

Research on Risks and Regulation of Intelligent Emergency Management from the Perspective of Algorithmic Governance

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Abstract: *The improvement of algorithmic governance and the continuous evolution of intelligent technologies have jointly promoted the transformation of emergency management toward an intelligent direction. From the perspective of "algorithmic governance empowerment," this paper analyzes the internal logic along three main lines: concept reshaping, technology driving, and demand traction. It also summarizes typical practical types and clarifies the development path. In the future, efforts should focus on algorithm design optimization and operational transparency, striving to achieve the scientific operation and accurate decision-making of emergency management algorithms, thereby providing support for the construction of the emergency management system of Chinese modernization.*

Keywords: *Algorithmic Governance; Intelligent Emergency Management; Risk Generation; Regulatory Approaches; Intelligent Governance*

1. Introduction

With the full arrival of the era of algorithmic intelligence, technologies such as the Internet, big data, and artificial intelligence continuously penetrate various fields of economic and social development. The field of emergency management is also undergoing profound changes due to the deep involvement of algorithms. By virtue of their unique advantages in data processing, pattern recognition, and intelligent decision-making, algorithms can accurately analyze the emergency behaviors and needs of multiple subjects, and they have gradually become an important force in promoting the reshaping of the emergency management system and transforming traditional emergency management models.

At present, global emergencies present compound characteristics of "high frequency, large scale, and strong linkage." Traditional emergency management models have gradually exposed systemic problems in information acquisition, decision-making efficiency, and coordination capabilities. Against the background of the continuous advancement of the Digital China strategy, the integration of cutting-edge technologies such as big data, artificial intelligence, and the Internet of Things with emergency management is deepening daily. Intelligent emergency management has become an important path to solving traditional difficulties and promoting the modernization of the emergency management system and capabilities. Zhong Kaibin (2020)

points out that technological innovation is a key factor in promoting the transformation of emergency management from "passive response" to "active prevention."

As the core component of intelligent technologies, algorithms are gradually embedded into key links such as risk identification, warning release, emergency response, resource allocation, and recovery and reconstruction through the collection, integration, analysis, and deduction of emergency data, and they have restructured the entire process of emergency management. However, the widespread application of algorithms in the field of emergency management has also brought new governance challenges. Zhang Aijun and Li Yuan (2019)^[2] propose that algorithmic power has a natural tendency to expand in the era of artificial intelligence, and the lack of effective constraints can easily lead to power alienation and fairness deficiency. Lin Huanmin (2022)^[3] argues that automatic decision-making algorithms face difficulties such as vague risk identification and unclear regulatory paths in their application in the public domain. Given the strong public attribute of emergency management, the performance of algorithm operation is not only related to technical efficiency but also directly affects public safety and social equity.

Based on this, this paper adopts algorithmic governance as an analytical framework, explores its intrinsic relationship with intelligent emergency management, sorts out the types of risks, and attempts to construct corresponding regulatory paths, so as to provide references for optimizing emergency management models and improving the level of intelligence.

2. Definition of Core Concepts and Theoretical Foundation

2.1 Definition of Core Concepts

2.1.1 Algorithmic Governance

Algorithmic governance refers to the process of guiding, regulating, and supervising the design, development, deployment, and application of algorithms through technical means, institutional arrangements, and ethical constraints. It strives to achieve transparency, fairness, and the rule of law in algorithm operation, thereby preventing various risks that algorithms may bring. Meng Tianguang and Zhao Juan (2018)^[4] argue that the key to algorithmic governance lies in achieving the coordination and unity of technical rationality and value rationality. In the field of emergency management, the goal of algorithmic governance is to regulate emergency algorithms and ensure that they play a scientific, fair, and efficient role in risk assessment, emergency decision-making, and other links.

2.1.2 Intelligent Emergency Management

Intelligent emergency management refers to a new management model that uses digital technologies such as big data, artificial intelligence, and the Internet of Things to embed algorithms into the entire process of emergency management, including risk identification, early warning, response, handling, and recovery. This model achieves systematic data collection, intelligent analysis, accurate decision-making, and efficient handling. Wen Zhiqiang and Li Yongjun (2022)^[5] point out that its core value lies in breaking down departmental barriers and optimizing resource allocation through technological empowerment. Zhang Haibo and Tong Xing (2022)^[6] show that intelligent emergency management helps to improve the accuracy of risk prevention and control and the efficiency of emergency response.

2.2 Theoretical Foundation

2.2.1 Algorithmic Power Theory

The algorithmic power theory holds that algorithms gradually form a new form of power in the digital age, which is characterized by concealment, expansiveness, and inequality (Zhang Aijun and Li Yuan, 2019)^[2]. In the field of emergency management, algorithmic power is manifested in its dominant position in risk assessment and emergency decision-making. The lack of effective constraints may lead to improper decision-making and even damage to the public interest.

