

From Tool Embeddedness to Value Symbiosis: Opportunities and Practical Challenges of Grassroots Governance Innovation in the Data Intelligent Era

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Abstract

Against the backdrop of the in depth advancement of the Digital China strategy and the accelerated iteration of new generation information technologies, data intelligent technologies are reshaping the forms, structures and logics of grassroots governance. This paper systematically analyzes the innovation opportunities for grassroots governance in the data intelligent era: the transformation of decision making models from experience driven to data driven, the upgrading of governance systems from fragmented governance to holistic governance, the leap in governance capacity from passive response to proactive prevention, as well as practical breakthroughs in improving service efficiency and reducing the burden on grassroots authorities. Nevertheless, technological embeddedness does not bring about one sided empowerment. In practice, multiple structural tensions have emerged, including technological suspension and efficiency paradox, digital formalism and the alienation of trace oriented management, bureaucratic inertia and organizational adaptation dilemmas, digital divide and equity challenges, alongside data security and ethical risks. These challenges stem from deep seated contradictions between technological logic and governance logic, between technical systems and institutional systems, and between instrumental rationality and value rationality. To tackle the above mentioned dilemmas, we must transcend the binary opposition between “technological determinism” and “social determinism”, pursue the organic integration of technological adaptation, institutional coordination and cultural adjustment, and build a new ecosystem for grassroots governance centered on people, which balances data intelligent empowerment and humanistic care. This paper puts forward optimization paths: adhering to demand orientation to realize precise alignment between technological embeddedness and governance needs; advancing institutional supply to strengthen the rule of law guarantee and organizational reconstruction for digital transformation; bridging the digital divide to safeguard fundamental rights and service accessibility for vulnerable groups; improving the data governance system to consolidate the bottom line of security and ethics; fostering digital literacy and building an actor network for multi party collaborative governance.

Keywords

Data intelligent Era; Grassroots Governance; Digital Empowerment; Technological Paradox; Governance Modernization.

1. Introduction

Grassroots governance is the cornerstone of national governance, which bears a direct bearing on people’s sense of gain, happiness and security. General Secretary Xi Jinping has profoundly pointed out: “A strong grassroots level makes a strong country, and secure grassroots ensures

nationwide stability. We must advance the fundamental work of modernizing grassroots governance. [1]" In the digital age, the rapid development of new-generation information technologies represented by big data, artificial intelligence, Internet of Things, blockchain and digital twins provides unprecedented technical possibilities for tackling long-standing chronic problems in grassroots governance such as information asymmetry, resource fragmentation, delayed response and poor coordination. In 2021, the Central Committee of the Communist Party of China and the State Council issued Opinions on Strengthening the Modernization of Grassroots Governance System and Governance Capacity, explicitly requiring authorities to "enhance smart governance capacity at the grassroots level", implement the "Internet + Grassroots Governance" initiative, and promote the integration and sharing of grassroots governance data resources [2]. Against such a background, digital transformation of grassroots governance has gained momentum across the country, and digital-technology-empowered grassroots governance has become a core driver for modernizing grassroots governance systems and capacities. Giving full play to the strengths of digital technologies carries important theoretical and practical significance for improving the "smart governance" service capacity of grassroots governments, innovating precise and refined grassroots social governance, and advancing the modernization of grassroots governance capacity [3].

However, technological empowerment is neither linear nor conflict-free. As digital transformation deepens, a host of practical dilemmas have surfaced. Some local governments have invested heavily in digital platforms, yet grassroots civil servants complain that "more platforms bring heavier workloads". Some systems emphasize "comprehensive trace-keeping", which forces civil servants to spend massive time entering data and uploading screenshots instead of serving residents. Some platforms pursue "closed-loop management" and "real-time response"; nevertheless, over-data-oriented assessment indicators have given rise to formalism that prioritizes "data compliance" over "service delivery". This phenomenon is summarized as "technological suspension": digital technologies are embedded in a formalistic manner and fail to effectively match real-world grassroots governance demands. Certain local digital governance platforms for grassroots work fall into an "overall efficiency paradox", whereby heavy technological input fails to generate corresponding high performance[4]. Meanwhile, addressing digital formalism at the grassroots has become a key academic topic. "Technological embeddedness and institutional reshaping" for grassroots reporting systems require two-way efforts[6]. "Formalism at fingertips" is typically manifested in excessive government-affiliated mobile applications, repeated data submission, trace-oriented management that shifts responsibilities, and assessment over-reliant on data metrics. It arises from the joint effects of institutional pressure, distorted incentive mechanisms and mismanaged technological governance. Research also identifies growing formalistic problems embedded in routine grassroots work, including online task assignment, trace-based task management and perfunctory task compliance[10].

