

# Research on Innovation in Rural Public Infrastructure Management under the Background of Rural Revitalization

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**Abstract:** To promote the sustainable development of rural public infrastructure management in the context of rural revitalization, this study focuses on management systems, funding strategies, and maintenance capacities. It analyzes existing challenges in these areas, such as underdeveloped management structures, limited financial investment, and weak maintenance capacities. Through a multi-stakeholder approach led by the government, involving social participation and market-driven initiatives, an efficient management system is established to ensure high facility utilization and service quality. The analysis indicates that a well-developed institutional framework and a robust multi-level funding structure can significantly enhance infrastructure management efficiency, providing strong support for rural development.

**Keywords:** Rural revitalization; Public infrastructure; Management innovation

**Online publication:** November 29, 2024

## 1. Introduction

In the context of rural revitalization, innovations in rural public infrastructure management are crucial for sustainable rural development and the well-being of rural residents. As a fundamental component supporting rural economic and social progress, infrastructure management has long faced issues such as financial shortages, limited maintenance capabilities, and underdeveloped management structures. Effective management innovations require the collaboration of government, village collectives, and market entities. Through optimizing institutional mechanisms, broadening funding channels, and strengthening maintenance capacities, infrastructure functionality can be maximized, leading to the rational allocation of resources and standardized maintenance practices. This foundation supports rural economic revitalization and improvements in quality of life.

## 2. Analysis of rural infrastructure management mechanisms

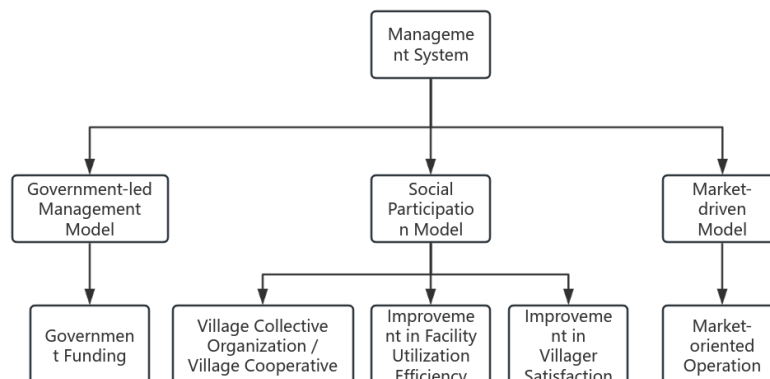
### 2.1. Structure of management systems

In the context of rural revitalization, the structure of rural public infrastructure management systems should focus on key elements such as government leadership, social participation, resource integration, and market-driven approaches. The government, as the primary driver of rural infrastructure construction and management, is responsible for policy formulation, financial support, and coordination, providing an overarching framework to ensure rational allocation and use of resources. Social participation, including village collectives, social organizations, and private capital, brings additional vitality and diverse support to infrastructure management, fostering a more varied and flexible management approach. Resource integration mechanisms are especially crucial, emphasizing the optimization of economies of scale and cost-efficiency through rural clusters and regional sharing, which enhances infrastructure utilization. The introduction of market mechanisms further refines the management system, elevating service levels and management efficiency through market-driven operations <sup>[1]</sup>.

### 2.2. Analysis of current management models

In the existing rural public infrastructure management model, government-led management predominates, supplemented by social participation and market-driven models, forming a government-guided, multi-stakeholder management system. The government-led model serves as the core of rural infrastructure construction and management, characterized by government departments responsible for planning, implementation, and oversight, with funding primarily derived from government budgets and special subsidies <sup>[2]</sup>. This model ensures standardized management and unified planning, suitable for addressing the high investment demands during the initial stages of infrastructure development, ensuring coverage and equity. However, an over-reliance on government funding can result in issues such as funding shortages and project delays.

