

Rural waste management enabled by digital technology: A Case Study of Wucheng District, Jinhua City

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Abstract. With the in-depth implementation of China's rural revitalization strategy, rural governance has become one of the key issues for sustainable development. Through the analysis of smart waste management practice case and combined with the theory of collaborative governance, it reveals the importance of digital technology in the synergy among government, villagers, and enterprises. Meanwhile, by comparing the traditional governance model with the rural governance model empowered by digital technology, it analyzes the promoting role and challenges faced by digital technology in rural waste management, providing theoretical and practical guidance for the modernization development of China's rural waste management.

Keywords: Rural governance; Digital technology; Smart Waste management; Collaborative governance.

1. Introduction

With the comprehensive victory in the battle against poverty and the successful completion of the task to build a moderately prosperous society in all respects, the focus of China's work related to agriculture, rural areas, and farmers has historically shifted to the stage of comprehensively promoting rural revitalization. Comprehensive promotion of rural revitalization is a systematic project, and the implementation of the rural revitalization strategy is a major strategic deployment in the new journey of building a modern socialist country in all respects [1]. Currently, there is a problem of imbalance in the participation of multiple subjects in rural governance. The trend of diversification of rural governance subjects has become a social consensus, and this changing trend is a profound manifestation of the objective changes in rural governance reality. The multi-level and complex nature of rural governance in China in the new era is increasingly prominent, and the traditional governance model relying solely on a single force cannot solve the problem. Digital technology is having a significant impact on agriculture, rural areas, and farmers, becoming a new engine for agricultural and rural modernization and an important strategic breakthrough for rural revitalization.

Waste management plays an indispensable role in rural living environment, directly affecting the quality of the ecological environment, residents' living environment, and the sustainable development of rural areas. Effective waste management not only promotes the balance of natural ecosystems in villages but also facilitates the efficient utilization and circulation of resources, reducing environmental burdens. At the same time, it enhances the overall image and attractiveness of rural areas, helping to attract tourists, investment, and talent, promoting the development of rural economy and tourism industry. Therefore, waste management is a fundamental task for achieving the goal of rural ecological livability, playing a crucial role in maintaining rural environment, improving quality of life, and promoting comprehensive economic and social development. Exploring how to integrate digital technology to promote overall progress in rural natural, cultural, and social ecological environments, effectively achieving rural ecological livability, and addressing the imbalance of multiple subjects in rural governance, enhancing governance efficiency, improving public services, promoting the implementation of rural revitalization strategy, and achieving the goal of coordinated urban-rural development and people's happy and beautiful life.

2. Analysis Framework and Research Methods

2.1. Analysis Framework

Waste management is an important issue in rural governance, especially in the current strategic background of rural revitalization. Collaborative governance is an important dimension of the modernization of the social governance system and governance capacity, with the diversification of governance subjects and consensus reached through participation and negotiation being its main features. Wucheng District of Jinhua City has established a smart waste management model through the introduction and application of digital technology, bringing together multiple subjects such as government, villagers, and enterprises, promoting the formation of a digital rural governance community, and solving the dilemma of imbalance among multiple subjects mentioned above [2].

Therefore, this paper will construct this analysis framework to explore how digital technology empowers rural governance, promotes the optimization and innovation of rural waste management systems, and contributes to the implementation of the rural revitalization strategy. First, it will sort out the main challenges and problems faced by current rural waste management; second, based on the theory of collaborative governance, it will analyze the roles, interactions, and existing problems of multiple subjects in rural waste management; third, through the case of smart waste management in Wucheng District, it will explore the role and experience of digital technology in promoting collaborative governance among multiple subjects. Lastly, strategies and recommendations are proposed to strengthen the construction of a collaborative mechanism for multiple subjects in rural waste management, aiming to provide useful references for the modernization of rural governance.