These observations raise a critical question: do data-intelligent technologies empower grassroots governance or create new governance dilemmas? How can we resolve the tension between technological empowerment and governance alienation? This is both a practical puzzle and an academic issue calling for in-depth responses. Existing studies have yielded valuable insights from perspectives such as technological empowerment, technological implementation, techno-bureaucracy and digital formalism. Still, systematic structural research that situates both opportunities and challenges within one unified analytical framework remains insufficient. This paper systematically sorts out the logics behind grassroots governance transformation in the data-intelligent era. While analyzing governance opportunities brought by technological empowerment, it dissects emerging paradoxes and dilemmas in practice, and further explores optimization paths from "tool-embeddedness"

toward “value symbiosis”, so as to offer theoretical references and practical guidance for modernizing grassroots governance systems and capacities.

2. Theoretical Logic and Core Opportunities for Grassroots-Governance Innovation in the Data-Intelligent Era

2.1. Internal Logic of Technological Empowerment

Digital-technology-driven “smart governance” of grassroots governments follows its inherent operational logic, which centers on optimizing grassroots governance and administration via digital information connectivity. Essentially, the internal logic lies in the fact that digital information connectivity substantially optimizes governance workflows of grassroots governments. Through real-time collection, efficient transmission, intelligent analysis and shared utilization of information, digital technologies break down information barriers and time lags in conventional governance. This enables governments to perceive social demands more accurately, allocate governance resources more expeditiously, and accomplish governance tasks in a better-coordinated fashion. Digital-technology empowerment for grassroots governance results from two interacting pathways: “contextual shaping” and “structural driving”. On one hand, digital technologies reshape the external governance context, forcing continuous digital transformation of governance practices by altering modes of information interaction. On the other hand, the penetration of digital technologies reconstructs the internal structure of governance, shifting governance operations away from traditional bureaucratic logics toward digital transformation. Ultimately, new forms of governance operations emerge featuring real-time interaction among actors, virtual online carriers and parallel practical actions. In this sense, digital technologies bring far more than marginal instrumental improvements to grassroots governance; they facilitate systematic transformation of governance models.

2.2. From Experience-Driven to Data-Driven

Traditional grassroots governance has long relied on experiential judgment and ad-hoc emergency responses, which undermine the accuracy, foresight and scientific soundness of decision-making. One core contribution of data-intelligent technologies lies in advancing governance from “experience-driven” to “data-driven”. Big-data analysis aggregates massive datasets from public-complaint channels, grid-based inspections, Internet-of-Things sensors and social-media platforms. Algorithm models conduct thematic classification and trend analysis to realize “decision-making, administration and innovation supported by data”[12]. By identifying high-frequency problems, high-incidence areas and high-risk time windows through big-data analytics, governance can evolve from “handling each case upon its arrival” to “proactive governance and preventive intervention in advance”. With unified address databases and linked demographic and market-entity information, governance elements can be precisely correlated, greatly boosting work efficiency. These practices demonstrate that data-driven governance improves efficiency and reshapes governance logic: shifting from “problem-solving after incidents occur” to “prediction and pre-intervention”.

2.3. From Fragmented Governance to Holistic Governance

Fragmented administration across departments and information silos have long plagued grassroots governance. Citizens may need to visit multiple agencies, fill in various forms and wait for multi-round procedural transfers to resolve one single complaint. By building unified digital platforms, data-intelligent technologies can integrate service channels, datasets, workflows and stakeholders, upgrading governance systems from fragmentation to integration. Holistic smart governance represents the integration of holistic-governance thinking and smart governance, encompassing three key elements: government digital transformation, integrated

governance practices and precise, efficient demand response[10]. Data-intelligent empowerment is pivotal for advancing holistic smart governance of digital governments. Integrated intelligent public-data platforms enable cross-level data connectivity, realizing the mechanism under which public complaints are “submitted through one single entry, processed on one unified platform and supervised via one integrated network”. These innovations improve administrative efficiency and reconstruct people-centered service logic: instead of delivering segmented services according to departmental functions, governments provide integrated services tailored to public demands.

