of governance systems [16]. In the frontier ethnic areas, this process is manifested as the institutional transformation from rigid bureaucratic control to flexible local adaptation [17]. Digital technology has standardized, made governance processes transparent, and made them more efficient in the grassroots governance process. Through digital means such as online approval, electronic archives, and intelligent dispatching, the traditional cumbersome administrative procedures have been simplified, and the governance chain has been optimized. Digital platforms make governance rights and responsibilities clearer and supervision more effective. Through technical means such as authority setting, process tracking, and result disclosure, the entire process of governance behavior can be recorded and managed traceably. The particularity of border ethnic areas requires that the governance system must have sufficient flexibility and adaptability. Digital technology, through modular design and parameter configuration, enables the governance system to be flexible and adaptable while maintaining core norms, and can effectively adapt to specific circumstances of different ethnic groups and regions.

3.3 Social Value Logic

Digital technology has empowered the modernization of grassroots governance in ethnic minority areas of border regions, not only reshaping the governance network but also achieving an elevation of value goals. In terms of governance mechanisms, digital platforms have broken the limitations of time and space, enabling various entities such as migrant workers and social organizations to achieve "virtual presence" and ensuring the equality of

expression of demands by lowering the participation threshold [17]. At the same time, incentive measures such as point systems and credit evaluations, along with cross-departmental data sharing mechanisms, have effectively stimulated the enthusiasm of the masses and strengthened the collaboration of the entities, comprehensively enhancing the governance efficiency [18]. In terms of value logic, this empowerment goes beyond the pursuit of simple technical efficiency: on the one hand, through applications such as remote medical care and online education, it promotes the equalization of public services and enhances people's livelihood; on the other hand, by digitizing collection and virtual display to activate the utilization of ethnic languages and traditional skills, it enhances cultural confidence while injecting new momentum into the integration of culture and tourism [19]. Moreover, relying on online communities to break geographical restrictions, it has constructed a platform for the interaction and integration among all ethnic groups, aiming to enhance emotional identification and consensus [12]. Finally, by using technologies such as intelligent monitoring and public opinion monitoring, it has comprehensively enhanced the ability to prevent risks and respond to emergencies, building a barrier for border security and stability, and laying a solid foundation for safeguarding national security and long-term stability [20].

4. The Practical Challenges of Digital Technology in Enabling the Modernization of Grassroots Governance in Frontier Ethnic Minority Areas

4.1 "Hard Constraints" of Technology Implementation

The primary obstacle to the digital transformation of governance in border ethnic areas lies in the limitations of physical access and the shortcomings of the governing entities' capabilities [21]. On one hand, due to the complex geographical environment, there are still many "blind spots" in network signal coverage, and the instability of power supply undermines the continuity of digital services. Many rural and pastoral families lack necessary digital devices or have low-quality equipment, making it difficult for them to run complex applications. Some border ethnic areas have weak power infrastructure and unstable power

supply, which affects the normal use of digital devices and the continuity of network services. On the other hand, influenced by the interweaving factors of language, culture, and educational level, the digital literacy of the masses and grassroots officials is generally lagging behind, making it difficult to bridge the "skills gap". The interweaving of language barriers, cultural differences, and educational levels makes it difficult for many people to master the use of digital tools. Moreover, the lack of a targeted bilingual training system combining Chinese and minority languages and continuous guidance leads to a mismatch between digital resource supply and actual demand, resulting in digital tools being trapped in the predicament of "not being usable and not being able to use". This constitutes a hard constraint on technological empowerment.

4.2 "Soft Obstruction" of Governance Operation

The rigidity of the institutional environment and the conflict with cultural logic constitute the soft resistance to the operation of digital governance in border ethnic areas [22]. At the institutional level, the degree of data sharing among public authorities is limited, resulting in "data islands". Factors such as inconsistent data standards, incomplete sharing mechanisms, and security concerns jointly lead to data barriers. During the process of promoting digital governance, the division of responsibilities and powers between different levels and departments is not clear enough. This has caused grassroots officials to view digital governance as an "extra burden", falling into a dual predicament of "multiple management" and lack of internal driving force. At the cultural level, the standardized logic of digital technology and local knowledge have significant tensions. On one hand, these platforms generally lack support for minority languages; on the other hand, the design logic of the system often departs from local production and living customs and values. This separation between technical rationality and ethnic traditional culture not only exacerbates the "cultural gap" in digital governance but also leads to serious "inadaptation" when technology is embedded in local society, hindering the substantive improvement of governance efficiency.

4.3 "New Challenges" for Transformation

and Development

The widespread application of digital technology has brought about new security risks, and these risks are particularly prominent in border ethnic areas [23]. The digital security protection capabilities in these areas are relatively weak, and there are higher risks of data leakage, tampering, and abuse. Especially for sensitive data related to ethnicity, religion, and borders, the security protection requirements are even higher. Excessive reliance on digital technology may lead to the weakening of traditional governance capabilities. Once the technical system fails, it may cause governance paralysis. In emergency situations, this risk is particularly prominent. Digital governance may exacerbate the exclusion of digital vulnerable groups, leading to new social inequality. In border ethnic areas, this exclusion may be compounded along dimensions such as ethnicity, age, and education, affecting social harmony.

