

THE REALISTIC LANDSCAPE, OUTSTANDING PROBLEMS AND OPTIMIZATION PATHS OF SMART COMMUNITY CONSTRUCTION IN CHINA

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Abstract: Community is the basic unit of grassroots social governance, and the construction of smart communities is an important practice in which digital technology empowers grassroots governance and advances the modernization of China's system and capacity for governance. On the basis of defining the connotation and characteristics of smart communities, this paper systematically reviews the policy evolution and main achievements of smart community construction in China, and points out that the current construction still faces such prominent problems as unsound top-level design and standard systems, data barriers and information islands restricting collaborative governance, the absence of long-term operation mechanisms caused by attaching more importance to construction than to operation, insufficient resident participation coexisting with the digital divide, and acute shortages of professional personnel and shortcomings in security governance. It then proposes optimization paths from the aspects of upholding party-building leadership and improving top-level design, deepening data governance to break information barriers, putting people first to expand service scenarios, innovating operation models to improve long-term mechanisms, and strengthening talent support and consolidating the security baseline, so as to provide academic reference for promoting the high-quality development of smart communities in China.

Keywords: Smart community; Community governance; Construction path

1 INTRODUCTION

The community is the basic unit of social governance and the "last mile" through which the Party and the government connect with and serve the masses. With the rapid development of new-generation information technologies such as big data, cloud computing, the Internet of Things and artificial intelligence, digital technology is profoundly reshaping the modes and patterns of grassroots governance, and the construction of smart communities has become an important lever for promoting the digitalization and intelligentization of grassroots governance. As an extension and practice of the smart city concept at the grassroots level, smart communities integrate various community service resources through information-based means, reshape the modes of public service supply and the structure of community governance, and are increasingly becoming an important carrier for enhancing residents' sense of gain, happiness and security.

At the policy level, the construction of smart communities in China has risen to a national strategic deployment. In 2014, the General Office of the Ministry of Housing and Urban-Rural Development issued the Guidelines for the Construction of Smart Communities (Trial), which for the first time provided systematic norms for the construction of smart communities [1]. In 2022, nine departments including the Ministry of Civil Affairs issued the Opinions on Deepening the Construction of Smart Communities, clearly proposing that by 2025, a smart community service platform featuring grid-based management, refined service, information-based support and open sharing should be basically built, and a new type of digital community featuring smart sharing and harmonious co-governance should be preliminarily created [2]. The report to the 20th National Congress of the Communist Party of China further emphasized improving the grassroots governance platform featuring grid-based management, refined service and information-based support, pointing out the direction for the construction of smart communities. The continuous improvement of the policy system has pushed smart community construction from local pilot projects to comprehensive implementation.

At present, the construction of smart communities in China has achieved remarkable results, but it still faces such realistic problems as non-uniform standards, difficult data sharing, unsustainable operation and insufficient participation, which still lag behind the people's expectations for a better community life. Systematically examining the realistic landscape of smart community construction in China, deeply analyzing the existing problems, and proposing targeted optimization paths are of important theoretical significance and practical value for promoting the high-quality development of smart communities and consolidating the foundation of grassroots governance. This paper first defines the connotation and characteristics of smart communities, then reviews the construction process and realistic achievements, further analyzes the outstanding problems, and finally puts forward optimization paths.

From the macro background of grassroots governance, with the acceleration of urbanization and large-scale population mobility, communities have increasingly become the core field for undertaking public services, resolving social contradictions and organizing residents' daily life, and traditional governance methods face challenges such as information asymmetry, resource fragmentation and untimely response. The in-depth application of digital technology provides new possibilities for solving these problems: relying on smart community platforms, communities can perceive governance situations in real time, precisely match residents' needs, and efficiently coordinate resources from all parties,

thereby promoting the transformation of grassroots governance from experience-driven to data-driven and from passive response to active service, laying a solid foundation for building a social governance pattern based on collaboration, participation and shared benefits.

