Research on the Mechanism and Optimization Pathways of Artificial Intelligence Enabling Emergency Culture Construction

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Abstract: *By leveraging its technical advantages in data-driven decision-making, intelligent analysis, and dynamic optimization, artificial intelligence (AI) deeply aligns with the core demands of emergency culture construction, which include value dissemination, knowledge popularization, practical application, and effectiveness enhancement. It serves as a key enabler in addressing challenges such as fragmented communication, superficial practice, and lagging effectiveness in grassroots emergency culture promotion. Therefore, this paper constructs a four-dimensional analytical framework encompassing "intelligent value anchoring, precise communication coverage, practical and scenario-based cultivation, and smart effectiveness enhancement." This framework is used to analyze the enabling logic of AI: specifically, by using intelligent algorithms to convey emergency safety values, multimodal technologies to broaden communication boundaries, simulation and drills to improve practical capabilities, and data feedback to optimize construction effectiveness. Ultimately, this process contributes to forming a trinity empowerment system for grassroots emergency capabilities, integrating "concept, ability, and mechanism." However, the current field faces challenges such as algorithm bias leading to value distortion and the digital divide exacerbating service exclusion. It is necessary to promote the deep integration of AI and emergency culture through four pathways, including strengthening algorithm fairness calibration and enhancing the inclusivity and adaptability of technologies. This will provide practical guidance for strengthening the foundation of grassroots emergency capabilities.*

Keywords: *artificial intelligence; emergency culture; grassroots emergency capabilities*

1. Introduction

As the "nerve endings" of the national emergency management system, the grassroots level serves as both the "last mile" for implementing major decisions and deployments and the "first mile" for responding to emergencies. Its governance security level is directly related to the consolidation of national security safeguards. As a core vehicle for building safety consensus and regulating safety behaviors, emergency culture construction urgently requires the support of artificial intelligence technology to break through traditional governance bottlenecks. In recent years, with the application of technologies such as mobile internet, big data, the Internet of Things, cloud computing, and artificial intelligence in the emergency field, humanity has entered the era of big data characterized by digital emergency response and intelligent emergency management[1]. The application of these technologies has injected new momentum into emergency culture construction, promoting its transformation from experience-driven to data-driven, from one-way dissemination to precise delivery, and from formalistic practice to scenario-based cultivation.

From the perspective of public services, improving grassroots emergency capabilities to achieve the equalization of public services is an important aspect of urban governance[2]. Strengthening emergency culture construction plays a significant role in enhancing grassroots emergency capabilities[3]. As a core area of technological innovation, artificial intelligence provides a key pathway for the technological empowerment of emergency culture construction. Existing research primarily focuses on the direct application of artificial intelligence in emergency management[4-6] or separately discusses the value and practice of emergency culture construction[7-9], yet it lacks systematic investigation into "how artificial intelligence empowers emergency culture construction." Firstly, it fails to deconstruct the coupling logic between artificial intelligence and emergency culture construction, making it difficult to reveal the internal mechanism of technological empowerment. Secondly, there is insufficient analysis of the

new challenges faced by artificial intelligence in empowering emergency culture construction within the context of digital transformation in grassroots governance. Thirdly, much of the research remains at the level of describing technical functions, lacking path designs tailored to the practical needs of the grassroots level. Based on this, this paper builds a four-dimensional analytical framework grounded in the technical characteristics of artificial intelligence and the requirements of emergency culture construction, analyzes the forms and mechanisms of empowerment, identifies the challenges, and proposes optimization pathways.

2. Analysis Framework for Artificial Intelligence Empowering Emergency Culture Construction

2.1 The Connotation and Core Characteristics of Artificial Intelligence Empowering Emergency Culture Construction

Emergency culture refers to the aggregate sum of emergency awareness, concepts, behaviors, safeguards, and norms formed by society in responding to major emergencies. Under normal safety conditions, it is characterized by a people-centered approach that prioritizes life and safety, encompassing processes of consciousness, behavior, and institutional norms. In the exceptional contexts of a risk society and emergency management, it focuses on holistic security, aiming at disaster prevention, mitigation, and relief[10]. Generative artificial intelligence, on the other hand, can play a significant role in public service domains such as social governance and public resource management[11].

