

Governance Dilemmas and Optimization Paths of Artificial Intelligence in Risk Early Warning for Emergencies

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Abstract: With the development of the risk society and the digital society, emergencies have begun to show new characteristics; they have hidden origins, are evolving at a high speed, have cross-domain impacts, and are multi-hazardous. The old way of experience-based and hierarchical early warning is no longer in line with the demands of modern emergency governance. AI can gather all kinds of data, analyse and forecast this data, issue early warnings of risks, and help people avoid problems in time. There are also problems in the implementation of governance, such as late institutional support, uneven data governance, weak supervision of algorithms, poor coordination among all parties, and a structural conflict between the logic of technology and the logic of governance. Systematically organise the application mechanism of artificial intelligence in risk early warning for emergencies, theoretically analyze the practical dilemmas in the four areas of institutions, data, algorithms and coordination based on this, put forward optimisation paths such as legalisation, standardisation, collaboration and human-centredness, and hope to provide theoretical support and practical reference for strengthening the intelligent early warning ability of emergencies, improving the risk pre-control system, and promoting the modernisation of China's national emergency management system and capacity.

Keywords: Artificial Intelligence, Emergency and Risk Early Warning, Data Governance and Modernisation of Emergency Management.

1. Introduction

In recent years, all kinds of risks have been increasing and digitalisation in society has also developed rapidly. Most serious emergencies are becoming more frequent and widespread, have a shorter risk transmission period, spread more rapidly, affect a larger number of people and places, and are more likely to trigger a chain reaction. The previous emergency early warning system was not automatic; it had to be passed along through the chain of command and relied on human judgment, so there were problems with the efficiency of information collection and analysis, accuracy of assessment, and speed of response^[1], and thus failed to discover and warn in time about hidden, nascent, and cross-border risks. Emergency management still has the problem of focusing too much on response and paying less attention to prevention. With the spread of digital technology in public administration, a cluster of intelligent technologies such as big data, artificial intelligence, the Internet of Things and satellite remote sensing has started to be applied to build an early warning system for risks and improve the efficiency of risk management. Help to change the old way of emergency management from passive response to active prevention and early warning before a disaster occurs^[2]. Artificial intelligence is good at data processing, model fitting, trend forecasting and anomaly detection, so it can collect and analyze all kinds of data from around the world, and now various applications of this technology are being developed to monitor natural disasters, issue early warnings for public health emergencies, prevent traffic accidents, identify risks to social security, and so on. There will always be problems with applying this technology in the government. The application of artificial intelligence in early warning for emergencies is a technical problem, but it is also a problem of governance reform; it will affect the distribution of power, institutional rules, relationships among all parties involved, values and beliefs, etc. There are many practical problems currently in intelligent early warning systems, such as data isolation barriers, a lack of supervision over the black-box nature of algorithms, unclear division of responsibilities, poor coordination among departments, weak public trust, etc. The problem of the technology-governance gap is getting worse and worse. Systematically organise the institutional, data, algorithmic and coordination problems that artificial intelligence faces in risk early warning,

investigate the origin of these problems, and put forward optimisation paths based on legalisation, standardisation, collaboration and human-centredness; thus, we can provide a reference for all levels of government to improve the design of intelligent early warning systems, break through data and information bottlenecks, strengthen supervision over algorithmic safety and build sound multi-stakeholder coordination mechanisms. Therefore, we will improve the accuracy, timeliness, credibility and comprehensiveness of early warnings for risks and emergencies, raise the prevention threshold for emergencies, effectively protect the security of life and property, and provide strong support for the construction of modern Chinese governance.

2. Application Logic of Artificial Intelligence in Risk Early Warning for Emergencies

2.1 Global Perception and Integration of Multi-Source Data

The foundation of artificial intelligence in early warning of risks from disasters is the collection and organisation of all kinds of data from all over the world. With the help of all kinds of carriers, such as Internet of Things monitoring devices, social media platforms, government information systems, industry operation databases and satellite remote sensing images, the deficiencies of traditional information collection channels can be corrected; generally, they are single-sourced, have limited coverage and are updated infrequently^[4]. All-weather, all-domain and real-time risk information can be obtained from many places, such as changes in the natural environment, the status of infrastructure operation, fluctuations in public opinion, signals of public behaviour and anomalies in public services. To solve the problems of dispersion, fragmentation, lack of structure and low usability of the aforementioned information, standardised, normalised, correlated and dynamically updated streams of high-quality risk data have been constructed; thus, a good data foundation has been laid for the early detection of potential risks, monitoring changes in the trend of risks and evaluating serious circumstances caused by risks. With the progress of data perception and integration, the model for early warning of risk has gone from collecting some data randomly to covering more aspects and being more proactive and timely.