The social participation model relies more on the support of village collectives and rural cooperatives, especially in the areas of routine maintenance and operational management. Through mechanisms such as village assemblies or village committees, village collectives mobilize local resources, fostering a framework of collective management and shared responsibility, thereby increasing infrastructure utilization and resident satisfaction. Currently, the market-driven model is limited to rural infrastructure management, with applications mainly seen in the partial commercialization of utilities such as water and electricity. The involvement of enterprises or private capital introduces a degree of vitality and professional expertise into rural infrastructure management; however, the overall scale remains constrained (**Figure 1**).



**Figure 1.** Analysis of rural infrastructure management models

These three models complement each other within the current management system, each fulfilling distinct roles that collectively drive rural public infrastructure management towards diversification and increased efficiency.

### **3. Current state of rural public infrastructure management**

#### **3.1. Incomplete management system**

The current rural public infrastructure management system exhibits several weaknesses, including unclear responsibilities, limited funding mechanisms, lack of oversight, weak maintenance structures, and low farmer participation. Ambiguous management responsibilities often lead to accountability issues, as the roles of government, village collectives, and social entities in infrastructure development and maintenance are not clearly defined. For instance, in some rural areas, roads are often constructed but poorly maintained due to the absence of a clearly designated responsible party, leading to a “build over manage” approach, which directly impacts the lifespan and safety of infrastructure.

Funding for rural infrastructure heavily relies on government allocations, lacking diverse financing channels, resulting in funding shortages that delay projects or compromise construction quality. Opportunities for private investment are limited, and effective market-based mechanisms have yet to be established, which constrains sustainable management. In terms of oversight, there is a lack of a robust monitoring system throughout the implementation of infrastructure projects. Some projects receive only superficial reviews at the acceptance stage, and this lack of regulation undermines project quality and financial efficiency. Additionally, the maintenance and management system is insufficient, with many infrastructures lacking systematic maintenance planning, which leaves assets unaddressed as they age or deteriorate <sup>[1]</sup>. For example, in certain rural areas, water supply systems face instability due to a shortage of technical personnel and maintenance funds, directly affecting daily life <sup>[3]</sup>. Low levels of farmer participation in the planning, construction, and management of infrastructure reduce the ability of facilities to meet actual needs, thereby affecting usage rates.

#### **3.2. Insufficient funding for management**

Although government financial support is the primary source for infrastructure development, due to budget priorities and funding allocation constraints, rural infrastructure often lacks adequate support. This limitation hinders project progress and sometimes prevents the full realization of initial planning and future expansions. Many rural areas rely solely on government grants to sustain infrastructure operations, a funding model that increases the risk of financial gaps. When fiscal constraints arise or funding priorities shift, support for infrastructure projects can be abruptly discontinued. The motivation for private capital to invest in rural infrastructure remains generally low. The return cycle in rural markets is often lengthy, and investment risks are high; public utilities such as water and electricity offer limited operational returns, which diminishes their attractiveness to private investors.

Despite national policies advocating for private capital involvement in rural public infrastructure, practical challenges persist. Limited policy incentives, complex approval processes, and stringent regulatory requirements restrict private sector participation, leaving government funding as the main support and weakening the role of private capital and market mechanisms in infrastructure development and management. Additionally, rural infrastructure management lacks sustainable funding mechanisms. In many rural areas, infrastructure operations and maintenance lack stable financial support, and there is little lifecycle planning, meaning initial investments in infrastructure often fail to carry through. In facilities like water supply and roads, while some areas raise funds through local government or village collectives, there is no stable source of funds for ongoing maintenance <sup>[4]</sup>. This

financial shortfall results in inadequate routine maintenance, exacerbating the aging of infrastructure assets.

### **3.3. Weak maintenance capabilities**

The management and maintenance capabilities for rural public infrastructure are notably insufficient, primarily due to an underdeveloped maintenance system, shortage of skilled personnel, low levels of specialization, and limited financial support <sup>[5]</sup>. In many rural areas, infrastructure maintenance lacks systematic long-term planning, and maintenance standards are unclear. Most repairs are temporary, reactive fixes, resulting in low maintenance efficiency. Due to financial and resource limitations, local governments and village collectives struggle to allocate enough skilled technicians for maintenance. As a result, most infrastructure relies on untrained local personnel for basic repairs, who often lack the necessary skills and experience to effectively address complex issues such as aging or faulty infrastructure.

