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Research on the Implementation Pathways of Rural Digital Governance Driven by Agile Governance: A Case Study of Tianjin Municipality

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Abstract: In the context of advancing the Digital Village Strategy, this paper examines key challenges in digital governance for suburban villages in Tianjin, characterized by fragmented perception, slow response, and superficial integration. We propose a three-dimensional agile governance framework, Sensitive Perception-Rapid Response-Social Integration, that emphasizes multi-stakeholder collaboration to establish a localized implementation model. Field studies in Jizhou, Baodi, and Wuqing Districts illustrate practical pathways for operationalization. Findings indicate that "Sensitive Perception" overcomes delayed risk identification through a combination of the social organism concept, multi-source data screening, and precise task allocation; "Rapid Response" improves service efficiency by leveraging public interest orientation, real-time information exchange, and coordinated stakeholder engagement; and "Social Integration" ensures long-term governance sustainability via principled decision-making, interest balancing, and consensus reconstruction. Drawing on Tianjin's rural characteristics, strong urban influence, dense industrial integration, and high population mobility, the study introduces the Suburban Rural Agile Governance Adaptation Model, offering replicable strategies for localized digital governance in urban fringe areas.

Keywords: Agile governance; Rural digital governance; Suburban villages; Practical pathways; Tianjin Municipality.

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1. Introduction

1.1. Policy and practical context

Digital villages serve as the core driver for rural revitalization. The Digital Village Development Action Plan (2022–2025) explicitly mandates "enhancing the precision of rural digital governance responses through agile governance." As a municipality directly under the central government, Tianjin administers 12 districts with agricultural activities, where 68% of villages exhibit "urban-rural integration" characteristics, marked by rapid urban element penetration, frequent industrial iteration, and diverse stakeholder interests [1]. By September 2024, Tianjin achieved a rural internet penetration rate of 67.2%, supported by the establishment of 18 municipal-level digital village pilot projects, which have been instrumental in advancing digital initiatives such as rural governance, agricultural production, and rural e-commerce.

However, significant shortcomings persist in digital governance, where in Ji County, fragmented IoT The device data

from certain villages reflects the data coordination bottlenecks pointed out by Yin; In Baodi District, The rigid approval procedures for agricultural affairs reflect the "functional suspension" phenomenon highlighted by Hao. In Wuqing District, Insufficient coordination of interests in agricultural-tourism scenarios has resulted in the "boundary conflicts" identified by Chen, urgently requiring agile governance for precise solutions.

1.2. Practical challenges and research gaps

Existing practices exhibit three prominent contradictions: In the first half of 2024, Jizhou District experienced a 32% incidence of delayed ecological risk warnings due to data interoperability gaps, highlighting significant perception lags; Baodi District's traditional "agricultural machinery subsidy application" process requires three-tiered circulation through village, township, and district levels, averaging 10 days and resulting in low response efficiency; In Wuqing District, the management of street vendors around scenic areas overlooked farmers' livelihoods, resulting in a 'crackdown-rebound' cycle and highlighting weak social integration capabilities.

Existing research has clear limitations, where the 'three-dimensional mechanism' constructed with Lingnan's Lixian County as a case study does not align with the characteristics of suburban villages; Du emphasizes the "capability dimension" of agile governance but lacks practical implementation pathways; Hao's The "value-factor-function" analysis falls short in incorporating the timeliness aspect within agile responses; Chen Ruihua emphasizes "platform embedding and rural interest conflicts" but fails to connect these with the broader governance process. Consequently, this study selects Tianjin as a case study, integrating established research methodologies to delve into agile approaches for digital governance in peri-urban villages, thus bridging the gap between theory and practice.

2. Theoretical analysis framework and research methods

2.1. Theoretical framework construction

This study constructs a three-dimensional framework of "Sensitive Perception-Rapid Response-Social Integration," rooted in a thorough understanding of the differences between agile governance and traditional governance paradigms (**Table 1**). In Tianjin's peri-urban villages, traditional governance has faced challenges in addressing the 'triple tensions' of space, interests, and time [2]. To counter these, a framework has been developed that specifically targets these issues: 'keen perception' to tackle spatial tension, and 'social integration' to resolve interest conflicts. interest tension, and "swift response" aligns with temporal tension.