Artificial Intelligence empowering emergency culture construction refers to the process of comprehensively optimizing and upgrading the entire workflow of traditional emergency culture-including value dissemination, knowledge propagation, practical cultivation, and effectiveness evaluation-by leveraging intelligent technologies such as big data and natural language processing. This process facilitates a shift from static dissemination to dynamic interaction, from generalized coverage to precise reach, and from experiential summarization to intelligent optimization.

The core characteristics of this model stem from the high degree of alignment between technological logic and the demands of emergency culture construction, which are specifically manifested in four aspects: First, intelligent value anchoring focuses on building safety consensus. By analyzing differences in the safety awareness of grassroots populations through data processing, it identifies the most suitable forms for disseminating the principle of "putting the people and their lives first," thereby promoting a shift in safety values from passive reception to active identification. Second, precise communication coverage enhances the effectiveness of knowledge reach. It customizes differentiated content based on the emergency knowledge needs of different groups and scenarios, addressing issues inherent in traditional methods such as uneven dissemination and monotonous formats. Third, practical and scenario-based cultivation facilitates the translation of emergency capabilities. Utilizing virtual simulation technology to create highly realistic scenarios allows the public to learn skills immersively, while post-action reviews help optimize plans, thereby driving the transformation of knowledge into practical response capabilities. Fourth, smart effectiveness upgrading improves the efficiency of iterative development. By integrating data from the entire process, it uses intelligent analysis to assess outcomes and generate optimization strategies, propelling emergency culture construction from manual adjustments to intelligent iteration.

These four aspects are mutually supportive, forming the core framework for Artificial Intelligence empowering emergency culture construction and providing an effective pathway that integrates culture and technology to strengthen the safety of grassroots governance.

Artificial Intelligence enabling the construction of emergency culture refers to the process of comprehensively optimizing and upgrading the entire workflow of traditional emergency culture-encompassing value transmission, knowledge dissemination, practical cultivation, and effectiveness evaluation-by leveraging intelligent technologies such as big data and natural language processing. This process facilitates a shift from static dissemination to dynamic interaction, from generalized coverage to precise reach, and from experiential summarization to intelligent optimization. The core characteristics of this model stem from the high degree of alignment between technological logic and the demands of emergency culture construction, which are concretely manifested in four aspects. First, intelligent value anchoring focuses on building safety consensus. It identifies the most suitable forms for disseminating the principle of "putting the people and their lives first" by analyzing differences in safety awareness among grassroots populations through data processing, thereby

promoting a shift in safety values from passive acceptance to active identification. Second, precise communication coverage enhances the effectiveness of knowledge reach. It customizes differentiated content based on the emergency knowledge needs of different groups and scenarios, addressing issues inherent in traditional methods such as uneven dissemination and monotonous formats. Third, practical and scenario-based cultivation facilitates the translation of emergency capabilities. By utilizing virtual simulation technology to create highly realistic scenarios, it allows the public to learn skills immersively, while post-action reviews help optimize plans, thereby driving the transformation of knowledge into practical response capabilities. Fourth, smart effectiveness upgrading improves the efficiency of iterative development. Through the integration of data from the entire process and the application of intelligent analysis to assess outcomes and generate optimization strategies, it propels emergency culture construction from manual adjustment to intelligent iteration. These four aspects are mutually supportive, constituting the core framework for Artificial Intelligence enabling emergency culture construction and providing an effective pathway that integrates culture and technology to strengthen the safety of grassroots governance.