2.2 Situation Analysis and Prediction by Intelligent Algorithms

Algorithmic models are the basis for artificial intelligence in early warning of risks, and these models can find risks, analyse correlations, predict trends, determine the extent of risk, set danger thresholds, etc. Many kinds of algorithms can be used to collect a large amount of high-dimensional, dynamic data and extract hidden patterns, abnormal correlations and mutation signals that are not easily observed with the naked eye, such as machine learning, deep learning, anomaly detection and time series analysis^[5]. The algorithmic assessment model is superior to the traditional early warning model based on expert knowledge and manual judgment in many ways; it has a high processing speed, wide coverage, is very consistent and stable in the presence of noise, can significantly reduce the early warning period, improve the sensitivity of risk detection, and make trend judgment more reliable. The algorithmic assessment function will offer an objective, quantitative and visual means for early warning work, and it is hoped that in the future, the form of risk early warning will be changed from experience-based, vague and post-event to scientific, precise and preemptive.

2.3 Precise Output and Adaptation of Scenario-Based Early Warning

The purpose of using artificial intelligence for early warning of risks is to collect all kinds of disaster information from all over the place and at all levels of government, as well as various response plans. Different kinds of emergencies have different causes, various ways of occurring, different degrees of damage, and thus need different responses. Not all artificial intelligence early warning systems are the same; according to the actual circumstances, some modifications need to be made in the data weights, model parameters, warning thresholds, information format and dissemination channels. By issuing all kinds of early warnings at all levels and in all areas, based on special and technical assessment results, official, accurate, understandable and practical early warning information can be provided; thus, government departments will be able to respond promptly and accurately, enhance the risk awareness and self-protection ability of the public, meet the demands of early warning systems, serve as a strong foundation for the development of artificial intelligence in effective governance, enable scenario-based precise output in this field to be realised, and help to standardise and regularise intelligent early warning systems.

3. Current Governance Dilemmas of Artificial Intelligence in Risk Early Warning for Emergencies

3.1 The Institutional and Regulatory System are Outdated Compared with Technology

With the rapid development of artificial intelligence in the field of risk early warning, there is now a serious problem that the existing institutional rules are inadequate and slow to be revised; as a result, their normal and orderly development has been obstructed. China has not yet built its own legal and institutional system to regulate the use of artificial intelligence in emergency situations at present. The first items for data sharing, algorithm registration, early warning release, responsibility allocation, fault tolerance and correction, etc., do not have specific, uniform and effective rules. Due to the lack of a clear division of responsibility for early warning errors, fault tolerance, etc., the relevant departments and organisations are generally conservative in their attitude; they do not want to release the data, are unwilling to try the technology boldly, and are afraid of taking risks. At the same time, there are no organisations to regulate the Design, testing, deployment and iteration of algorithmic models. There is no single technical norm, evaluation index or ethical norm, so the quality and operation of intelligent early warning systems vary among different parties. There has been a delay in the supply of institutions for early warning of artificial intelligence, and practice has long preceded rules. As there is no organisation of laws and institutions for technology, there will be governance risks and operating hazards.