On this basis, an "Agile Governance Adaptation Model for Suburban Villages" is further proposed, which embeds Tianjin rural areas' distinctive characteristics, strong urban influence, dense industrial integration, high population mobility, into the design and operation of the three-dimensional mechanisms, achieving localized theoretical innovation and precise implementation.

Table 1. Comparison between agile governance and traditional governance paradigms

Mechanism dimension	Core philosophy	Key competencies	Time program
Sensitive perception mechanism	Organic social concept	Multi-source data filtering and grading capabilities	Risk identification → Data verification → Task initiation
Rapid response mechanism	The principle of prioritizing the public interest	Cross-entity real-time information exchange capability	Demand matching → Resource allocation → Collaborative execution
Social integration mechanism	Sustainable governance concept	Ability to balance and coordinate diverse interests	Public consultation → Alignment of interests → Consolidation of consensus

2.2. Research methods and case selection

2.2.1. Case study method

Ji County focused on "digital monitoring + risk early warning" practices to validate its keen perception mechanism; Baodi District validated its rapid response mechanism through "government services to villages" initiatives; Wuqing District validated its social integration mechanism via "scenic area-farmer collaboration" practices.

2.2.2. Literature review method

The study conducted a systematic analysis of policy documents, including the Tianjin Digital Village Development Action Plan (2023–2025) and the Jizhou District Digital Village Construction Implementation Plan, and integrated key research perspectives on agile governance and rural digital governance.

3. Sensitive perception mechanism: Prerequisite for collaborative governance actions

Acute perception serves as the frontline sentry post for agile governance, requiring early risk identification through the sequence of "conceptual guidance - data integration - precise task allocation." Its core logic draws upon Yan's framework of "social organism concept + analytical screening capability + task allocation procedures" [3].

3.1. Case presentation

In 2023, Jizhou District launched its Digital Rural Monitoring Platform, integrating three core data categories as outlined [4]:

(1) Ecological perception data collected via 38 river water-quality monitoring devices and 92 farmland soil-moisture sensors;

(2) Government data comprising 19 types of foundational information from seven departments, including civil affairs and environmental protection;

(3) Public sentiment data aggregated through village-level WeChat group analyses and feedback submitted via the Jinyun rural platform.

Together, these components form a multidimensional data system spanning ecology, governance, and public welfare.

In June 2024, the platform detected ammonia nitrogen levels exceeding 1.2 mg/L in a river channel in Xiaying Town. It immediately initiated a three-tiered assessment, classifying the risk as ecological, defining the affected area as three administrative villages covering 800 mu (~130 acres) of farmland, and assigning a Level I urgency with a three-day response deadline [5]. Using the platform's task assignment program, responsibilities were allocated across departments: Xiaying Town Government managed local coordination, the District Ecology and Environment Bureau conducted detection and source tracing, and the District Agriculture and Rural Affairs Commission oversaw farmland protection.

Through this multi-department coordinated response, the pollution source, direct sewage discharge from a farmhouse restaurant, was identified within two days, and remediation was completed promptly, preventing damage to farmland crops.

3.2. Analysis of key elements

The agile effectiveness demonstrated in this case derives from the synergistic interaction of conceptual leadership, technological empowerment, and institutional innovation.

At the governance philosophy level, the approach integrates factor interconnectivity and holistic systems thinking, situating river pollution not as an isolated event but within the broader nexus of environmental management, agricultural production, and villagers' livelihoods. This perspective clarifies governance priorities by tracing pollution chain effects while avoiding the pitfalls of single-dimensional interventions, instead coordinating a full spectrum of influencing factors.