2.4. From Passive Response to Proactive Prevention

Conventional grassroots governance operates mostly in a reactive mode: problems draw attention only after they escalate. The sensing and analytical capabilities of data-intelligent technologies shift governance toward earlier stages, enabling pre-event prevention and in-process control. Internet-of-Things sensors monitor diverse safety risks in real time; AI-powered video algorithms automatically identify common urban-governance issues; big-data analytics help predict trends such as mass incidents, public-health risks and intensifying social conflicts. This transition from “passive disposal” to “proactive risk prevention” improves governance performance and lowers social costs for crisis response.

2.5. From One-Way Administration to Multi-Party Collaborative Governance

Data-intelligent technologies also provide convenient channels for public participation in grassroots governance, facilitating the shift from “unidirectional government administration” to “multi-stakeholder collaborative governance”. Mobile mini-programs, government-affiliated applications, social-media tools and online deliberation platforms lower participation thresholds. Residents can report problems, submit suggestions, evaluate services and take part in decision-making anytime and anywhere. Integrated public-service platforms embedded with online deliberation functions allow residents to discuss and vote on community public affairs online. With the function of “one-click submission, full-process transparency and evaluable outcomes” for public appeals, government response speed and service quality are subject to real-time public oversight. Such technology-enabled participation mechanisms raise resident engagement and construct a closed-loop governance structure of “demand- response -feedback-improvement”, making grassroots governance more responsive to public will and needs.

3. Practical Challenges for Grassroots Governance in the Data-Intelligent Era

3.1. Research Method

“Technological suspension” means digital technologies are embedded in grassroots governance in formalistic ways and fail to effectively match real-world governance demands. Typical problems include formalistic embeddedness of digital technologies and digital functions divorced from stakeholders’ practical needs. In terms of internal mechanisms, the digital bureaucratic system makes digital technologies largely attached to grassroots administrative organizations, preventing deep integration between technologies and governance practices. Digital power games turn digital-function development into contests over power and disperse governance stakeholders’ rights.[5] Digital dependence fosters techno-centrism among grassroots governments and leads to irrational application of technologies.

Accompanying technological suspension is the “overall efficiency paradox” of grassroots digital-governance platforms. From a “technology-institution” co-construction perspective, scholars point out that technological embeddedness and institutional reshaping for reporting systems require two-way efforts. Progress limited to either dimension will result in efficiency

dilemmas[6]. In other words, the more digital platforms pursue high-efficiency control through standardization and proceduralization, the more they conflict with the situational flexibility required for grassroots governance. Consequently, “platforms are built, yet workloads grow heavier”. This “digital-empowerment paradox” reminds us: without alignment with real grassroots needs, technological embeddedness will backfire against original design intentions.

3.2. Digital Formalism and Alienation of Trace-Oriented Management

Digital formalism denotes a new variant of formalism in the information age. Its essence lies in treating the outward form of information technologies as an end in itself within grassroots governance. It substitutes real goals with superficial forms, prioritizing external digital manifestations while ignoring intrinsic needs and practical performance in digital application. Distinct from traditional formalism, digital formalism features “instrument over-utilization”, “remote governance” and “digital trace-keeping”. It weakens governance effectiveness, alienates relations between the Party and the public, and fosters inflated political achievements. Digital formalism prevails in routine grassroots tasks, manifested as: online task assignment, whereby superior authorities deem instructions “issued” once delivered via work chat groups; trace-oriented task management, which overemphasizes “trace-keeping for everything” and requires photos, location markers and ledgers for each assignment; perfunctory compliance, in which grassroots civil servants mechanically check-in or inflate data merely to meet assessment standards, disregarding actual outcomes. Alienation of trace-oriented management stands out: trace-keeping is originally designed to record workflows and verify performance through documentation. In practice, however, it evolves into excessive trace-keeping at the expense of real outcomes. Civil servants devote substantial time to data entry, screenshot uploading and ledger filling, leaving less time for serving residents[7].

Digital-governance formalism results from implicit control exercised by functional departments and flexible implementation at grassroots governments. At a deeper level, “formalism at fingertips” emerges from the mutual construction of institutional pressure, distorted incentive structures and mismanaged technological governance. In short, digital formalism is not purely a technical problem; it represents the projection and distortion of existing bureaucratic operational logics under digital conditions.