2.2.2 Algorithmic Administration Theory

The algorithmic administration theory mainly explores the application of algorithms in administrative decision-making and execution, as well as the related legal regulation issues. Wang Huaiyong and Deng Ruohan (2022)^[7] point out that algorithmic administration, while improving administrative efficiency, also brings challenges such as opaque decision-making and unclear responsibility definition, which need to be regulated through legalized approaches.

2.2.3 Intelligent Governance Theory

The intelligent governance theory emphasizes the construction of a collaborative governance system of "technology plus institutions." Meng Tianguang (2023)^[8] argues that the core of intelligent governance lies in properly handling the relationship between technological empowerment and governance norms, so as to achieve the deep integration of algorithmic technology and public governance.

3. The Internal Logic of Algorithmic Governance Empowering Intelligent Emergency Management

The empowerment of intelligent emergency management by algorithmic governance involves three levels of logic: conceptual, technological, and demand-related, which correspond respectively to value

logic, operational logic, and goal logic.

3.1 Concept Reshaping: Value Logic

The era of algorithmic intelligence has given rise to new concepts such as "diverse collaboration," "algorithmic transparency," and "technology for good." These concepts have driven emergency management from traditional passive response toward active prevention, from fragmented handling toward whole-process management, and from single-subject participation toward diverse collaborative governance (Wen Zhiqiang and Fu Meijia, 2023)^[9]. This conceptual transformation helps narrow the gap between the actual situation and the ideal goals of emergency management.

3.2 Technology Driving: Operational Logic

The emergency knowledge system supported by algorithmic technology gradually reshapes the operational mechanism of emergency management. It provides technical support for links such as prevention and preparation, warning release, and emergency response. At the same time, it promotes the deepening of multi-subject emergency knowledge and the process of socializing emergency management. The positive interaction between technology and mechanisms promotes the continuous optimization and upgrading of the traditional emergency management system.

3.3 Demand Traction: Goal Logic

The emergency demands in the new era present the characteristics of refinement, convenience, and intelligence, which point out the development direction for intelligent emergency management. Algorithms can aggregate multi-source data for in-depth analysis to meet differentiated emergency demands. By breaking down information barriers, algorithms construct a flow chain of "data-information-resources" to optimize the emergency response process. Relying on new-generation information technologies, algorithms achieve accurate transmission and intelligent assessment of emergency data, thereby providing clear goal orientation for the intelligent transformation.

4. Types of Risks in Intelligent Emergency Management from the Perspective of Algorithmic Governance

From the perspective of the embedding of algorithmic governance into emergency management, the risks in the process of intelligent emergency management can be divided into three stages: design, operation, and application.

4.1 The Algorithm Design Stage: Risks of Value Bias and Technical Defects

Such risks are fundamental risks that originate from the "technology-driven" tendency in the algorithm design stage. At the value level, algorithms may embed the subjective judgments of designers, deviate from the public interest orientation, excessively pursue efficiency while ignoring fairness, and thus lead to uneven resource allocation (Hou Dongde, 2023)^[10]. At the technical level, the limitations of artificial intelligence itself cause algorithms to have deficiencies in accuracy and stability, making it difficult for them to adapt to complex and changeable emergency scenarios (Zhang Chenggang, 2018)^[11].

4.2 The Algorithm Operation Stage: Risks of Black Box Operation and Power Alienation

Algorithmic black boxes mainly manifest as opaque decision-making logic and untraceable data processing processes, which can easily trigger public distrust and also create difficulties in responsibility determination (Jia Kai and Xue Lan, 2021)^[12]. Regarding power alienation, if algorithms lack effective constraints, they may gradually dominate emergency decision-making, weaken the judgment position of human subjects, and even cause decision-making rigidity or interest problems arising from technological monopoly (Zhang Aijun and Li Yuan, 2019^[2]; Zhong Kaibin, 2020^[1]).

4.3 The Algorithm Application Stage: Risks of Responsibility Vacuum and Insufficient Coordination

The responsibility vacuum manifests as the involvement of multiple subjects in algorithm

application, yet the lack of a mechanism for dividing responsibilities easily leads to a situation where no one is held accountable when algorithms make errors (Wang Huaiyong and Deng Ruohan, 2022^[7]; Wang Gui, 2021^[13]). Regarding insufficient coordination, information barriers between departments make data interoperability difficult and algorithm standards inconsistent, and the overall situation presents a fragmented characteristic (Wen Zhiqiang and Li Yongjun, 2022^[5]). In addition, issues of data security and privacy protection are also prominent, and the lack of adequate regulations in relevant links may threaten public security and personal privacy (Ma Ben and Mao Qingduo, 2015^[14]; Jia Kai and Xue Lan, 2021^[12]).