At the technological level, the Tianjin Rural Risk Grading Model enables intelligent, multi-source data screening. By the first half of 2024, Jizhou District achieved a 91% risk identification accuracy rate, markedly outperforming traditional

manual screening methods and overcoming perception delays caused by fragmented data sources [6].

At the implementation mechanism level, the model moves beyond conventional "top-down administrative contracting." Drawing on modular task-allocation principles, it delineates departmental responsibilities according to professional expertise, establishing a governance structure characterized by specialized oversight, coordinated action, and minimal functional overlap. This avoids efficiency losses associated with hierarchical, multi-layered management and forms an agile perception loop of "holistic sensing-precise identification-efficient division of labor."

4. Rapid response mechanism: The key to collaborative governance actions

Rapid response serves as the operational core of agile governance, requiring a focus on public interest, leveraging technology as a connecting link, and ensuring collaboration as a safeguard. Its core logic draws upon Yan's framework of 'public interest supremacy + information', which aligns with the principles of public interest in information protection as discussed in the references. communication capability and multi-stakeholder co-governance procedures, while incorporating Chen's dynamic negotiation approach.

4.1. Case Study: Baodi District's "smart agricultural machinery government services" initiative

In response to the cumbersome administrative procedures associated with agricultural machinery services and the heavy time and labor burden placed on farmers, Baodi District launched an innovative smart agricultural machinery administrative service system in 2024 [7]. The system integrates online and offline channels and promotes multi-departmental collaboration to establish a full-chain agile response mechanism [8].

Online, the Baodi Agricultural Affairs mini-program functions as a unified service portal, offering intelligent guidance and automated material-checklist notifications to support accurate application routing. A three-tier digital communication network ("village-town-district") has been formed, with designated specialists at each level ensuring that complex farmer inquiries receive responses within one hour. Offline, mobile service vehicles equipped with professional devices travel across towns and subdistricts according to seasonal agricultural schedules, enabling on-site processing and door-to-door verification [9].

Since implementation, the system has produced notable improvements. Between January and September 2024, 1,246 service matters were completed, reducing the average processing time from 10 days to 3.5 days. The completion rate reached 99%, accompanied by significant gains in villager satisfaction. Drawing parallels with the region's high agricultural mechanization, similar to Tianchang City, Anhui Province, where mechanization exceeds 90%, the initiative contributed to a 15% increase in machinery utilization during spring plowing, substantially enhancing local grain production.

4.2. Key factor analysis

The improvement of governance efficiency in this case is fundamentally driven by the agile response mechanism, which enables a three-dimensional restructuring of processes through "concept anchoring, capability support, and procedural safeguards" [10]. This model directly addresses two long-standing bottlenecks in traditional administrative services, time lag and information blockage.

At the level of concept anchoring, public-interest orientation is placed at the forefront, with service design closely aligned to key agricultural production cycles. During the spring plowing period, a green channel for agricultural machinery services was activated, expediting the processing of 312 subsidy applications and advancing fund disbursement by 10 days. This ensured timely alignment between farming progress and people-centered governance values.

For capability support, a dual-layer interaction model combining digital communication groups and service specialists enables real-time coordination between villagers' needs and departmental responses. In 2024, the average response time for farmer inquiries was reduced to 0.8 hours, a substantial improvement over traditional phone-based consultations, resulting

in a 75% increase in service efficiency and effectively eliminating delays caused by information gaps.

Within procedural safeguards, a dynamic negotiation mechanism was established to involve farmers, government departments, and enterprises in shared governance. Local agricultural machinery manufacturers and repair enterprises participated in formulating annual inspection standards, ensuring that safety verification clauses corresponded to practical operational needs and avoiding policy-practice mismatches. Together, these mechanisms created a rapid-response loop of "accurate demand capture-swift resource allocation-practical service delivery."

5. Social integration mechanism: Ensuring the effectiveness of collaborative governance actions

5.1. Case study: Wuqing district's "tourist attraction-digital farmers collaboration" practice

5.1.1. Specific governance measures

Digital monitoring was strengthened through the establishment of a *Digital Monitoring Platform*, which applies real-time data analytics and smart sensing technologies to oversee stall operations in the scenic-area periphery. This system enables timely detection and resolution of issues such as unauthorized vending and traffic congestion.