2 THE CONNOTATION AND MAIN CHARACTERISTICS OF SMART COMMUNITIES

2.1 The Connotation of Smart Communities

As for the connotation of smart communities, there is a relatively consistent definition between official documents and academia. The *Opinions on Deepening the Construction of Smart Communities* clearly states that a smart community is a new form of community governance based on information-based and intelligent management and service, which fully applies information technology means such as big data, cloud computing and artificial intelligence, and integrates various community service resources [2]. This definition reveals three basic elements of smart community construction: first, new-generation information technology as the technical support; second, the integration of various community service resources as the basic condition; third, information-based and intelligent management and service as the core function. Foreign scholars such as Caragliu et al. define a smart city as an urban development form that promotes sustainable economic growth and improves the quality of life through investment in human capital, social capital and traditional and modern communication infrastructure, and a smart community is a concrete extension of the smart city concept at the grassroots community level [3].

From the perspective of conceptual origins, "smart community" is the concrete manifestation of the Western "smart city" movement at the community level. Coe et al. systematically elaborated the concept of smart community at an early stage, holding that the application of new technologies locally would trigger economic, social and political transformations and promote a more community-based governance model with greater connectivity, the core of which lies in enhancing community governance capacity through collective intelligence and social learning [4]. From the perspective of governance, smart community construction is not merely a simple superimposition of technical means, but a profound change in governance philosophy and governance methods. Some scholars define intelligent community governance as a new community governance model that applies and embeds new-generation information technologies such as the Internet, big data, the Internet of Things, cloud computing and artificial intelligence into the community governance system, and, according to different combinations of government dominance and residents' self-governance, divide China's intelligent community governance practices into four types: technology empowerment, technology enabling, empowerment and enabling, and technology disembedding [5]. This shows that the technical logic and governance logic of smart community construction are closely coupled, and technology can truly release its effectiveness only when it is embedded in the existing governance system and serves governance objectives.

From the perspective of development context, smart community construction is an inevitable result of the extension of smart city construction to the grassroots level. Smart cities focus on the overall operational efficiency of cities and the level of public services, while smart communities focus on the specific fields of residents' daily life and community governance; the two share the same concept and support each other technically. With the promulgation of the *Guidelines for the Construction of Smart Communities (Trial)* in 2014 and the implementation of the *Opinions on Deepening the Construction of Smart Communities* in 2022, the connotation of smart community construction has been continuously enriched, gradually moving from single applications such as intelligent security and intelligent access control in the early stage to platform-based, scenario-based and systematic overall construction [1-2].

2.2 Main Characteristics of Smart Communities

Combining policy definitions and relevant research, the construction of smart communities in China mainly presents the following characteristics. First, technology: supported by information technologies such as big data, cloud computing, artificial intelligence and the Internet of Things, the whole process of community information perception, transmission, analysis and application is made intelligent [2]. Second, service: relying on the comprehensive information platform for smart communities and offline community service institutions, a convenient and beneficial smart service circle is intensively built to provide community life services, community governance and public services integrating online and offline [2]. Third, collaboration: multiple subjects including the government, the market, society and residents are promoted to participate collaboratively, reshaping the relationship structure among community governance subjects [5]. Fourth, people-orientation: smart community construction should adhere to "society as the substance and technology as the instrument", take responding to residents' needs and improving people's well-being as the value orientation, and avoid falling into the trap of pure technical rationality [6].

3 THE EVOLUTION AND REALISTIC ACHIEVEMENTS OF SMART COMMUNITY CONSTRUCTION IN CHINA

3.1 Increasingly Complete Policy Evolution and Top-Level Design

The construction of smart communities in China has roughly experienced an evolution from pilot exploration to comprehensive promotion and from single technical application to systematic governance reform. Since 2009, on the basis of smart city construction, Shanghai, Beijing and other places took the lead in carrying out smart community pilot

projects; after the promulgation of the Guidelines for the Construction of Smart Communities (Trial) in 2014, the construction of smart communities began to follow rules [1]; the Opinions on Strengthening and Improving Urban-Rural Community Governance issued in 2017 emphasized enhancing the informatization application capacity of communities; and the Outline of the 14th Five-Year Plan (2021-2025) for National Economic and Social Development and the Long-Range Objectives Through the Year 2035 further proposed building convenient and beneficial smart service circles and intelligent residential areas by relying on community digital platforms and offline community service institutions [1]. The continuous input of policy instruments has provided strong support for the construction of smart communities.