3.3. Bureaucratic Inertia and Organizational Adaptation Dilemmas

Digital transformation of grassroots governance entails not only upgrades to technical systems, but also profound changes in organizational structures and operational logics. Nevertheless, entrenched path-dependence and inertial resistance within the bureaucratic system create structural tensions against the flexibility, flatness and decentralization of digital technologies. Although digital technologies provide powerful drivers for governance transition, digital adjustment of governance structures cannot be accomplished overnight. Co-evolution demands adaptation from both external contexts and internal structures[4].

Specifically, adaptation dilemmas manifest in three aspects. First, structural contradictions between departmental fragmentation and data sharing. Digital governance calls for cross-departmental and cross-level data flows. However, long-standing departmental barriers, interest segmentation and the notion of “proprietary data” within bureaucracies hinder data integration. In many regions, despite massive investment in big-data platforms, real “data silos” are institutional rather than technical in origin. Second, rhythm conflicts between bureaucratic assessment and digital-era response requirements. Digital governance emphasizes rapid response, while bureaucratic assessments follow monthly, quarterly or annual cycles, accompanied by multi-layer approval and upward-reporting inertia. Grassroots civil servants face dual pressures: real-time platform-based assessment alongside conventional periodic reporting. Third, capability contradictions between rigid workflows and flexible disposal.

Digital platforms are usually designed for standardization and normalization. Yet grassroots governance frequently deals with complex, non-standard “intractable cases” that demand flexible solutions for elastic problems.

3.4. The Digital Divide: Equity Challenges in Technological Empowerment

While enhancing governance performance, data-intelligent technologies may exacerbate social inequalities and produce “digital divides”. The digital divide refers not merely to access gaps (availability of devices and networks), but also skill gaps (digital literacy) and outcome gaps (differential benefits derived from digital tools). Within grassroots-governance scenarios, vulnerable groups including the elderly, low-income populations, persons with disabilities and residents in remote areas face a “triple divide”: lack of smart devices or internet access; inability to operate government-affiliated applications and mini-programs; even with basic access, they often cannot obtain services equal to those enjoyed by younger demographics.

While digital-technology penetration advances smart urban governance, it widens digital divides. Fundamentally, the digital divide represents power reconstruction and redistribution driven by technology, data and algorithms. It is reflected in digital control that constrains vulnerable groups’ rights, digital burdens causing mismatches between public-service supply and demand, and digital exclusion preventing equitable public access[13]. Promoting digital-governance tools within communities encounters practical digital-divide challenges, and “flexible governance” serves as a vital policy instrument to help residents bridge such divides.[14]

3.5. Data-Security and Algorithmic-Ethics Risks

Digital transformation of grassroots governance involves collection, storage, utilization and circulation of massive personal information, making data security and privacy protection increasingly prominent. On one hand, grassroots governance needs sensitive resident data including identity records, household information, health status, property details and behavioral trajectories. On the other hand, grassroots authorities possess relatively limited capacity for data protection, which raises risks of data leakage, misuse and excessive collection. Digital governance may fall into ethical dilemmas including humanistic dilemmas, algorithm-related dilemmas, accountability dilemmas and science-technology dilemmas, such as controversies over technological stakeholders, algorithmic discrimination and bias, ambiguous accountability, and privacy-surveillance risks. Breakthrough approaches are proposed from perspectives integrating digital human rights and digital sovereignty, digital justice and digital jurisprudence, as well as digital supervision and “technology for public good”[16].

Meanwhile, algorithm-driven governance faces ethical hazards. When grassroots governance increasingly relies on algorithms for complaint allocation, risk rating, resource distribution and even “credit scoring”, problems such as algorithmic discrimination, black-box algorithms and ambiguous algorithm accountability emerge. Individuals affected by erroneous or biased algorithms may lack channels for appeal and correction. Existing legal frameworks have not fully addressed these issues, forming ethical pitfalls requiring high vigilance in data-intelligent grassroots governance.

4. Underlying Logic of Dilemmas: Triple Tensions among Technology, Institution and Culture

The aforementioned challenges are not isolated. They are rooted in deep-seated tensions: between technological logic and governance logic, between instrumental rationality and value rationality, and between technical systems and social systems. Grasping these tensions provides directional guidance for resolving dilemmas.