2.2. Research Methods

This study adopts the inductive method, literature review method, and case analysis method, with rural waste management as the main research object. Through in-depth analysis of leading case in the field of rural waste management and summarizing their experiences and lessons, the aim is to explore the future development direction and path of rural waste management. The rapid development of information technology, including the Internet of Things, big data, artificial intelligence, etc., is of great significance in social governance. These technologies not only provide reference for overcoming the current difficulties in rural governance but also indicate the direction of upgrading and evolving rural governance in the future, playing a demonstrative and leading role. Therefore, studying how digital technology empowers rural governance has a certain representativeness and effectiveness.

3. Case Analysis: Practice of Rural Smart Waste Management in Wucheng District, Jinhua City

3.1. Reform Background

As a part of Jinhua City in Zhejiang Province, Wucheng District began implementing rural waste classification as early as 2014, making it one of the earliest areas in the country to carry out rural domestic waste classification. However, during the initial stage, Wucheng District's waste management practices faced many problems. These problems mainly manifested in the lack of awareness and enthusiasm for waste classification among villagers, inadequate infrastructure, and insufficient government supervision.

Firstly, there was insufficient awareness and enthusiasm for waste classification among villagers. Due to low cultural levels and difficulties in accessing information, the elderly and children could not understand the government's waste classification policy, leading to a weakening of waste classification awareness and the emergence of resistance. At the same time, inadequate infrastructure also increased the difficulty of waste classification for villagers. Problems such as incomplete garbage container facilities and untimely cleaning seriously affected the smooth progress of waste

classification work. Insufficient government supervision was also a prominent issue, with inadequate supervision facilities and insufficient law enforcement personnel leading to frequent chaos in waste management.

3.2. New Model of "Smart Waste Management"

The practice of the new model of smart waste management in Wucheng District, Jinhua City, has shown significant effectiveness. Recognizing the urgency of waste classification and environmental governance, the government of Wucheng District has taken a series of innovative measures, leading rural governance towards digitization and intelligence.

Firstly, while introducing digital technology, the government of Wucheng District has strengthened the leadership of party building and emphasized the integration of party building with the environment. Members of the Communist Party play a leading role and act as liaisons with several households, regularly supervising and guiding villagers to participate in environmental sanitation and waste classification improvement work [3]. For example, by promoting knowledge about waste classification, villagers' participation and sense of identity in environmental protection work have been enhanced.

Secondly, through the construction of a rural living environment big data platform and a digital supervision platform for waste classification, a digitalized waste classification supervision and processing model has been created. Each household has a corresponding QR code, and the classified garbage bins placed in front of each household are also numbered. Villagers can scan the QR code to access the mini-program to provide feedback, enabling intelligent monitoring and data management throughout the waste classification process. Villagers can also accumulate points based on their waste sorting practices and exchange these points for daily necessities periodically. This sorting model effectively solved the problem of inadequate source classification, not only enhancing governance efficiency and management level but also fully leveraging the power of rural communities.

Finally, cleaning companies also actively assumed social responsibility. By real-time monitoring of garbage cleaning vehicles, understanding their real-time location, operational status, etc., they ensure that garbage cleaning vehicles arrive at each village on time and complete the cleaning tasks; at the same time, through grid management of sanitation workers, the fine management of rural sanitation work has been realized. Moreover, using modern information technology to generate detailed work reports and data analysis, and feeding this information back to the rural management departments, helps the departments understand the garbage cleaning situation and sanitation work progress in each village, promptly identify and solve existing problems, and propose corresponding improvement suggestions.

Through the organic combination of digital technology and innovative forms, the "Smart Waste Management" governance model in Wucheng District, Jinhua City, has achieved significant results, providing a valuable reference and example for the innovation and development of rural governance models in China. This model not only improves the level of environmental sanitation but also stimulates villagers' awareness of environmental protection, promoting the sustainable development of rural ecology.

3.3. The Tripartite Interactive Relationship

In the waste management practice of Wucheng District, Jinhua City, a close tripartite interactive relationship among the government, villagers, and enterprises has brought many advantages and effectiveness.