The issuance of the Opinions on Deepening the Construction of Smart Communities in 2022 marked that China's smart community construction has entered a new stage of systematic integration, quality improvement and efficiency enhancement. The Opinions deployed key tasks in six aspects: intensively building smart community platforms, expanding smart community governance scenarios, constructing a new landscape of community digital life, promoting the application of big data in communities, streamlining and consolidating community data entry, and strengthening the construction and renovation of smart community infrastructure, and required that the focus of smart community construction shift from "construction-oriented" to "long-term operation" [1-2]. From the perspective of development focus, smart community construction presents an evolution logic from "management" to "service" and then to "governance", and the construction objective has shifted from pure facility intelligentization to the overall reshaping of the governance system [1].

The Opinions on Deepening the Construction of Smart Communities also clarified the basic principles of smart community construction, namely upholding the Party's overall leadership, putting people first, adhering to overall planning, adhering to demand orientation, and adhering to safe development, and deployed safeguard measures from four aspects: strengthening organizational leadership, strengthening planning guidance, strengthening guarantee support, and strengthening pilot demonstration, providing a systematic action guide for smart community construction in various localities [2]. This marks that China's smart community construction has moved from scattered exploration to a new stage of coordinated promotion of top-level design and local practice, and the systematization and synergy of the policy system have been significantly enhanced.

3.2 Remarkable Achievements and Increasingly Diverse Practical Exploration

Through continuous innovative exploration, the construction of smart communities in China has achieved remarkable results. In terms of platform construction, localities have intensively promoted the construction of comprehensive information platforms for smart communities on the basis of existing foundations, promoted the networking, docking, migration and integration of community information systems across levels and departments, continuously expanded government service items handled "at fingertips", "online" and "nearby", and significantly improved community service efficiency [2]. In terms of governance scenarios, intelligent applications such as smart party building, grid management, intelligent security, smart elderly care and epidemic prevention and control have been accelerated, and the capacity for whole-cycle community management has been continuously enhanced [2]. In terms of data application, the basic data on key groups in communities has been continuously improved, and applications such as big data-assisted decision-making and precise dynamic monitoring have been gradually deepened, providing support for the scientific allocation of community service resources [2].

Local practices present a pattern of blooming flowers and have formed several models worth learning from. The smart community construction in Zhouzhen, Pudong New Area, Shanghai adheres to a people-centered approach and optimizes the community governance structure by strengthening party-building leadership and responding to residents' needs, providing a practical sample of "society as the substance and technology as the instrument" for smart community construction [6]. Chengdu takes the information-based digital platform as the governance carrier and promotes smart community construction from top to bottom; the fuzzy-set qualitative comparative analysis of 21 smart communities shows that its governance effectiveness presents four models: terminal service-driven, platform integration-driven, online collaboration-driven and comprehensive application-driven [7]. These practices show that there is no one-size-fits-all solution for smart community construction, and it is necessary to explore according to local conditions based on community resource endowments and development needs [5, 7].

From the perspective of governance models, the practical forms of intelligent community governance in China are increasingly diverse. According to the two dimensions of government dominance and residents' self-governance, existing practices can be roughly summarized into four types: technology empowerment, technology enabling, empowerment and enabling, and technology disembedding. The technology empowerment type takes the government as the leading subject and improves governance efficiency with the help of technology; the technology enabling type focuses on empowering residents' participation through technology; the empowerment and enabling type pursues the simultaneous improvement of government governance capacity and residents' self-governance capacity; and the technology disembedding type is manifested in the disconnection between technology application and governance objectives [5]. Different types of practices differ in applicable scenarios, promotion paths and governance effects, and also provide rich empirical materials for subsequent institutional improvement and model optimization.

At the same time, smart community construction shows broad prospects in empowering grassroots governance with technology. The intervention of digital technology promotes grassroots governance to transform from refined to intelligent, from "person-person" routine interaction to "person-machine" routine interaction, and from fragmented

governance to integrated governance, providing more solid technical support for the construction of community governance communities [1]. On the whole, China's smart community construction has entered a new stage from "having or not having" to "being good or not good", and how to achieve high-quality development has become an urgent question to be answered.