First, tensions between technological logic and governance logic. Technological logic pursues standardization, proceduralization and high efficiency. By contrast, governance logic requires responsiveness, contextual adaptability and flexibility. Technical designers tend to translate all real-world problems into quantifiable indicators and executable workflows. However, grassroots governance deals with real people and diverse, unstandardized circumstances that cannot be reduced to standardized procedures. Over-reliance on technical tools erodes indispensable human empathy, trust and contextual judgment in governance. When technological logic overrides governance logic, alienation emerges whereby “technology becomes an end in itself” [4].

Second, tensions between instrumental rationality and value rationality. In Weberian terms, instrumental rationality focuses on efficiency of “means-ends” relations, while value rationality emphasizes intrinsic legitimacy of actions. Grassroots governance in the data-intelligent era faces risks of inflated instrumental rationality and weakened value rationality. As assessment indicators grow more refined and data-oriented, “public satisfaction” may be simplified to “work-order completion rates”, and “service quality” reduced to “response time”. Intangible values such as trust, dignity, fairness and sense of gain become marginalized. When grassroots civil servants are preoccupied with operating mobile devices, entering data and processing work orders, their face-to-face interactions with residents — the precious “human capital” of grassroots governance — shrink drastically.

Third, collaborative imbalance among technical, institutional and cultural systems. According to socio-technical-system theory, successful technological embeddedness hinges on co-evolution among technical, organizational, institutional and cultural systems. Current dilemmas of grassroots-governance digital transformation essentially stem from imbalanced coordination among these systems. Technical systems iterate rapidly, yet institutional systems (assessment systems, data-sharing regimes, fault-tolerance and error-correction mechanisms) lag behind. Digital platforms demand flat-structured collaboration, while bureaucratic organizational structures and power relations remain fragmented across departments. Decision-makers and technical personnel may believe in “technological omnipotence”, whereas grassroots-governance culture emphasizes relationship-orientation, human-centered ethics and contextual wisdom. Mismatch among these systems prevents technologies from integrating into governance practices and turns them into extra burdens for grassroots civil servants.

5. From Tool-Embeddedness to Value Symbiosis: Analysis of Optimization Pathways

5.1. Adhere to Demand-Orientation and Realize Precise Alignment between Technological Embeddedness and Governance Needs

The key to avoiding “technological suspension” lies in designing technical systems based on real grassroots demands, instead of imposing solutions driven merely by technical capabilities. Technological embeddedness and institutional reshaping require mutual construction and iterative advancement; mere technological investment cannot automatically translate into governance performance. Therefore, user-centered design principles should be adopted throughout the full lifecycle of digital-platform construction: conduct in-depth research on pain points, demands and usage habits of grassroots civil servants and residents in pre-construction phases; invite front-line practitioners to participate in function design and prototype testing during development; establish continuous feedback mechanisms post-launch for iterative optimization based on real-world usage. Drawing upon agile-governance concepts, policymakers should pursue rapid iteration with small incremental improvements instead of imposing “one-size-fits-all” mega-platforms [6]. Meanwhile, technical systems should maintain

appropriate resilience and flexibility, permitting grassroots authorities flexible configuration and elastic operation rather than rigid, immutable workflows[18].

5.2. Deepen Institutional Supply and Strengthen Rule-of-Law Safeguards and Organizational Reconstruction for Digital Transformation

Technological empowerment must be accompanied by institutional empowerment. Mutual construction between technology and institutions holds the key to resolving digital-governance dilemmas. Party committees and governments at all levels should accelerate institutional innovation for grassroots digital governance. First, improve rights-obligation-benefit regimes for data sharing, formulate rules for data collection, storage, utilization and circulation, break departmental barriers of “proprietary data”, while safeguarding data security and citizen privacy. Second, reform assessment and evaluation systems: shift from process-orientation to outcome-orientation, replace data-ranking metrics with public feedback, and take people’s real sense of gain as the highest standard instead of over-reliance on platform-generated “completion rates” or “positive-review rates”. Third, establish fault-tolerance and error-correction mechanisms, encouraging grassroots civil servants to adopt localized flexible disposal under basic rules, and avoid risk-averse attitudes and formalism induced by overly rigid assessment. Fourth, promote grassroots organizational reconstruction: appropriately delegate power, optimize workflows and integrate functions to align bureaucratic structures with functional requirements of digital platforms.