5. Regulatory Approaches for Intelligent Emergency Management from the Perspective of Algorithmic Governance

From the perspective of algorithmic governance, intelligent emergency management serves as an important path for promoting the modernization of the national emergency management system and capabilities. However, while algorithms improve efficiency, they also bring systemic risks such as value bias, power alienation, and responsibility vacuum. These risks mainly originate from the interaction failure between the technical system and the institutional environment. The construction of regulatory paths should follow the basic logic of "embedding technology into institutions, constraining power with institutions, and bearing responsibility within power," so as to form a closed-loop governance from four dimensions: design, operation, application, and multi-subject collaboration.

5.1 Algorithm Design: Value Embedding and Structural Optimization

The design stage is a critical node for value loading and technical defect generation, and its core lies in achieving the unity of instrumental rationality and value rationality. First, one should embed value benchmarks. One should establish the dual criteria of "public interest priority and procedural justice balance," transform normative elements such as fairness and security into constraints of the algorithm's objective function, and incorporate them into the underlying architecture through value-sensitive design. One should also take into account regional and group differences to avoid value bias under the guise of technological neutrality. Second, one should enhance model robustness. In response to the extreme uncertainty of emergency scenarios, one should include low-probability and high-impact variables in the training set, use methods such as adversarial training and transfer learning to improve model adaptability, and establish a dynamic evaluation and parameter adjustment mechanism. Third, one should build a participatory mechanism. One should break the closed development model of technical experts, establish a tripartite collaboration mechanism of "technical experts, emergency management experts, and public representatives," and use algorithmic impact assessments to identify and resolve potential value conflicts and technical risks in the early stages of design.

5.2 Algorithm Operation: Transparency Mechanism and Power Checks and Balances

The core of regulation in the operation stage lies in solving the "black box" dilemma and achieving a dynamic balance between technological power and human rationality. First, one should establish a hierarchical and transparent information disclosure system: one should disclose core elements such as model architecture and parameter weights to regulatory authorities; one should provide explanations of decision-making logic to professional audiences; and one should display functional boundaries and basic principles to the general public in a visual manner, thereby balancing supervisory effectiveness and the protection of trade secrets. Second, one should construct an algorithmic power constraint system. One should clarify the "auxiliary decision-making" positioning of algorithms, form a decision-making chain of "algorithm recommendation - human review - final decision," and mandate human intervention and retain the right of veto in matters involving the right to life and significant property rights. Meanwhile, one should establish an "algorithm circuit breaker" mechanism that automatically triggers manual takeover when an output significantly deviates from common sense. Third, one should establish a full-cycle traceability mechanism. One should leave complete traces at key nodes such as data input, model invocation, and decision output, and one should combine blockchain technology to ensure immutability and timestamp certification, thereby providing a factual basis for subsequent accountability and judicial relief.

5.3 Algorithm Application: Norm Construction and Responsibility Allocation

The regulation in the application stage focuses on the systematic shaping of the external institutional environment. First, one should promote special legislation. On the basis of reviewing existing laws, one should study and formulate the Emergency Management Algorithm Regulation, clarify the technical standards for algorithm access, operational procedures, and applicable boundaries, and ensure its alignment with the Personal Information Protection Law and the Data Security Law. Second, one should construct a multi-dimensional responsibility allocation mechanism. One should adopt a "role-based responsibility allocation" model, clarifying the product liability of designers, the operational responsibility of deployers, the decision-making responsibility of users, and the supervisory responsibility of regulators. One should also establish joint liability and recourse mechanisms among all parties. Third, one should strengthen compliance constraints on data governance. One should follow the principles of "minimum necessity" and "purpose limitation," implement data classification and grading, localized storage, and encryption requirements, promote the application of privacy-preserving computation, and establish a routine monitoring mechanism for data quality. Fourth, one should establish a routine compliance review mechanism. One should cover pre-launch safety assessments, random inspections during operation, and in-depth investigations after incidents, introduce third-party audits to enhance professionalism, and explore "sandbox regulation" to provide a controlled testing environment for innovation.

5.4 Governance Structure: Collaborative Optimization and Ecosystem Cultivation

The effectiveness of algorithmic governance depends on the rationality of the governance structure. One should transcend the government-centric single model and build a collaborative ecosystem with complementary functions among multiple subjects. The government should assume the functions of institutional supply, interest coordination, and bottom-line guarantee. It should break down departmental barriers and integrate ethical review and safety assessment into algorithm procurement evaluation. Enterprises should promote the internalization of social responsibility through a combination of "hard law" and "soft law." They should establish an algorithm ethics officer system and improve algorithm insurance and compensation funds. Research institutions should strengthen frontier research on algorithm fairness and interpretability, promote the transformation of research results into technical standards, and undertake the public education function of algorithm literacy. Regarding public participation, one should establish institutionalized channels for soliciting opinions, complaints and reports, and citizen review. One should also cultivate the public's ability to understand algorithm decisions and their critical awareness.