2.2 Construction of the Analytical Framework

The technical advantages of Artificial Intelligence-characterized by "data-driven decision-making, intelligent analysis, and dynamic optimization"-are highly aligned with the core operational logic of emergency culture construction, which involves "value dissemination, knowledge popularization, practical application, and effectiveness enhancement." Building upon this alignment, this paper constructs a four-dimensional analytical framework encompassing "intelligent value anchoring, precise communication coverage, practical and scenario-based cultivation, and smart effectiveness upgrading." At the level of intelligent value anchoring, the focus is on the need for disseminating emergency culture values. Data mining technology is employed to identify gaps in the safety value awareness among grassroots populations, generating tailored value communication content. This process deeply integrates the principle of "putting the people and their lives first" into the daily fabric of grassroots governance, thereby solidifying the ideological foundation for emergency culture construction. The level of precise communication coverage centers on the goal of popularizing emergency culture knowledge. Leveraging user profiling technology and multimodal content generation capabilities, it enables the contextual customization and personalized delivery of emergency culture content. This approach effectively broadens the reach of services and significantly enhances the accessibility of emergency culture. The level of practical and scenario-based cultivation targets the key link of translating emergency culture into practice. By utilizing virtual simulation technology to construct highly realistic emergency scenarios and combining it with intelligent assessment technology, a closed-loop practice system of "scenario simulation, practical operation, and algorithmic review" is established. This accelerates the transformation of safety knowledge into practical emergency response capabilities. The level of smart effectiveness upgrading addresses the objective of enhancing the efficacy of emergency culture. Through big data analysis, it tracks the effectiveness of the entire process of emergency culture communication and practice, automatically identifies weaknesses in the construction efforts, and generates targeted optimization plans. This facilitates the continuous iteration of emergency culture construction effectiveness, providing technological support for the improvement of grassroots emergency capabilities.

3. The Forms and Mechanisms of Artificial Intelligence Empowering Emergency Culture Construction

The deep integration of Artificial Intelligence into the entire process of emergency culture construction has given rise to three types of innovative practical forms, providing robust support for the enhancement of grassroots emergency capabilities. The first form is the intelligent consensus-building form, which focuses on the conceptual shaping phase to achieve precise transmission of safety values. By incorporating safety awareness data from grassroots populations, it customizes communication content that aligns with the cognitive habits of different groups, such as audio-based publicity for the elderly and interactive animations for teenagers. Simultaneously, it identifies exemplary cases and advanced deeds within the emergency field, extracting core values and transforming them into tangible communication materials. This enhances public emotional resonance and fosters a consensus atmosphere where "the whole population values safety." The second form is the intelligent capability-strengthening form, concentrating on the core phase of capability enhancement to promote the transformation of emergency practices towards real-scenario application. Utilizing virtual

simulation technology, it constructs various types of emergency simulation scenarios, such as fires and floods, allowing the public to master self-rescue and mutual-aid skills through immersive operations. Algorithms record key data from the practice process, providing participants with personalized capability assessments and improvement suggestions. Concurrently, by analyzing group practice data, it optimizes scenario difficulty and training focus, thereby enhancing the precision of practical cultivation. The third form is the intelligent collaborative governance form, which revolves around mechanism innovation to improve the system of whole-society participation in emergency culture construction. Relying on intelligent platforms to integrate resources from multiple entities-including the government, social organizations, and the public-it establishes a collaborative operational mechanism encompassing "demand reporting, resource matching, and task allocation." Furthermore, by analyzing data on public participation behaviors, it implements intelligent incentive systems, such as point-based rewards and honor certifications. This fully mobilizes public enthusiasm for participation, ultimately forming a multi-stakeholder governance pattern characterized by government leadership, societal involvement, and public collaboration.

4. The Challenges and Causes of Artificial Intelligence Empowering Emergency Culture Construction

4.1 Practical Challenges in Artificial Intelligence Empowering Emergency Culture Construction

Currently, the application of artificial intelligence in emergency culture construction still faces multiple challenges, which constrain its enabling effect on grassroots emergency capabilities. First, the distortion of intelligent value transmission is manifested in algorithm bias leading to deviations in the dissemination of safety concepts. Some artificial intelligence models are trained on historical data; if the data underrepresent vulnerable groups, it can easily generate value dissemination content that overlooks the needs of these groups. The "black box" nature of algorithms makes the generation logic of value dissemination content difficult to interpret. If the content exhibits biases in value orientation, it is challenging to trace the responsible entity, thereby affecting public acceptance of safety concepts. Second, the insufficiency of precise communication coverage is reflected in the digital divide exacerbating service exclusion. Weak digital infrastructure in some rural and remote areas makes it difficult for AI-enabled emergency culture services to reach these populations. Digitally disadvantaged groups, such as the elderly and low-income individuals, lack the ability to use intelligent platforms, preventing them from effectively accessing personalized communication content and practical services. This creates a dilemma where "the more advanced the technology, the more uneven the coverage." Third, the limited effectiveness of practical and scenario-based cultivation stems from the superficial application of technology, which hinders capability transformation. Some virtual simulation scenarios are disconnected from the actual risks faced at the grassroots level, and the parameters generated by algorithms do not fully incorporate regional risk characteristics, resulting in the public's practical skills being inadequate for real emergency situations. Intelligent assessment algorithms often focus excessively on the correctness of operational steps while lacking sufficient evaluation of the reasonableness of response strategies, making it difficult to comprehensively reflect emergency capability levels. Fourth, prominent data security risks trigger a crisis of trust, undermining the foundation of governance. The application of artificial intelligence requires the collection of personal data from the public. Inadequate data encryption and storage mechanisms can easily lead to the risk of data leakage. Some members of the public harbor doubts about the fairness of algorithmic decision-making, leading to reduced trust in intelligent emergency culture services and dampening their enthusiasm for participation.