5.3. Bridge the Digital Divide and Safeguard Fundamental Rights and Service Accessibility for Vulnerable Groups

Technological empowerment should benefit the whole population. Inclusive design strategies must target digitally vulnerable groups including the elderly, persons with disabilities and low-income communities. Constructing a community-level digital-inclusion framework is vital for popularizing digital technologies and enabling all residents to share digital dividends[15]. Specifically, offline service channels should be retained as alternative options to avoid mandatory online-only services; develop age-friendly and barrier-free digital products; deliver digital-literacy training to help vulnerable groups overcome skill-based divides; establish proactive-detection and targeted-assistance mechanisms for special-needs groups, identify marginalized populations via data screening and deliver door-to-door services. Inclusive design is more than a technical concern; it reflects value positions. The ultimate objective of grassroots governance in the data-intelligent era is not digitalization per se, but equitable access to public services and governance dividends for all.

5.4. Improve the Data-Governance System and Consolidate Security and Ethical Bottom Lines

Data security and privacy protection constitute bottom-line requirements for data-intelligent governance. Authorities should accelerate laws and regulations governing grassroots data governance, clarify scopes of personal-information collection, usage purposes, retention periods and data-destruction mechanisms, and strictly restrict excessive or unauthorized data collection. For high-risk applications such as facial recognition, trajectory tracking and credit scoring, prudent assessment and approval procedures must be instituted, alongside public participation and external oversight. Preventing algorithmic discrimination requires systematic interventions addressing biased datasets and flawed algorithmic design[17]. Furthermore, advance algorithm transparency and interpretability, set up algorithm-audit and appeal-remedy mechanisms to guarantee fairness and accountability of algorithm-driven decisions. Grassroots practices should follow the “minimum-necessity principle”: refrain from collecting information irrelevant to services, avoid retaining data beyond legally prescribed time limits, and prohibit utilization of data for unauthorized purposes.

5.5. Foster Digital Literacy and Build an Actor Network for Multi-Party Collaborative Governance

Grassroots governance in the data-intelligent era requires dual empowerment for “digital citizens” and “digital civil servants”. On one hand, strengthen digital-literacy training for grassroots civil servants, enhancing their capacities in data analysis, platform operation and human-machine collaboration, so that they can harness technologies rather than being controlled by them. Surveys reveal rising problems including digital bureaucracy, digital fragmentation and insufficient digital literacy within grassroots digital governance. Agile governance as an innovative governance model can effectively mitigate these deficiencies[18]. On the other hand, improve residents’ digital literacy and participatory capacity. Community education, public-welfare training and volunteer tutoring help residents master basic digital skills while cultivating rational, responsible and compliant digital behaviors. The ultimate goal is to construct a multi-stakeholder collaborative-governance actor network covering governments, market entities, social organizations and residents, to realize coordinated and shared governance supported by digital platforms.

6. Conclusion

The data-intelligent era brings profound paradigm-shift opportunities for grassroots governance: transitions from experience-driven to data-driven modes, from fragmentation to holistic governance, from passive response to proactive prevention, and from one-way administration to multi-party collaborative governance. These opportunities demonstrate tremendous potential for technological progress to empower governance modernization. Nevertheless, technological embeddedness does not produce unqualified empowerment. Practical challenges including technological suspension, digital formalism, organizational adaptation dilemmas, digital divides and data-security risks warn us of deep-seated tensions between technological logic and governance logic, instrumental rationality and value rationality, and technical systems and social systems. Ignoring such tensions may lead to adverse outcomes: burden increase instead of burden reduction, internal friction instead of efficiency gains, and exclusion instead of inclusive benefits.

To escape these dilemmas, we must reject “technological determinism” and recognize the limitations and contextual contingency of technologies. We should pursue organic integration of technological adaptation, institutional coordination and cultural adjustment. Technical design must be rooted in real grassroots demands; institutional building must keep pace with technological iteration; assessment and evaluation must return to the people-centered value origin; digital divides must be proactively bridged through inclusive design; data security must be embedded within legal and ethical frameworks. Ultimately, data-intelligent technologies serve as instruments rather than ends. The ultimate goals of grassroots governance are people’s all-round development, social fairness and justice, and warm communal bonds. Modernization of grassroots governance in the data-intelligent era represents a profound transformation from “tool-embeddedness” toward “value symbiosis”: technologies should serve humans instead of humans serving technologies; data should inform decision-making rather than replace human judgment; algorithms should boost efficiency rather than erode human empathy. Only in this way can data-intelligent technologies act as powerful engines for modernizing grassroots governance, instead of generating new governance burdens[19].

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