5. The Optimized Path for Digital Technology to Empower the Modernization of Grassroots Governance in Frontier Ethnic Areas

5.1 Building an Inclusive Digital Ecosystem

The deepening of digital governance is rooted in the solid support of infrastructure and the comprehensive modernization of people. On one hand, the "infrastructure + terminal" dual-wheel drive strategy needs to be deeply implemented. Focus on border villages and remote agricultural and pastoral areas, build a "fixed + mobile + satellite" composite network system to eliminate coverage blind spots; at the same time, supplement with financial subsidies to lower the threshold of smart terminals, ensure that digital services "are built for use as soon as the network is established, and take effect as soon as it is completed", and lay a solid foundation for inclusive digital services. On the other hand, a multi-level digital literacy improvement mechanism should be constructed to activate the internal driving force of governance. For grassroots officials, digital governance should be included in regular training to promote their transformation from "not knowing how to use" to "being good at using"; for the general public, relying on village-level platforms and "digital experts" as role models, through the "leadership by cadres, promotion by capable individuals, and mutual assistance among the masses" linkage model, precisely assist in bridging the "skill gap".

Through the synchronous resonance of "upgrade of 'things'" and "empowerment of 'people'", ultimately form a positive and virtuous digital ecosystem where all people participate and jointly share.

5.2 Enhance the Resilience of the Governance System

To overcome the deep-rooted obstacles in governance operations, it is necessary to give equal emphasis to system optimization and cultural integration. At the institutional level, we should adhere to the principles of unified standards and safety control, break down the "data islands" among different departments, and establish a closed-loop governance chain of "discovery, circulation, disposal, feedback, and evaluation". Through process integration and data reuse, we can effectively reduce the burden on the grassroots and improve the efficiency of collaborative handling. At the cultural level, we need to create governance scenarios that combine commonalities and individuality, develop multilingual interfaces and voice interaction systems, and embed local customs and social relationships into the design of digital systems. At the same time, we should introduce local forces such as bilingual communicators and respected elders to promote the deep integration of digital technology and local culture, eliminate the coldness of technical rationality, and enhance the affinity and recognition of governance.

5.3 Scientific Planning of Development Path

The sustainable development of digital governance requires strict security guarantees and scientific implementation paths. Firstly, a full life-cycle data security management system should be established, implementing hierarchical and classified management for sensitive information such as ethnicity and religion, improving disaster recovery backup and the "online + offline" dual-track operation mechanism, and preventing risks of technological dependence and algorithm bias. Secondly, following the logic of "pilot first, differentiated promotion, and dynamic optimization", select mature areas for pilot projects, and formulate differentiated plans for different levels. Finally, establish a comprehensive assessment system covering governance efficiency, cultural adaptability, and security level, and use regular monitoring to

promptly correct deviations, ensuring that digital governance can be stable and sustainable in border ethnic areas.

6. Conclusion

Digital technology has profoundly changed the resource allocation, organizational operation and public participation methods in grassroots governance, providing new paths for border ethnic areas to solve problems such as large governance radius, high costs, information asymmetry and low collaborative efficiency. This paper systematically analyzes the basic logic, practical dilemma and improvement direction of its embedding. It is found that the internal logic of digital technology empowering the modernization of grassroots social governance in frontier ethnic areas is a multi-level and multi-dimensional complex system. The logic of technology empowerment provides the basic support for the improvement of governance capabilities, the logic of institutional reconstruction shapes the rules framework of governance operation, the logic of social value constructs the organizational network of governance participation, and clarifies the goal orientation of governance development. These three logical dimensions are interrelated and mutually supportive, jointly forming a complete logical chain of digital technology empowering the modernization of grassroots governance in border ethnic areas. At the same time, digital technology empowering the modernization of grassroots governance in border ethnic areas faces multiple practical challenges. These challenges are intertwined and mutually reinforcing, forming a complex constraint network. Only by systematically identifying these challenges and deeply analyzing their internal mechanisms can we provide scientific basis for the design of optimized paths and promote digital technology to truly empower the modernization of grassroots governance in border ethnic areas.

Based on the above analysis, this paper proposes that to promote the modernization of grassroots social governance in frontier ethnic minority areas, it is necessary to integrate the efforts to strengthen the foundation and enhance the capabilities of the entities, to reshape the institutional logic and optimize the cultural adaptation, to build a secure barrier and adopt a scientific planning approach. From a deeper perspective, the empowerment of digital

technology in the modernization of grassroots social governance in border ethnic areas is not only an update of governance methods, but also a reconfiguration of governance concepts. It requires that grassroots governance shift from merely emphasizing efficiency to emphasizing both efficiency and fairness; from merely emphasizing technological investment to emphasizing both technological construction and cultural adaptation; and from merely emphasizing governance outcomes to the overall optimization of the governance process, governance relationships, and governance recognition. Especially in frontier ethnic minority areas, to truly achieve results in digital governance, it is necessary to always adhere to the people-centered development ideology and use whether the people are willing to use, whether they can use, and whether they truly benefit as important criteria for evaluating the effectiveness of digital empowerment.

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