The lack of specialization in management and maintenance further constrains overall operational quality. Rural areas generally lack dedicated maintenance organizations or departments responsible for the systematic operation and repair of infrastructure. Instead, village officials often manage these tasks in addition to their regular duties, which compromises both professionalism and consistency, introducing a level of randomness and unpredictability into the management model. Even in areas where maintenance organizations are established, deficiencies in institutional structure and limited management expertise mean that infrastructure operation and maintenance lack longevity and sustainability. Funding for maintenance is particularly limited in rural public infrastructure. In many villages, the operational costs for infrastructure maintenance primarily rely on funds raised by the village collectives. However, these funds are often limited and unstable, failing to meet actual maintenance needs. For facilities such as water supply and roads, routine inspection and upkeep are typically funded through temporary government grants. Due to limited resources in village collectives, regular maintenance is often unattainable.

## **4. Innovative approaches to rural public infrastructure management**

### **4.1. Strengthening management systems**

Strengthening the management system for rural public infrastructure requires a multi-level, multi-perspective approach to ensure that infrastructure management is scientific, standardized, and sustainable. Clearly defining the responsibilities of all stakeholders and establishing an efficient, multi-stakeholder coordination mechanism is essential. As the core driver, the government should set up a well-structured division of responsibilities that ensures clear roles for village collectives, social organizations, and market entities while encouraging resident participation in decision-making and management to enhance facility utilization and satisfaction. For funding mechanisms, it is crucial to develop diversified financing channels. Government funds should be leveraged to attract private capital by creating investment incentives aligned with the characteristics of rural markets, thereby increasing private sector involvement in infrastructure development and management. A shared-risk policy framework should also be established to foster greater capital participation.

In terms of maintenance management, a standardized management system must be introduced, with scientifically sound maintenance protocols. Maintenance standards tailored to rural needs should be established, particularly for infrastructure such as roads and water supply systems, with specific frequency and quality requirements to minimize issues of aging and damage due to lack of regulation. Moreover, introducing market-driven professional maintenance services can enhance the quality and efficiency of infrastructure upkeep. Engaging third-party professional organizations or establishing regional maintenance alliances can ensure the

continuity and high quality of routine repairs. To secure stable funding, a long-term financial support mechanism is essential. Reliable maintenance funding can be ensured through dedicated funds and village-level fundraising efforts. Particular emphasis should be placed on training local, skilled maintenance personnel to foster a professional, localized management workforce, thus ensuring long-term operational effectiveness and achieving professional and standardized management of infrastructure.

## **4.2. Expanding funding channels**

Expanding funding channels for rural public infrastructure requires building a multi-tiered, diversified financing system to ensure variety and stability in funding sources. The government should leverage its financial guidance role, gradually shifting to a “government-led, socially-involved” model. This includes establishing dedicated support funds to secure initial investments in infrastructure development and maintenance, while also attracting private capital. Fiscal policies should favor multi-channel financing, encouraging different types of capital to participate in rural infrastructure projects through public-private partnership (PPP) models, thus bringing financial resources, technology, and management expertise to rural areas. Under supportive policies, green credit, special bonds, and other financial instruments should be created to boost investment attractiveness, with low-interest loans or targeted subsidies helping to mitigate investment risks.