3.2.1 Villager Main Body

First, Wucheng District has highlighted the main role of villagers. Through the "Party Building plus Environment" model, the government guides villagers to participate in environmental sanitation cleanup and waste sorting improvement work, fully mobilizing villagers' enthusiasm and initiative. As direct participants and beneficiaries of waste classification, villagers actively engage in waste

classification through the system of party members connecting with households, improving their awareness and understanding of environmental sanitation cleanup, forming good sorting habits and behaviors. In the digital age, the cost of participation for villagers is reduced, and the application of digital technology makes it easier for them to express their demands and opinions, thereby promoting the democratization and transparency of governance.

3.2.2 Government Guidance

The government plays a guiding and coordinating role in governance practice. Through policy-making, providing resource support, and supervision and management, the government provides significant support for governance practice. In multi-governance, the government is no longer the only decision-maker but participates in decision-making with other entities, forming an open and transparent governance mechanism.

Secondly, Wucheng District has consolidated the guiding role of the government. In the work of waste sorting, the government plays an important role in organization and coordination, policy-making, and supervision and management. By establishing digital supervision platforms, the government has achieved intelligent monitoring and data management throughout the waste sorting process, strengthened the supervision and management of waste sorting work, and ensured the smooth progress of waste sorting efforts.

3.2.3 Enterprise Support

Lastly, enterprises have also played a supporting role. As important participants in social governance, cleaning companies and other enterprises play a significant support and assistance role in waste sorting efforts. Under a multi-governance framework, enterprises pursue not only economic benefits but also social benefits, committing to building a harmonious and stable governance system together with the government and society. Utilizing their resources and technological advantages, enterprises have provided technical support and financial backing for waste sorting efforts, promoting the in-depth development of waste sorting work. Through providing technical support, financial investment, and fulfilling social responsibilities, enterprises actively participate in rural governance, contributing to the development of ecologically livable villages.

4. Logical Analysis: Digital Technology Empowering Rural Governance

4.1. Traditional Rural Governance Models

Traditional rural governance has always employed a top-down, command-and-control governance model, with grass-roots governments acting as the main governance body for decision-making and management. They serve as a "megaphone" for higher-level governments, further refining and rolling out a series of policy measures and conducting propaganda work. In this process, there has not been a good interaction between grassroots governments and villagers. Instead, it has been a one-way output from grass-roots governments, neglecting the important role that villagers, as rural actors, can play. As an important stakeholder in rural governance, villagers are passively "incorporated" into the rural construction process without sufficient space to exercise their initiative and proactivity, leading to a lack of internal driving force for rural development. Meanwhile, enterprises and social organizations often cannot obtain the benefits they expect in rural governance, making their roles more "voluntary" in nature. As "rational economic agents," some of them may engage in improper behaviors to seek more benefits, leading to the wastage of resources.

4.2. Digital Empowerment in Rural Governance Models

With the continuous development of technology, using digital technology to empower social governance has become an important trend driving the modernization of social governance. Using data as a driving force can bridge the information gap between various stakeholders to some extent and promote collaborative governance.

Firstly, the collective governance force of rural society is consolidated [4]. The application of digital governance technology makes rural decision-making more open and transparent, to a certain extent reducing the participation costs of villagers. This eliminates the traditional, elitist representative decision-making and changes the situation of governance on a single track, promoting democratic decision-making in rural areas, and giving villagers more opportunities to participate in expressing their wishes. In this mechanism, they can demonstrate their initiative and enthusiasm, combining their experiences and practices in life to provide constructive suggestions for the governance of their village. In the current situation of the urban-rural binary structure and large urban-rural disparities, the new generation of rural residents often have low belief and weak sense of belonging to the village. However, increasing the sense of achievement and pride can stimulate villagers' enthusiasm for participating in rural affairs and also increase their sense of belonging.