4 OUTSTANDING PROBLEMS IN SMART COMMUNITY CONSTRUCTION IN CHINA

4.1 Unsound Top-Level Design and Standard Systems

Smart community construction involves multiple departments such as civil affairs, political and legal affairs, cyberspace administration, industry and information technology, and housing and urban-rural development, but some localities lack unified planning and top-level design, regional overall promotion is not uniform, and smart community construction presents a fragmented situation. Taking Hefei as an example, the practice of smart community construction in this city has prominent problems such as non-uniform regional overall promotion and different software and hardware platform standards in different localities [8]. Due to the lack of unified technical standards, data standards and service standards, systems built by different communities and different manufacturers are incompatible with each other, forming a scattered pattern of "one platform for each community", which not only wastes resources but also leaves hidden dangers for subsequent integration and upgrading. In some localities, there are also phenomena of unbalanced policy implementation and uneven construction progress, and the development gap between urban and rural areas and between regions is obvious [7].

4.2 Data Barriers and Information Islands Restricting Collaborative Governance

Data is the core resource of smart community construction, but at present, the difficulty of community data fusion and sharing is great and the phenomenon of fragmented segmentation is prominent [8]. Affected by factors such as departmental interests, data security and management systems, functional departments such as public security, civil affairs and health have respectively established relatively closed information systems; the same data source is repeatedly collected in different departmental systems with different standards, and community workers repeatedly fill in and enter data through multiple channels, making the burden at the grassroots level heavy. The interconnection and intercommunication of community governance data is insufficient, cross-departmental business collaboration is not smooth, and it is difficult for the comprehensive information platform for smart communities to truly play the role of a data aggregation and sharing hub [7]. In addition, the single dimension of data collection and the lag in dynamic update restrict the application effectiveness of big data in precise services, risk warning and other aspects.

The practice represented by Hefei shows that in smart community construction, the degree of data standardization and normalization is insufficient, the interfaces between systems are not unified, and the phenomenon of "interconnection without integration" of data is relatively common [8]. Community-level data is often scattered in the hands of multiple subjects such as property management, grid workers and residents' committees, lacking a unified collection and governance mechanism, which makes the high-quality data foundation for deep applications such as big data analysis and precise warning insufficient, and the comprehensive benefits of smart communities are difficult to fully manifest.

4.3 Emphasis on Construction over Operation and the Absence of Long-Term Operation Mechanisms

Smart community construction generally has the problem of "attaching more importance to construction than to operation". Some localities equate smart community construction with hardware procurement and platform launching. After the project is completed, there is a lack of continuous operation and maintenance investment, resulting in idle systems, weakened functions and stagnant updates. The shift of the focus of smart community construction from "construction-oriented" to "long-term operation" means that the construction model, investment mechanism and operation logic all need to be correspondingly adjusted [1]. However, at present, the funds for smart community construction mainly rely on fiscal input, the mechanism for social capital participation is not sound, and the market-based operation model is not yet mature. Sustainable operation faces multiple constraints of capital, technology and talent, restricting the continuous release of the effectiveness of smart community construction.

Unclear operation subjects and unclear operation and maintenance responsibilities are also realistic obstacles restricting long-term operation. Smart community platforms involve multiple subjects such as government departments, technology enterprises and property management companies, and the connection between subjects in the construction period and the operation period is not smooth, which is easy to produce the problem of "transfer upon completion and lose management upon transfer". At the same time, some application scenarios lack continuous content update and function iteration, residents' frequency of use declines year by year, and platform activity is insufficient, further weakening the actual effect of smart community construction.

4.4 Insufficient Resident Participation Coexisting with the Digital Divide

Smart community construction must ultimately be reflected in residents' feelings and participation, but at present, there is generally a problem of insufficient collaborative participation of multiple subjects [7]. Some smart community construction projects are promoted from top to bottom by the government, with insufficient research on residents' needs,

and application scenarios are disconnected from residents' actual needs; online consultation, online discussion and other participation channels have not fully played their role, and residents' enthusiasm and initiative in participating in community governance need to be improved. At the same time, elderly people, disabled people and other groups face the dilemma of the "digital divide", with high operational thresholds for smart devices and insufficient supply of age-friendly services, and they are easily marginalized in smart community construction. Empirical studies show that information exposure, technical rationality and technology dependence are multiple limitations restricting the development of smart community construction toward the socialization of social governance, and pure technical promotion can hardly truly shape a new community form [6].

