

Research on the Mechanism and Path of Improving the Refined Governance Level of Resource-based Cities in Sichuan Driven by Digitalization

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ABSTRACT

This study identifies key governance challenges in Sichuan's resource-based cities, including fragmented management systems, technological underutilization, talent deficits, and funding constraints, stemming from data silos, ambiguous accountability, weak policy attractiveness, and limited capital mobilization. The research proposes an integrated digital governance framework comprising data-driven decision systems, intelligent monitoring platforms, multi-stakeholder coordination mechanisms, and precision service delivery models. Corresponding implementation strategies emphasize critical infrastructure upgrades, institutional innovation, talent ecosystem development, and digital-industrial integration, collectively enhancing governance precision while facilitating economic transformation in these resource-dependent urban centers.

KEYWORDS

Digitalization; Resource-based Cities; Refined Governance

1 Introduction

Sichuan Province hosts 13 resource-based cities, making it a significant region for such urban centers. These cities possess abundant mineral, energy, and agricultural/forestry resources, which have historically driven economic growth. Key mineral reserves include Panzhihua's titanium (world's largest) and vanadium (third largest), as well as substantial coal, natural gas, rock salt, and precious metals in cities like Luzhou, Guangyuan, Dazhou, and Zigong. Additionally, regions such as Aba and Liangshan are rich in hydropower and agroforestry resources, supporting related processing industries.

However, with industrialization, many resource-based cities face challenges such as resource depletion, low utilization efficiency, and sluggish economic growth. These issues necessitate refined governance models to facilitate sustainable urban transformation. Digital technologies (e.g., big data, IoT, AI) offer innovative solutions, and the Sichuan government has implemented policies in industrial restructuring, ecological restoration, urban renewal, and cultural-tourism integration. Some cities, like Luzhou (top-ranked in national evaluations), Yibin (successful eco-transformation), and Zigong (zero waste landfill), have achieved notable governance outcomes. Nevertheless, systemic challenges persist.

This study examines the existing governance issues in Sichuan's resource-based cities within a digitalization framework, proposing mechanisms and pathways to enhance refined governance through digital transformation.

2 Literature review

Resource-based cities have long been a topic of global research. As early as the 1920s, studies on resource-based cities emerged. Innis explored the process of resource-based cities from development, utilization to depletion, analyzed the economic history of Canada, and pointed out that the single-industry development model in resource city exploitation would bring numerous problems (Innis, 1930) ^[1]. From the 1970s to the mid-1980s, scholars expanded their research objects from individual towns to a wide range of cities, focusing more on identifying development issues in resource cities and seeking solutions. With the increasingly prominent problems of resource-based cities, domestic and foreign research on resource-based cities has shifted focus to refined governance. Tarigan analyzed the economic transformation of Indonesian cities and argued that the unlimited government management model formed in long-term social governance ignores the cultivation and support of governance subjects (Tarigan, 2017) ^[3]. Ashlie and Denton believed that ecological environment governance in resource-based cities should not rely solely on government management, but should also fully mobilize the active participation of enterprises, the public, social organizations and other subjects (Ashlie, Denton, 2019) ^[4]. With the development and application of digital technologies, more and more scholars have begun to study the application of digital technologies in the governance of resource-based cities. Jeffrey J. Pittaway et al. proposed that to build an ecological civilization system for resource-based cities using digital resources, governments should exert multiple functions. Currently, some government managers lack relevant digital management knowledge, so digital

technology talents should be introduced into the public sector (Jeffrey J&Pittaway, 2020) ^[5]. Taking resource-based cities in Liaoning Province as the research object, Yuan Junbin proposed that resource-based cities should promote digital and information construction, and use digital technologies to improve governance efficiency (Yuan Junbin, 2020) ^[6]. Zheng Tingting pointed out that governments of resource-based cities should seize the opportunities of digitization, combine with the cities' own development advantages, and promote the application of digitization in resource-based city governance (Zheng Tingting, 2021) ^[7]. Xie Liying emphasized that resource-based cities should strengthen forward-looking urban governance planning, promote the sharing of big data, network information security protection, and enhance the integration and sharing of urban governance data (Xie Liying, 2022) ^[8].

3 The current problems of refined governance in resource-based cities of Sichuan

3.1 Poor management synergy

Sichuan's resource-based cities face significant challenges in governance, primarily due to unclear responsibilities and poor interdepartmental collaboration. Overlapping duties between management departments create confusion and accountability issues, which hinder coordinated efforts. Additionally, the lack of an integrated data-sharing platform prevents the timely exchange of information. Departments operate with isolated databases, and discrepancies in data collection methods and standards make integration difficult. For example, Luzhou's "Smart City Brain" still has 30% of its data inaccessible across departments. The absence of a central leadership mechanism further exacerbates these issues, leading to fragmented actions that slow the progress of refined urban governance.