4.2 Deep-Seated Causes of the Challenges in Artificial Intelligence Empowerment

The challenges faced by artificial intelligence in empowering emergency culture construction are, at their core, rooted in a misalignment between technological logic and the actual needs of emergency culture construction as well as the realities of grassroots governance. This misalignment manifests specifically as disconnections across four dimensions.

First, there is a disconnection between technology and values. Algorithm design fails to prioritize the core safety value of "putting the people and their lives first." Some models merely pursue dissemination effectiveness, generating content that deviates from safety principles. Furthermore, the training data lacks representation from diverse grassroots groups, especially vulnerable populations, making it difficult to achieve equitable coverage in value dissemination.

Second, there is a misalignment between technology and context. Digital infrastructure resources are disproportionately allocated to urban areas, while rural and remote regions suffer from insufficient investment, leaving technological applications without adequate hardware support. Additionally, most intelligent services follow standardized designs that do not account for the usage habits of digitally disadvantaged groups, resulting in poor adaptability.

Third, there is a disconnect between technology and practice. At the grassroots level, there is a shortage of interdisciplinary talent proficient in both artificial intelligence and emergency management, hindering the optimization of technological applications. In some regions, artificial intelligence is treated as a mere "achievement project," with only basic functionalities deployed and core technologies not deeply integrated, reducing empowerment to a superficial formality.

Fourth, there is an imbalance between technology and security. The collection and use of data lack clear regulations, leading to ambiguous security responsibilities. The opaque decision-making logic of algorithms makes it difficult to address public concerns, thereby undermining trust-building efforts.

5. Optimization Pathways for Artificial Intelligence Empowering Emergency Culture Construction

In response to issues such as value transmission distortion, uneven communication coverage, superficial technological application, and data security risks encountered by artificial intelligence in emergency culture construction, it is essential to adhere to the core principles of "value guidance, inclusive adaptation, practice orientation, and security controllability." Optimization pathways should be constructed from the following four aspects to ensure that technological empowerment consistently serves the fundamental objectives of emergency culture construction and the core needs of grassroots governance security.

5.1 Strengthen Algorithm Fairness Calibration to Ensure the Accuracy of Intelligent Value Transmission

The core issue of distortion in intelligent value transmission lies in the disconnection between the technological logic of algorithms and the value orientation of "putting the people and their lives first." Optimization must focus on building a fair and credible value transmission system to achieve synergy between values and technology. First, it is essential to establish the principle of value-first algorithm design. Incorporating compliance with the safety principles of emergency culture as a core objective of artificial intelligence can prevent a sole focus on technical metrics from deviating from the essence of "building safety consensus," thereby ensuring that disseminated content aligns with core demands. Second, it is crucial to adhere to the baseline of data fairness. Improving mechanisms for diverse data collection and evaluation, and supplementing safety awareness data from rural, remote, and vulnerable groups can eliminate "blind spots" in value dissemination at the source, ensuring that safety concepts reach all groups. Third, it is necessary to construct a framework for algorithm transparency and accountability. Making the generation logic of value dissemination public, clarifying the responsibilities of all parties, and establishing a rapid response mechanism for bias correction can help resolve the trust crisis caused by algorithmic "black boxes."

