Safety Emergency Science

Research Article

Enabling the upgrading of security emergency technology in the AI era

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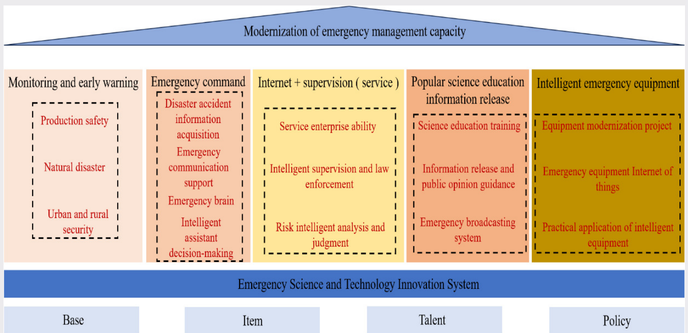

ABSTRACT: Currently, various industries are facing a variety of security risks and challenges. With the development of a new generation of information technology, artificial intelligence (AI), which enables security emergency technology upgrades, has become an inevitable trend. To enable AI to upgrade security emergency technology, this paper proposes a methodological path that couples advanced sensing systems, data resource sharing databases, and smart models in the cloud and security and emergency fields. Moreover, this paper proposes improving and strengthening the management of safety emergency science and technology with systematic thinking to improve the level of industry science and technology with AI and other technologies with the awareness of taking the lead, promoting the construction of an industry innovation system with a system concept, strengthening the coordination and cooperation with advantageous innovation resources with an open attitude, and strengthening the original innovation ability with the spirit of consolidating the foundation and strengthening the source to build a safety emergency science and technology innovation system. This paper provides an effective reference for the transformation and upgrading of the security emergency field in the latest round of scientific and technological revolution.

KEYWORDS: artificial intelligence (AI); safety emergency; technology upgrade; scientific and technological revolution; innovation system

1 Introduction

Since the beginning of the 21st century, with the deepening of scientific and technological changes in various disciplines, such as information, energy, biology, and materials, core technology has been continuously updated and upgraded, thus subverting the production structure of traditional industries (Tomur et al., 2024). As the soul and leading technology of the new generation of scientific and technological revolution, artificial intelligence (AI) plays a crucial role in major scientific and technological upgrades in the fields of information, energy, materials, and life (Lakkimsetti et al., 2024; Sáez et al., 2024), as shown in Fig. 1.

In terms of information, technical problems such as information security, operation speed, and measurement accuracy have been effectively solved. In terms of energy, power batteries and hydrogen energy technology are constantly innovating and upgrading in a wide range of applications (Semin and Kormshchikov, 2024). In biology, great innovations have been made in major life science research, such as gene technology, cell biology, organ science, and synthetic biology. In terms of materials, a series of topological materials based on solid-state physics support the development of strategic frontier high technology. Unlike the previous single or single group of technologies that have caused technological changes in industry, current technological changes focus mainly on breakthroughs in multiple fields or multiple core technologies of the main technology, thus promoting the overall upgrading of the industry. Therefore, the complex system science formed by diverse disciplines dominated by artificial intelligence is leading the third world scientific revolution in a new form of interdisciplinary research. The new round of scientific and technological revolution presents the following remarkable characteristics:

(1) System breakthrough. Compared with the previous breakthroughs in single technology, single discipline or technology groups, the new generation of information technology represents a breakthrough in multidisciplinary systematization. With the vigorous rise of emerging disciplines, traditional disciplines are constantly changing and upgrading. Emerging technologies such as modern theories, new methods, new disciplines, and new schools have emerged one after another with the renewal of the knowledge system of basic disciplines and have achieved a comprehensive breakthrough in the systematization of disciplines.

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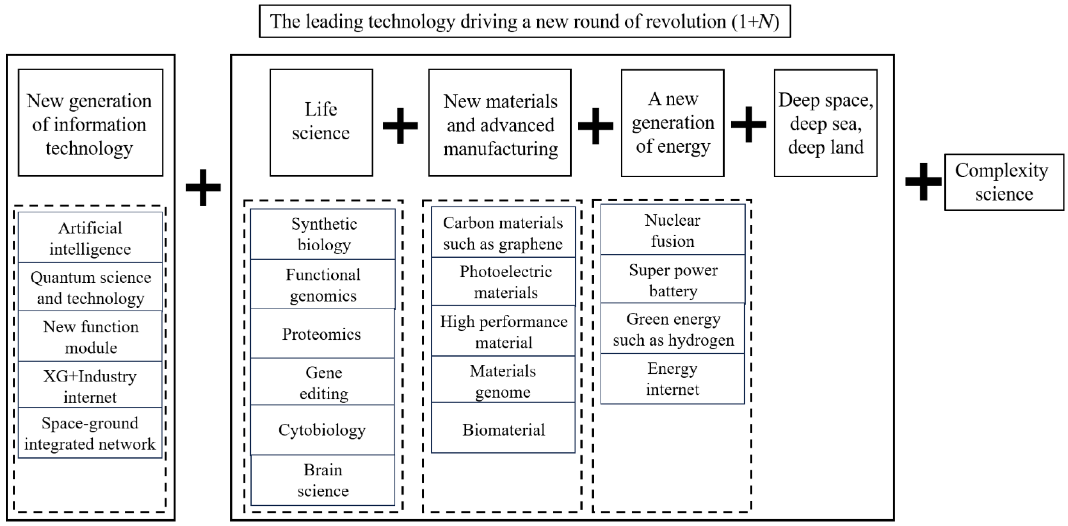

Fig. 1 Leading technology driving a new round of revolution.