3.2 Lagging technical application

Although some resource-based cities in Sichuan have paid attention to the application of digital technology in urban governance, the overall application is still lagging behind. The coverage rate of technologies such as big data and artificial intelligence is less than 30%, and they are mainly concentrated in data statistics and aggregation, failing to effectively support in-depth decision-making. In areas such as traffic control, disaster warning response, and public service optimization, the application of technology is still limited and relies on manual operation. Especially in natural disasters and public health emergencies, artificial intelligence has not yet achieved rapid identification and effective response. The main reason for the technological lag is the lack of attention to digital governance and insufficient R&D investment, which limits the improvement of governance efficiency.

3.3 Shortage of high-end talents

Digital governance requires compound talents with expertise in both information technology and urban governance. However, resource-based cities in Sichuan face a shortage of such high-end talents, exceeding 50%, and attracting and retaining them remains a significant challenge. High-end professionals typically prefer megacities due to better salaries, industry opportunities, and development prospects. In contrast, resource-based cities offer slower technological updates, fewer digital projects, and limited career growth opportunities, making it difficult for talents to thrive. Additionally, the lack of supporting infrastructure in these cities, such as in education, healthcare, and transportation, further deters talented individuals from settling in these areas. Local talents, too, often seek opportunities in megacities with better living conditions and prospects. This talent gap not only hampers the development of innovative digital governance solutions but also slows progress in enhancing urban governance efficiency.

3.4 Insufficient funding investment

In Sichuan's resource-based cities, the funding allocated to digital governance accounts for less than 5% of fiscal expenditure. Digital governance is a complex system, encompassing projects such as network infrastructure, data platforms, system development, and maintenance, all of which require adequate financial support. These cities are often economically reliant on resource industries, which makes them vulnerable to market fluctuations. Recent adjustments in the energy sector have led to declining benefits in related industries, slowing economic growth and reducing government revenue. As a result, available funds for investment in digital governance remain limited. This funding shortage is reflected in the slow rollout of 4G networks in mining areas, delayed 5G network construction, and the aging of monitoring facilities, which cannot be updated promptly. Furthermore, data center construction has progressed slowly, and many digital governance projects have stalled or failed to operate effectively. The lack of sufficient funding has made it difficult to build a high-speed, stable network environment, integrate and manage data efficiently, and maintain systems, all of which are essential for advancing digital governance in these cities.

4 Analysis on the mechanism of digitalization driving the improvement of refined governance level in resource-based cities of Sichuan

4.1 Data-driven decision-making mechanism

Big data theory focuses on utilizing data collection, analysis, and mining to support decision-making. For digital governance in Sichuan's resource-based cities, the priority is to establish a unified urban big data platform. Although various departments have gathered substantial data, it remains isolated and underutilized. To overcome this, data collection should be standardized, and real-time data should be captured using technologies like big data and IoT. This data integration should encompass key areas such as natural resources, ecology, industry, transportation, and public services. Analyzing this data will help diagnose governance issues, identify key areas for improvement, and predict future trends. This approach can inform decisions in urban planning, industrial policy, and disaster response. For example, Mianyang's big data platform, which integrates data from multiple departments, aids scientific decision-making. To address data security concerns, technologies like blockchain can be applied to ensure secure storage and transmission, providing a strong foundation for data-driven decision-making.

4.2 Intelligent supervision mechanism

Implementing intelligent supervision in Sichuan's resource-based cities requires an IoT-based real-time monitoring system to oversee mineral extraction, environmental conditions, and urban infrastructure. High-definition cameras, sensors, and GPS devices should track mining activities, transportation, and resource efficiency, while environmental monitoring networks assess air, water, and soil quality. Urban infrastructure, such as roads and drainage systems, can be monitored through embedded sensors to ensure structural integrity and functionality.

The system's effectiveness depends on integrating AI and IoT for predictive analytics and adaptive control, enabling automated risk detection and decision-making. A dynamic early warning mechanism should trigger alerts when predefined thresholds are breached, notifying relevant authorities via real-time notifications. A closed-loop response framework ensures rapid incident resolution, maintaining regulatory compliance and operational continuity.

4.3 Collaborative governance mechanism

Collaborative governance theory emphasizes that urban governance involves joint participation and collaboration among multiple stakeholders. To improve governance in Sichuan's resource-based cities, a digital collaborative governance platform should be developed to integrate data from the urban big data platform. Currently, separate governance among departments and inefficient information circulation hinder effective collaboration. Thus, creating a platform that connects data from various departments can streamline processes and enhance governance efficiency. The system should be scalable, using cloud computing to expand during peak periods and reduce resources during low-volume times, optimizing costs.

Additionally, a new digital governance model should be established, allowing for broader citizen participation. Urban governance apps or mini-programs should be designed to enable residents to easily offer feedback through features like "urban governance suggestion box" or "contribute ideas for urban governance." These platforms will allow residents to provide suggestions at any time, which can be reviewed and organized by relevant departments. For instance, Luzhou's "Smart City Brain," which integrates data across multiple fields like transportation and environmental protection, processes over 1 million pieces of data daily, serving as a model for improving collaborative governance.