5.2 Enhance the Inclusivity and Adaptability of Technology to Broaden the Reach of Precise Communication

The insufficiency in communication caused by the digital divide fundamentally stems from the failure of technological applications to account for grassroots disparities and the needs of different groups. Optimization efforts must center on inclusivity and promote the adaptation of technology to communication demands from three aspects. First, it is essential to follow the logic of balanced resource allocation. Increasing investment in digital infrastructure in rural and remote areas will narrow regional technological disparities, enabling intelligent services to extend to the furthest reaches of the grassroots level. Second, it is crucial to adhere to the principle of service inclusivity. By simplifying operational processes and optimizing adaptable service formats in line with the cognitive habits and capabilities of digitally disadvantaged groups, the barriers that technological thresholds pose to acquiring safety knowledge can be broken down. Finally, it is necessary to construct a comprehensive, coordinated communication system. Integrating online platforms with traditional offline channels, and flexibly adjusting the primary communication channels based on regional technological foundations,

will achieve seamless coverage of emergency culture and manifest the inclusive nature of public services.

5.3 Deepen the Integration of Technological Applications to Enhance the Effectiveness of Practical and Scenario-Based Training

The superficial application of technology stems from the disconnect between Artificial Intelligence and the "practice-based cultivation" objective of emergency culture, where technology remains merely a tool. Optimization efforts must focus on building a deeply integrated system of technology, practice, and capability, concentrating on three core directions. First, application must be anchored by actual demand. By aligning with the practical risks and gaps in emergency capabilities at the grassroots level, technology should be directed toward scenario-based simulations and personalized assessments to prevent it from becoming detached from reality and degenerating into mere formalism. Second, implementation must be advanced in phases, adapted to the local capacity for adoption. Based on the level of digital governance in different regions, technological functions should be deployed in stages. Areas with weaker foundations should first implement basic services, while regions with greater capacity can subsequently advance more complex applications. This approach avoids resource wastage and ineffective practices. Third, practice must be iterated through closed-loop optimization. The public's performance in real emergency situations should serve as the basis for calibrating practice scenarios and evaluation standards in reverse, forming a virtuous cycle of "practice feedback, technological optimization, and capability enhancement." This ensures that technology effectively serves the cultivation of practical emergency skills.

5.4 Improve the Data Security Governance System to Strengthen the Trust Foundation for Intelligent Governance

The root causes of data security and trust crises lie in the lack of security baselines and public participation in data governance. Optimization must aim for "security controllability and public trustworthiness" to build a comprehensive governance system. First, it is essential to establish a firm institutional baseline for data security. This involves clarifying the scope of data collection for emergency culture construction, establishing a full-process security guarantee mechanism, conducting regular security audits, preventing data leakage risks, and safeguarding public information rights. Second, public participation must be leveraged to enhance trust in algorithms. By disclosing the core algorithmic logic of intelligent services and establishing channels for public inquiry and review, algorithmic decision-making can be subjected to social oversight, thereby alleviating public concerns. Third, a multi-party collaborative supervision framework should be constructed. Integrating resources from the government, technology providers, and third-party institutions to establish a regular evaluation mechanism for AI applications will enable real-time risk monitoring and early warnings. This ensures that technological empowerment remains secure and controllable, thereby solidifying the trust foundation for intelligent governance.

6. Conclusions and Discussion

Artificial Intelligence empowering emergency culture construction represents a significant pathway to enhance grassroots emergency capabilities and build a Safe China. This paper, through a four-dimensional analysis, examines its enabling logic and practical forms, identifies practical issues such as algorithm bias and the digital divide, proposes optimization directions including algorithm calibration and technological adaptation, and finds that this model can effectively improve the accuracy of safety value transmission, the practical effectiveness of emergency training, and the degree of collaborative participation. Its core lies in the deep alignment of technological, cultural, and governance logics, ultimately aiming to drive the transformation of grassroots emergency capabilities from being experience-driven to data-driven, and from being government-led to being whole-of-society collaborative. Future efforts need to focus on balancing algorithmic efficiency with value fairness, cross-domain data sharing, and the cultivation of interdisciplinary talent at the grassroots level. Further exploration should be integrated with specific regional practices to provide more practical theoretical and practical support.

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