The reason is that insufficient resident participation is closely related to the technical logic of smart community construction. At present, many smart community platforms are designed with the management end as the center, and the resident end functions are relatively weak, and online services do not match residents' real needs well; the existence of restrictive factors such as information exposure and technical rationality also makes residents doubt the smart platform and affects their willingness to participate [6]. How to reconstruct platform functions from the perspective of residents and smooth participation channels so that smart communities truly become a field for residents to co-build, co-govern and share is an issue that smart community construction must face squarely.

4.5 Acute Shortages of Professional Personnel and Shortcomings in Security Governance

Smart community construction requires both professionals who understand technology and compound talents who understand governance, but at present, the talent supply is obviously insufficient [5]. The coverage of informatization skills training for community workers is limited, the informatization literacy of grassroots teams is uneven, and digital governance talents are lacking, restricting the in-depth application and sustainable operation of smart platforms. At the same time, the problems of data security and personal information protection in smart community construction are becoming increasingly prominent. Community data involves sensitive information such as residents' identity, health and family; the security management systems in the links of data collection, storage, use and sharing are not yet sound, and the risks of personal information leakage and abuse cannot be ignored [2]. How to delimit the boundaries of the application of technologies such as facial recognition and how to keep algorithmic decision-making transparent and fair are also governance topics that need to be answered urgently.

In addition, the fairness and transparency of algorithm application also need attention. In smart community construction, algorithm-based decisions such as intelligent evaluation, automatic dispatch and risk warning are increasingly widely applied, but the opacity of algorithm rules may bring deviations in governance results and affect residents' sense of fairness and trust. While promoting smart community construction, it is necessary to simultaneously improve algorithm governance and supervision mechanisms to ensure that technology application conforms to public interests and the requirements of the rule of law, making digital governance both forceful and warm.

5 PATH CHOICES FOR PROMOTING THE HIGH-QUALITY DEVELOPMENT OF SMART COMMUNITIES IN CHINA

5.1 Upholding Party-Building Leadership and Improving Top-Level Design and Standard Systems

Upholding and strengthening the Party's overall leadership is the fundamental guarantee for smart community construction. Party leadership should be carried through the whole process and all aspects of smart community construction to ensure the correct direction of construction [2]. The coordinating role of Party organizations should be brought into full play: smart community construction plans should be uniformly formulated with the city divided into districts as the unit, intelligent construction in fields such as community governance, community service infrastructure operation and public utility management should be coordinated, and different types of newly built communities and old communities should be treated differently [2]. The planning, policy and standard systems for smart community construction should be accelerated, technical standards, data standards, service standards and evaluation index systems should be improved, and system integration, data sharing and business collaboration should be promoted to provide a unified institutional framework for smart community construction [2, 8]. At the same time, the leading role of pilot demonstration should be brought into play: smart community construction pilots should be carried out with counties (cities, districts, banners) as the unit, successful experiences and typical practices should be summarized and promoted in time, and the overall level of smart community construction should be improved [2].

5.2 Deepening Data Governance and Breaking Information Barriers

Data sharing is a key link in smart community construction, and "information islands" should be broken with data governance as the main line. Community information sharing lists should be formulated, the mechanisms of unified collection, unified form-making and unified reporting should be improved, a standardized, uniformly managed and dynamically updated community data resource system should be accelerated, and grassroots work ledgers and report forms should be greatly reduced [2]. The data resource sharing and exchange mechanism between township (subdistrict) and department government information systems should be improved, data resources should be opened to communities according to the needs of serving the masses, and the interconnection and intercommunication of the comprehensive information platform for smart communities with the urban operation and management service platform and the smart

property management service platform should be promoted [2]. While ensuring data sharing, the source governance of data quality should be strengthened, the basic data on key groups such as key places, permanent residents and floating population in communities should be improved, big data mining applications should be deepened, and the level of precise dynamic monitoring, prediction and early warning based on high-frequency big data should be improved [2]. Through system integration and business collaboration, data should run more and the masses should run less, effectively empowering and reducing burdens for the grassroots [8].