6. Conclusion and Prospect

From the perspective of algorithmic governance, intelligent emergency management serves as an important path for promoting the modernization of the national emergency management system and capabilities. Algorithmic technology plays a key enabling role in optimizing emergency management processes and improving emergency response efficiency. However, with the continuous deepening of its application, it also brings multiple risks such as value bias, technical defects, black box operation, power alienation, responsibility vacuum, and insufficient coordination. These risks arise from the inherent uncertainty of the technical system, the relative lag in institutional supply, and the unclear boundaries of responsibilities among various subjects. The interplay of these three factors presents a complex mechanism in which technology, institutions, and subjects influence and reinforce each other.

To address the above risks, one should base the response on the structural origins of risk generation and construct a multi-dimensional regulatory strategy of "technological optimization, institutional improvement, ethical guidance, and multi-subject collaboration." One should seek a dialectical unity between technological empowerment and regulatory constraints, and promote the development of intelligent emergency management toward a high-quality and sustainable direction.

Looking to the future, with the continuous evolution of general artificial intelligence technologies, the application scenarios of algorithms in the field of emergency management will further expand, and the forms of algorithmic risks will become more complex and diverse. Research on algorithmic governance in the next stage should focus on the following aspects: first, one should promote the deep integration of technological innovation and ethical research, and gradually solve structural problems such as algorithmic black boxes and algorithmic discrimination; second, one should accelerate the

systematic construction of laws, regulations, and industry norms, and promote algorithmic governance toward rule-of-law and refinement; third, one should strengthen collaborative linkages and functional integration among multiple subjects, so as to form a governance synergy supported by technology, institutions, and ethics; fourth, one should actively draw on international experience and participate in global governance, and on this basis, build an algorithmic governance system for emergency management that conforms to Chinese conditions and has Chinese characteristics. One should continuously improve the intelligent, scientific, and precise level of emergency management, and provide solid technical support and institutional guarantees for protecting the safety of people's lives and property, as well as for maintaining national security and social stability.

References

- [1] Zhong Kaibin. *National Emergency Management System: Framework Construction, Evolution Process and Improvement Strategies*. *Reform*, 2020, (06): 5-18.
- [2] Zhang Aijun and Li Yuan. *Algorithmic Power in the Age of Artificial Intelligence: Logic, Risks and Regulation*. *Journal of Hohai University (Philosophy and Social Sciences Edition)*, 2019, 21(06): 18-24+109.
- [3] Lin Huanmin. *Risk Identification and Differentiated Regulation of Automatic Decision-Making Algorithms*. *Comparative Law Studies*, 2022, (02): 188-200.
- [4] Meng Tianguang and Zhao Juan. *Data-Driven Intelligent Social Governance: Theoretical Construction and Governance System*. *E-Government*, 2018, (08): 2-11.
- [5] Wen Zhiqiang and Li Yongjun. *From "Plate Integration" to "Organic Integration": A Study on the Optimization Path of China's Emergency Management System with Chinese Characteristics*. *Chinese Public Administration*, 2022, (05): 155-157.
- [6] Zhang Haibo and Tong Xing. *The Generative Mechanism of China's Emergency Management Effectiveness*. *Social Sciences in China*, 2022, (04): 64-82+205-206.
- [7] Wang Huaiyong and Deng Ruohan. *Algorithmic Administration: Practical Challenges and Legal Responses*. *Administrative Law Review*, 2022, (04): 104-118.
- [8] Meng Tianguang. *Intelligent Governance: Governance Issues in the Era of General Artificial Intelligence*. *Sea of Learning*, 2023, (02): 41-47.
- [9] Wen Zhiqiang and Fu Meijia. *Big Data Empowers the Transformation of Government Emergency Management Models: Type Summarization and Future Directions*. *Administrative Forum*, 2023, 30(04): 79-86. DOI: 10.16637/j.cnki.23-1360/d.2023.04.009.
- [10] Hou Dongde. *Basic Problems and Institutional Framework of Artificial Intelligence Law*. *Political Science Forum*, 2023, (06): 61-72.
- [11] Zhang Chenggang. *The Age of Artificial Intelligence: Technological Development, Risks and Challenges, and Order Reconstruction*. *Nanjing Social Sciences*, 2018, (05): 42-52.
- [12] Jia Kai and Xue Lan. *Global Comparison and Chinese Practice of AI Ethical Issues and Security Risk Governance*. *Public Management Review*, 2021, 3(01): 122-134.
- [13] Wang Gui. *The Rise, Challenges, and Legal Adaptation of Algorithmic Administration*. *E-Government*, 2021, (07): 2-14.
- [14] Ma Ben and Mao Qingduo. *The Application of Big Data in Emergency Management*. *Chinese Public Administration*, 2015, (03): 136-141+151.