Secondly, there is a holistic reform of grassroots government governance models. In the traditional governance model, the government often addresses the needs of the people based on its own functions. However, the government's functions are static, while governance needs are dynamic. Even if different government departments collaborate, it is difficult to effectively address and handle complex and changing needs, leading to a problem of inefficiency in governance. The digital rural governance system has unique capabilities for integrating information and resources. The establishment of a data governance platform broadens the communication channels between the government and villagers. The grassroots government can more fully understand the villagers' demands and consolidate their scattered problems and suggestions into a data governance repository [5]. Through statistical analysis methods, they can more accurately understand the villagers' demands, reasonably allocate resources, and improve governance effectiveness. Transitioning from using "functions" as a starting point to using "needs" as a guide, the grassroots government has restructured its organizational structure to be flatter and conducted holistic reforms of business processes, coordinating various stakeholders to jointly promote the realization of "intelligent governance" in rural areas.

4.3. Challenges Facing Digital Rural Governance Construction

Firstly, how to enhance villagers' digital literacy? In the current digital era, villagers' digital literacy constraints hinder the improvement of rural governance capabilities, especially in economically underdeveloped villages. This is because they are influenced by traditional agrarian culture, coupled with generally low levels of education, which means they may not readily understand and accept digital technology [6]. Enhancing villagers' digital literacy, increasing their familiarity with various hardware facilities and information platforms, can stimulate their enthusiasm to participate in rural governance through digital technology. This, in turn, can better bridge the digital divide, eliminate information asymmetry issues, and promote the formation and development of digital rural governance communities.

Secondly, how to adapt digital construction to different rural areas in China? With vast territory and varying degrees of rural development across regions, rural governance in China exhibits heterogeneity and complexity. The construction of digital rural governance communities cannot rigidly follow a single path but must innovate models based on the geographical characteristics of each village. Exploring differentiated models of digital rural governance communities within the existing institutional framework requires broad attention.

Thirdly, how to deepen and expand the theory of digital governance communities? Theory guides practice, and practice drives theoretical innovation. In China, the proposal of the theory of social governance communities has enriched the connotation of public governance. In the practice of rural digital construction, new theories of digital governance have emerged. In the future, how to innovatively expand the theory of digital rural governance communities to better guide the practice of rural digital construction is also a question that must be considered.

5. Discussion and Conclusion

Solving rural waste management is not only an urgent environmental challenge but also a systematic project that requires the concerted efforts of the government, various sectors of society, and the vast villagers. In the current digital era, digital technology is widely applied to rural governance, providing new ideas and methods for addressing rural waste management issues.

Digital empowerment in rural governance is driving rural governance towards digitalization and intelligence. Digital rural governance is not just simple technological applications but also the reconstruction and optimization of rural governance systems and models. Through the application of digital technology, intelligent monitoring and data management of rural waste can be achieved, improving governance efficiency and level. On the other hand, digital rural governance also includes comprehensive consideration of the socio-economic and cultural development of rural areas, promoting the improvement of rural informatization and digital literacy, and advancing the modernization and sustainable development of rural governance.

As a forward-looking and innovative academic proposition, the digital rural governance community leads the new trend of public management in the digital age. Guided by national policies, digital rural construction has become one of the key tasks promoted across various regions.

In the future, we should place greater emphasis on the application of digital technology in rural waste management, enhancing the efficacy and level of rural governance through digital means.

In practice, we should formulate digital rural governance plans that align with the local characteristics of each area. This includes, but is not limited to, advancing the construction of new smart villages in a categorized manner, establishing and perfecting village information model platforms, and improving operational management service platforms. Meanwhile, strengthening cooperation with enterprises and scientific research institutions to jointly promote the construction of digital villages, providing more scientific and effective solutions for rural governance.

In summary, digital rural governance is an important part of the current rural revitalization strategy and one of the key paths to solving the issue of rural waste management. Only by fully leveraging the advantages of digital technology and deepening the cooperative co-construction among governments, enterprises, social organizations, and villagers can we enhance the level of rural governance and achieve sustainable development of rural society.

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