5.3 Putting People First, Expanding Service Scenarios and Bridging the Digital Divide

Smart community construction should adhere to "society as the substance and technology as the instrument", take satisfying the people's aspirations for a better life as the starting point and foothold, and make technology truly serve residents' needs rather than dominate residents' life [6]. Around high-frequency service items such as employment, health, elderly care, disability assistance and childcare, the ways of providing government services and public services should be innovated, service scenarios integrating online and offline should be expanded, and more services should be handled "at fingertips", "online" and "nearby" [2]. High attention should be paid to the digital divide: digital skills education and training services should be strengthened, the basic needs and usage habits of minors, elderly people, disabled people and other groups should be fully considered, and age-friendly and accessible services should be provided; for high-frequency service items such as medical treatment, social security, civil affairs and living expenses payment, offline handling channels should be retained and "one-stop" services should be promoted to ensure that all groups can share the achievements of smart community construction [2].

5.4 Innovating Operation Models and Improving Long-Term Operation Mechanisms

To solve the problem of "attaching more importance to construction than to operation", the key lies in innovating the operation models of smart community construction. A funding mechanism for smart community construction featuring government guidance and multi-party participation should be improved, social forces should be encouraged to participate in "Internet + community services", and service models and products should be innovated [2]. Market-based operation models for smart community construction should be explored; through government purchase of services or cooperative development and other ways, various market subjects should be supported to undertake the operation of smart community construction projects, and innovation and iteration should be promoted [2]. At the same time, smart community construction should be effectively connected with the renovation of old residential areas in cities and towns, the construction of complete communities and the construction of age-friendly communities, resource allocation should be coordinated, and the comprehensive benefits of construction investment should be improved, so as to realize the transformation from "being built" to "being used well" and "operating well" [1].

5.5 Strengthening Talent Support and Consolidating the Security Baseline

Talent is the intellectual support for smart community construction. Informatization skills training for community workers should be strengthened, the digital literacy of grassroots teams should be improved, and graduates of information-related majors in institutions of higher learning should be guided to find employment and start businesses in fields related to smart community construction [2]. Compound talents with both technical ability and governance ability should be cultivated, professional social workers, community workers and information technology personnel should be promoted to collaborate, and sustainable talent supply should be provided for smart community construction [5]. At the same time, the concept of safe development should be firmly established: network and data security management of smart communities should be strengthened, and the protection of key information infrastructure should be strengthened; the community data security management and guarantee system should be improved, with emphasis on strengthening the supervision of data management and use by property service enterprises in residential areas, and residents' personal information and privacy should be protected according to law [2]. When new technologies such as facial recognition are used in fields such as maintaining public security, they should be promoted prudently and carefully in accordance with relevant laws and regulations, ensuring that technology application always operates on the track of the rule of law [2].

6 CONCLUSION

Smart community construction is an important practice for advancing the modernization of the grassroots governance system and governance capacity in the digital era and a key lever for improving community governance effectiveness and enhancing people's well-being. In recent years, under the dual effects of policy guidance and technology drive, China's smart community construction has achieved remarkable results in platform construction, scenario expansion, data application and practical exploration, injecting strong momentum into grassroots governance. However, it should also be clearly recognized that smart community construction still faces such realistic problems as non-sound standards, difficult data sharing, unsustainable operation, insufficient participation, talent shortage and security risks, and there is still a considerable gap from the goal of a new type of digital community featuring smart sharing and harmonious co-governance.

To promote the high-quality development of smart communities, it is necessary not only to give full play to the empowering effect of digital technology, but also to return to the origin of governance, adhere to a people-centered approach, and unify technical rationality with institutional rationality and instrumental value with humanistic value. In the future, on the premise of upholding party-building leadership, the top-level design and standard system should be further improved, data governance should be deepened to break information barriers, people should be put first to expand service scenarios, operation models should be innovated to improve long-term mechanisms, and talent support should be strengthened to consolidate the security baseline, promoting smart community construction from technology embedding to systematic reconstruction and from government promotion to co-construction, co-governance and shared benefits, so that smart communities truly become a field for carrying residents' happy and beautiful life and lay a solid grassroots foundation for comprehensively building a modern socialist country.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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