3.2 Double Imbalance in the Data Governance Structure

To build a good artificial intelligence early warning model, we need high-quality, complete and tradable risk data; otherwise, the scope of governance over all kinds of data will directly limit the application of intelligent early warning. Due to the bureaucratic and fragmented nature of the government, emergency data are scattered at all levels of various departments and different places under different market organisations. Data and business collaboration among the various departments, areas and systems is not standardised, institutionalised or legally guaranteed; thus, there are problems of data barriers and information silos^[8]. In addition to the barriers in the circulation of data, there are also serious defects in the quality management of the entire data life cycle. There are many problems with the data: the norm for data collection is irregular, there is a slow update and maintenance of dynamic data, the labelling system is not standardised, there is no handling for missing values and outliers, and the distribution of positive and negative samples is unbalanced; these will directly affect the training efficiency of algorithmic models and seriously reduce the accuracy and reliability of risk early warning. The two defects are a lack of circulation and low quality; therefore, it cannot obtain a large number of good, continuous and reliable data for the intelligent early warning system. Therefore, such systems will not be able to achieve the full effect of the technology, and there will also be a problem of secondary governance, such as distortion of early warning or failure due to data deviation.

3.3 Obvious Deficiencies in Algorithmic Governance Capacity

The main part of the algorithm model for the intelligent early warning system is to generate an early warning signal based on risk data. The interpretability, reliability and fairness of the early warning results will determine whether people believe the warnings issued by the government in times of crisis. Due to the high complexity, non-linearity and specialisation of the algorithmic model itself, it is an "algorithm black box" that is difficult for outsiders to understand. Government regulators, frontline emergency responders and the general public cannot fully trace the generation logic, decision basis and uncertainty boundaries of the early warning conclusions; thus, it is difficult to gain social acceptance for the early warning results, and serious problems exist in determining responsibility and supervision over the process. At the same time, there are also problems with the algorithmic model during the training process, such as bias in the training data, deviation from historical samples and design bias; thus, it is possible that not all risks will be identified, or excessive early warnings will be issued for certain areas, groups or types of risks, and the fairness and openness of risk governance will be damaged^[9]. If the sample size is too small, for example, because of bad weather, a new infectious disease, or other sudden changes in society, then the stability, robustness and adaptability of the algorithmic model will also be reduced; there will be a high risk of missing judgments, incorrect judgments and delayed judgments. The Security and Control of Algorithms need to be improved.

3.4 Lack of Coordination Among the Parties

Artificial Intelligence Risk Early Warning is an organised project that involves many parties, such as governments, enterprises, research institutions, social organisations and the public. The current system of joint governance is still flawed and has not been fully realised. There is no platform for cross-departmental and cross-region coordination and command in the government; thus, the flow of information is poor, release standards are not uniform, joint responses are slow, and it is difficult to build a unified early warning system. At the level of government-enterprise relations, the channels, rights and responsibilities, incentives, guarantees, etc., for technology companies with core technologies, data resources and platform capabilities to participate in emergency early warning are not clear. Most of the cooperation in data, technology and emergencies is irregular and does not have a fixed institution. At the level of government-society interaction, there are very few channels for public and social organisations to participate in risk identification, information feedback, early warning dissemination and emergency response; thus, there is a lack of social awareness, trust and participation in intelligent early warning. Generally speaking, the current artificial intelligence early warning system is still government-led; there is no clear division of rights and responsibilities among all parties, the integration process is not good, and the incentives and constraints are out of sync. Therefore, the benefits of using technology to improve the system of government have not been realised to the fullest extent.

4. Optimization Paths for Artificial Intelligence in Risk Early Warning for Emergencies

4.1 Increase the number of institutions and build an institutionalized and standardized support system

First, improve the Design of the top-level institutions, and then it will be necessary to apply artificial intelligence to all links of the early warning system for emergencies. The whole chain of intelligent early warning should be under the rule of law, clear division of rights and responsibilities needs to be established for the safe and orderly use of this technology in the field of early warning, and stable institutional expectations should be provided. Efforts should be made to issue special regulations and normative documents in the field of intelligent early warning to clarify the main rules for data sharing, algorithm filing, early warning issuance, division of rights and responsibilities, and privacy protection^[10]. At the same time, technical standards, evaluation norms, operating procedures and ethical codes need to be established and strengthened to unify the requirements for early warning classification, model testing, effect assessment and information dissemination, promote the transition from scattered exploration to standardised and normalised operation of intelligent early warning. At the same time, the rights and obligations of all parties should be reasonable, and mechanisms for determining responsibility in the event of a deviation from the early warning, fault tolerance and correction should be strengthened. The above measures will increase the early warning responsibility of all parties and leave room for technological innovation and trial-and-error exploration; thus, they will be jointly developed and improved in the future.