To further diversify funding sources, village collective economic organizations should be encouraged to actively raise resources, such as through income from land transfers or surplus from collective village economies, establishing village-level funds dedicated to routine maintenance and equipment upgrades. Local governments can also establish regional cooperation funds, breaking the limitations of individual villages by promoting resource sharing and mutual aid across areas, thereby facilitating cross-village infrastructure co-development and resource integration, which ease the financial burden on single villages. Innovative crowdfunding models should also be explored, using a “villagers fund, community reward” approach to enhance local engagement and accountability, ensuring sustainable funding<sup>[6]</sup>. By combining expanded financing channels, diversified investment, and policy support, a long-term funding mechanism can be progressively built to provide continuous financial support for infrastructure management and maintenance.

## **4.3. Enhancing management and maintenance capabilities**

Enhancing the management and maintenance capabilities of rural public infrastructure requires a systematic, professional, and collaborative approach to gradually build an efficient management and maintenance framework. Establishing standardized management and maintenance protocols is essential. This includes developing specific maintenance guidelines for different types of infrastructure, such as inspection and repair standards for roads and water systems, ensuring quality across all usage cycles. Additionally, local governments should work together to create a regular inspection system for rural infrastructure, with scheduled monthly maintenance and anomaly checks to create a reliable support structure, effectively extending the lifespan of these assets. Introducing third-party professional maintenance teams can improve the level of professionalism in infrastructure management. Through public tenders, governments and village collectives can engage experienced companies to handle routine maintenance and equipment upgrades, addressing operational instability caused by a shortage of skilled technicians. Where market conditions allow, exploring the establishment of regional infrastructure maintenance agencies or alliances can help optimize resources for shared facilities across villages or regions, enhancing overall operational efficiency.

Strengthening local maintenance talent is also critical. The government can support village collectives in implementing regular training programs focused on day-to-day maintenance, fault detection, and basic repairs, building a skilled local maintenance workforce, and reducing reliance on external technicians. Specialized training should be provided for specific infrastructure types, such as water and power systems, enabling village-level maintenance staff to handle emergency issues. By increasing local technical reserves, infrastructure maintenance efficiency is improved, and the self-sufficiency of rural areas is strengthened. A long-term financial support mechanism for maintenance should also be established. It is recommended that local governments allocate special funds and use village collective revenue to establish dedicated maintenance funds, ensuring a stable financial source. Leveraging regional cooperation, villages or townships can develop resource-sharing models to ease the financial burden on individual villages, ensuring effective maintenance throughout the infrastructure lifecycle.

## 5. Conclusion

In the context of rural revitalization, rural public infrastructure management should adopt a multi-dimensional approach encompassing strengthened management systems, expanded funding channels, and enhanced maintenance capabilities to create an efficient and sustainable management framework. Future efforts should emphasize policy guidance to encourage multi-stakeholder collaboration, continuously refine infrastructure management mechanisms, and establish effective resource allocation and long-term maintenance support, thereby providing robust support for rural economic growth and improved quality of life for residents.

## Disclosure statement

The author declares no conflict of interest.

## References

- [1] Li Q, Lv S, Cui J, et al., 2024, Sustainability Constraints on Rural Road Infrastructure. *Sustainability*, 16(16): 7066.
- [2] Tripathi V, Preetha GS, 2024, Public Health Infrastructure and Human Resources in Tribal Areas of India: A Decadal Assessment (2012–2022) with Rural Health Statistics data. *International Journal of Health Governance*, 29(2): 162–175.
- [3] David A, Heejin K, 2022, The Value of Rural and Urban Public Infrastructure. *Economic Development Quarterly*, 36(3): 177–192.
- [4] Surjapada P, Surajit P, 2022, Rural Roads Infrastructure under PMGSY in India and West Bengal. *Asian Journal of Research in Social Sciences and Humanities*, 12(5): 275–283.
- [5] Niels T, Gerstenberger M, Bogenberger K, et al., 2019, Model-based Optimization of Public Charging Infrastructure Planning in Rural Areas. *Transportation Research Procedia*, 2019(41): 342–353.
- [6] Pelucha M, 2019, Smart Villages and Investments to Public Services and ICT Infrastructure: Case of the Czech Rural Development Program 2007–2013. *European Countryside*, 11(4): 584–598.

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