Capacity-building efforts centered on regular e-commerce training sessions that equipped 12 households with the ability to use Douyin livestreaming to market local specialties. Following the training, participating households achieved an average monthly income increase of 2,800 Chinese yuan, demonstrating the tangible economic benefits of digital skill enhancement.

Consensus reconstruction was advanced through quarterly *"Public Opinion Tea Gatherings."* These dialogues invited farmers, scenic-area management teams, and tourist representatives to jointly formulate the *Scenic Area Periphery Business Convention*. The convention was subsequently published on the Wuqing Digital Village platform for public supervision, transforming governance consensus from administrative mandates into a model of multi-party co-endorsement [11].

5.2. Integration of key elements

The sustainability of governance outcomes stems from social integration mechanisms that convert one-time administrative interventions into ongoing processes of interest balancing and consensus formation. Guided by principles of sustainable development, the district moved away from a "one-size-fits-all" rectification model. Free stall allocations and training subsidies were incorporated into the annual budget of the District Culture and Tourism Bureau, ensuring policy continuity and preventing the recurrence of short-term governance setbacks [12].

Interest balancing was strengthened through a dual approach combining designated stall zones with income-enhancing livestreaming support. This strategy simultaneously alleviated street congestion and broadened farmers' income channels, thereby achieving an "interest equilibrium" grounded in coordinated factor management [13].

Consensus-building procedures were further refined through the use of *public opinion tea gatherings*, which repositioned farmers from passive "regulated objects" to active "participatory stakeholders." Key mechanisms, such as the stall rotation system and the hygiene points system, were incorporated into the business agreement directly from farmer proposals, enhancing institutional legitimacy and embodying the logic of value co-creation.

6. Conclusion

6.1. Research findings

The three-dimensional mechanism of "Acute Perception-Swift Response-Social Integration" aligns closely with the governance needs of Tianjin's suburban villages. "Acute Perception" mitigates information delays arising from the rapid flow of urban-rural factors; "Swift Response" meets farmers' time-sensitive service demands; and "Social Integration"

helps reconcile the interests of diverse stakeholders. Tianjin's experience demonstrates the effectiveness of integrating multiple governance approaches. By anchoring governance in this three-dimensional mechanism, while incorporating principles of multi-stakeholder collaboration and interest coordination, the city has developed a localized agile governance pathway that is well suited to the practical conditions of peri-urban villages.

6.2. Innovation highlights

Research innovation is reflected across three dimensions. At the theoretical level, the study develops the *Suburban Rural Agile Governance Adaptation Model*, addressing a long-standing gap in digital governance research specific to suburban villages. At the practical level, it proposes a set of operational tools, such as the "Digital Monitoring Platform," "Mobile Service Vehicles," and "Agricultural Assistance Zones", which are substantiated by real-world cases and offer strong replicability. At the scenario-adaptive level, the study incorporates the distinctive attributes of Tianjin's suburban villages to formulate a differentiated governance pathway, one that departs from traditional rural governance models and responds more effectively to the dynamics of peri-urban settings.

6.3. Practical recommendations

To consolidate governance outcomes, efforts should be strengthened across three directions. One necessary direction is a shift toward scenario-driven, precision-intelligent technological deployment. This includes prioritizing sensing terminals at critical nodes and establishing a municipal-level "Suburban Governance Thematic Database" to break down data silos. Another direction concerns institutional design, emphasizing the creation of an agile response incentive system. A dedicated digital-governance talent pool for suburban areas and optimized grassroots performance indicators would provide stable organizational support. A further direction calls for bringing internet platform enterprises into the governance framework as a "fourth pillar," enabling deeper participation throughout the governance process and transforming their involvement into a long-term mechanism that supports rural industrial revitalization and balanced stakeholder interests.

Disclosure statement

The authors declare no conflict of interest.

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