4.2 Optimisation of Data Integration and Construction of an Integrated High-Quality Governance Pattern

The first way to improve the efficiency of intelligent early warning is data governance. We need to solve the problems of barriers and quality by institutionalisation, systemisation and normalisation. We need to build cross-departmental, cross-regional and cross-level emergency data hubs and sharing and exchange platforms, clarify the data-sharing catalog, permission boundaries, flow process and security specifications, etc. The above will help to solve the problem of unwillingness, fear or inability to share data at the institutional and mechanistic levels^[11]. A Data Quality Management System should be established to cover all links in the life cycle of collection, aggregation, cleaning, labelling, updating and verification; norms and technical standards need to be unified; dynamic feedback and continuous improvement must be introduced to enhance the completeness, accuracy, timeliness and usability of the data at all times. Due to the reasons of national security, public safety and privacy, we need to promote the orderly integration of government data, enterprise data and social data, build an emergency data resource system for all regions, support dynamic updates, ensure security and controllability, allow open sharing, and thus provide a high-quality data foundation for intelligent early warning.

4.3 Strengthen Algorithm Supervision and Improve the Credibility and Fairness of Early Warning

The Governance of Algorithms will affect the trust in and reliability of early warnings. In general, we should be able to regulate and explain things; be fair and safe; build a complete regulatory system. A filing management system and a third-party audit system should be established for the high-risk early warning algorithm, and end-to-end supervision mechanisms need to be set up in all links of the life cycle of Design, testing, deployment, operation and maintenance, iteration and decommissioning to increase the transparency of the algorithms and reduce the trust risk and decision-making risk of the "algorithm black box". We should also incorporate public values and fairness in the training and optimisation of models, strengthen the review of geographical bias, group bias and scenario bias, reduce discriminatory early warnings and omitted early warnings, and protect the publicness and fairness of risk governance. Strengthen the mechanism of human-machine collaboration for decision-making, clarify that algorithms will be used as support tools in the process of making decisions, maintain and improve the rights of review, intervention and final decision for experts, and enhance the stability, reliability and adaptability of early warning in complex and extreme situations.

4.4 Strengthening the Coordination Mechanism and Building a Multi-stakeholder Intelligent Early Warning Ecosystem

The Degree of Collaborative Governance will affect the general operating environment of the intelligent early warning system. Strengthen the construction of a multi-stakeholder governance model under the leadership of the government, obtain the support of enterprises and research institutions, and involve all sectors of society. Strengthen the internal coordination mechanism of the government, clarify the responsibilities of all departments for risk perception, assessment, early warning and response, unify the command platform and information release standards, and achieve closed-loop efficient operation of perception-assessment-early warning-response-handling. We need to improve the institutional Design of government-enterprise cooperation, clarify the links, rights and responsibilities, incentives and guarantee mechanisms for enterprises to participate in emergency early warning, and gradually add technical, data, platform and talent support. We need to increase the channels for public participation, strengthen the popularisation of intelligent early warning science and public capacity training, improve the public's ability to recognize early warning information, respond promptly to it, be more willing to provide feedback, and build a modern intelligent early warning ecosystem with top-down linkage, internal and external coordination, multi-party participation, joint construction and sharing.

5. Conclusion

Given that the risk society is closely linked to the digital society, artificial intelligence can be employed to correct the deficiencies of the old early warning system, achieve timely and accurate early warning of serious emergencies in time and place, and promote the construction of an intelligent emergency governance system. This paper has provided a way to improve the four areas of institutions, data, algorithms and coordination; it has also put forward a specific plan of action and some important practical suggestions to address the serious governance problems currently facing artificial intelligence in early warning for emergencies and to turn technological advantages into effective governance. In the future, we should always keep the core value orientation of public governance in mind, continue to promote the deep adaptation and dynamic integration of technological logic with governance logic, innovate in regulation and regulate in innovation, continuously improve the governance system for intelligent early warning, strengthen China's capacity to prevent and resolve major risks, and build a solid technological and institutional barrier to safeguard national public security and social stability.

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