4.4 Precise service mechanism

To establish an effective precise service mechanism, a comprehensive digital governance framework should be implemented to optimize public service delivery. This involves developing integrated online platforms that utilize blockchain-based electronic certifications and AI-powered automated approvals to significantly reduce administrative redundancies. For citizen services, the system should employ big data analytics to enable personalized service recommendations, particularly in critical areas like social security and healthcare. The business sector would benefit from a fully digitized licensing system incorporating smart verification and automated compliance checks. This transformation reflects contemporary public management theories that emphasize technological integration, operational efficiency, and user-centric design in government services. The proposed model not only enhances service quality but also improves governance transparency while reducing administrative costs.

5 Path selection for digitalization-driven refined governance of resource-based cities in Sichuan

5.1 Strengthening digital infrastructure construction

The digital transformation of Sichuan's resource-based cities demands substantial infrastructure upgrades to overcome existing technological constraints. Current network infrastructure remains inadequate, particularly in remote mining regions where unreliable 4G connectivity and delayed 5G deployment hinder governance efficiency. Accelerating 5G network construction and modernizing fiber-optic broadband systems are imperative to ensure seamless connectivity and high-speed data transmission. These improvements will facilitate both enhanced public services and industrial operations.

Equally critical is the modernization of data processing capabilities to accommodate expanding urban datasets. Existing data centers, constrained by outdated hardware and insufficient computational power, require upgrades to cloud-based architectures and high-performance computing systems. Such enhancements will enable effective management of complex governance data spanning transportation, environmental monitoring, and public administration. The integration of edge computing and AI analytics will further optimize data utilization, supporting more responsive and intelligent urban governance frameworks. This comprehensive infrastructure development forms the foundation for implementing advanced smart city solutions.

5.2 Improving the institutional system of digital governance

The institutional advancement of digital governance in Sichuan's resource-based cities necessitates three key reforms that form an integrated governance framework. First, comprehensive legal frameworks must be established to standardize data governance, ensuring secure collection, sharing and utilization while protecting privacy, with particular attention to sector-specific regulations for mining and environmental data. Second, organizational restructuring should clarify departmental responsibilities through mandate realignment and enhance coordination via a cross-functional digital governance task force led by senior officials, incorporating regular interdepartmental coordination mechanisms. Third, a multi-dimensional performance evaluation system must be implemented, incorporating both quantitative metrics (operational efficiency, processing timelines) and qualitative indicators (inter-agency collaboration, citizen satisfaction), with results directly tied to departmental assessments and resource allocation. These reforms collectively create an accountable, performance-driven governance architecture that supports sustainable digital transformation while maintaining public trust and regulatory compliance through transparent oversight mechanisms. The proposed framework specifically addresses the unique challenges of resource-based urban governance, balancing industrial requirements with smart city development objectives.

5.3 Strengthening the construction of digital talent team

The digital transformation of Sichuan's resource-based cities necessitates a comprehensive talent development strategy encompassing education, training, and retention. Higher education institutions must reform curricula by establishing specialized programs in data science, machine learning, and intelligent governance systems, with particular emphasis on applied learning tailored to local governance requirements. Concurrently, government agencies should implement tiered professional development programs combining online modules and hands-on workshops to upgrade the digital competencies of existing personnel across various administrative functions.

To address talent acquisition challenges, these cities should develop competitive compensation packages incorporating housing subsidies and educational benefits, while establishing clear career progression pathways in digital governance roles. This multi-pronged approach - combining academic preparation, workforce upskilling, and strategic recruitment - will create a sustainable talent pipeline to support the region's smart city initiatives and digital administration objectives. The integration of these measures will ensure both the immediate operational needs and long-term innovative capacity of urban digital governance systems are met.

5.4 Promoting the integration of digital governance and industrial development

The digital-industrial integration in Sichuan's resource-based cities requires a three-dimensional transformation strategy. Core resource industries must undergo intelligent upgrading through smart manufacturing systems and digital supply chain networks, as demonstrated by Dazhou's intelligent mining and Panzhihua's steel industry platforms. Concurrently, strategic cultivation of emerging digital economy sectors - including AI, cloud computing and industrial big data - should be accelerated to diversify the economic structure.

A critical synergy must be developed between digital governance systems and traditional sectors like cultural tourism, leveraging Sichuan's rich heritage through smart tourism platforms and digital experience enhancements. This integrated

approach simultaneously modernizes traditional industries while incubating new economic growth poles, creating a balanced industrial ecosystem that combines resource advantages with digital innovation. The resultant industrial restructuring will enhance regional competitiveness while establishing sustainable development pathways for post-resource economic transition.

6 Conclusion

Resource-based cities in Sichuan have achieved certain results in digital governance, but problems still exist. Against the backdrop of the digital era, it is necessary to follow the trend, transform governance concepts, and apply digital technologies efficiently, enabling digitization to empower the refined governance of resource-based cities in Sichuan. This requires improving the mechanism for enhancing the level of refined governance driven by digitization in resource-based cities of Sichuan, optimizing the path for enhancing the level of refined governance driven by digitization, and further improving the level of refined governance.

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