(2) Cross-fusion. The interdisciplinary subject with all-round cross- and cross-border integration and innovation as the methodical research mode has led to breakthroughs in multidisciplinary, relevant, and multidirectional groups (Yang et al., 2023). The new generation of information technology provides advanced and efficient scientific research and innovation methods and cross-integration platforms for solving classic problems and breakthroughs in various disciplines and has become a catalyst and binder for system breakthrough and cross-integration among disciplines, fields, macro- and microsystems, science and technology, the natural sciences, and the social sciences.

(3) Subverting innovation. On the basis of the original innovation of basic research, major breakthroughs have been made in both scientific principles and basic technologies, resulting in many technological upgrades, industrial replacements, knowledge renewals, and cognitive subversions, which have revolutionary impacts on scientific research methods, production methods, working methods, and lifestyles.

(4) Depth extension. With the significant improvement in scientific means and the increase in systematic investment annually, the field of scientific research has expanded from micro- to cosmology, and the exploration of true knowledge has gradually deepened (Jalal et al., 2021). At the micro level, significant innovations have been made in the research of gene function and protein function in the field of molecular biology. There have been new breakthroughs in the discovery, design, and manufacture of novel functional materials. The integrated circuit chip breaks through 2 nm, approaching the limit of Moore's law. At the cosmological level, there have been further developments in the study of stress waves, black holes, dark matter, and dark energy from time to time. China's international space station is ready for operation, as many countries launch satellites to explore the deep spaces of Mars, the Sun, and the Moon. Further progress has been made from time to time in ten thousand meters of deep-sea exploration and deep drilling. Recent breakthroughs have been made in ultrahigh-speed aircraft and ultrahigh-speed train tests.

(5) Complex decryption. With the interweaving of various factors and the interweaving and integration of science, technology, and economic society, it will become the research norm to form a complex large-scale system and large science to understand real problems in nature by creating new paradigms and applying new modes of thinking. Composite system science is a new form of interdisciplinary scientific research. It takes complex systems as the research object, transcends reductionism as the methodological feature, reveals and explains the operation law of complex systems as the main task, and improves people's ability to understand the world, explore the world, and transform the world as the main purpose (Siegenfeld and Bar-Yam, 2020). In scientific research on complex systems, powerful tools such as big data, artificial intelligence, and advanced instrumentation are used to reveal the internal structure and connections of complex systems, the interaction rules between various elements and variables, the system motion and balance rules, and the characteristics of nonlinear motion changes.

(6) Mission-led. Major risks such as the novel coronavirus epidemic, global climate change, arms races, and regional war conflicts have brought severe challenges to human survival and development in the absence of major changes over the past century (Zhu et al., 2022). Taking into account this, from basic research to technological innovation, the mission of scientists is unprecedentedly important, and mission-oriented research has become the conscious behavior of scientists and the priority goal of national science and technology policy.

(7) Accelerated transformation. In 1997, American scholar D. E. Stokes (Klahr, 2019) proposed a two-dimensional model of "application and foundation" and reported that the research results formed by application-oriented basic research can promote innovative productivity and then develop new industries or update existing industries. After that, the French scientist Pasteur proved that the purpose of understanding the world and the application of knowledge can coexist in the process of scientific research. With the tightening of the innovation chain, the interaction and integration of science and technology are deepening. The latest achievements in science and technology have accelerated their penetration and application in the economic, cultural, military, and social fields, resulting in changes in the existing forms.

On the basis of the current trend of scientific and technological development, we should not only use the cross-integration of modern technology and traditional security emergency technology but also accelerate the upgrading of scientific and technological levels in the field of security emergencies. It is also essential to master the laws and characteristics of modern scientific and technological innovation and improve the overall level of research and opening up in the field of safety emergencies.

2 Challenges and opportunities for security and emergency response

According to the Kuznets curve (Fig. 2), after China's per capita GDP exceeds $10,000, the incidence of production safety accidents is stable (Khatatbeh and Moosa, 2023). However, urban safety has entered a high-risk period, which presents severe challenges for disaster prevention and emergency rescue.

In terms of natural disasters, the Global Risk Report 2019 noted that the climate will continue to warm in the future, exacerbating global risk and further triggering changes in systemic risk, with far-reaching implications for global development (Rosenzweig and Solecki, 2019). In recent years, China's provinces (autonomous regions and municipalities) have been affected by natural disasters such as drought, floods, typhoons, earthquakes, and geological disasters. Among them, more than 70% of the cities and more than 50% of the population are distributed in high-risk areas of meteorological, seismic, geological, and marine disasters; 58% of the land area is in the high-risk area with a seismic intensity above 7 degrees. More than 2/3 of the country's land area is challenged by floods. In particular, the El NiñO and Nar NiñA meteorological phenomena have caused approximately 600 cities in China to face the threat of floods. Notably, natural disasters and production and urban coupling security risks increase, and the harm to urban property and people's lives increases. In terms of industrial accidents, under the extensive expansion growth mode, various industries have gradually revealed hidden safety hazards, such as backward equipment technology, extensive management, weak safety awareness of employees, low levels of intrinsic safety, and low levels of safety monitoring and early warning (Yin, 2023). Industrial parks with concentrated enterprises and personnel face risks such as fires, explosions, poisoning, suffocation, electric shock, transportation accidents, environmental pollution, floods, and lightning strikes, which can easily lead to major accidents such as mass death and injury. The interior and exterior decoration materials of large single or ethnic buildings, such as high-rise buildings and urban complexes, can easily cause fires. On the other hand, with the development of high-tech, new materials, new technologies, new processes, new products, and other new industries, new formats have added additional security risks. Moreover, the large-scale and complicated production process system of equipment is becoming increasingly large scale, automated and complicated, which easily causes chain reactions and increases the possibility and severity of accident amplification, coupling and derivation (Chen et al., 2024). For example, fire accidents occur in electric vehicles, electric bicycles, and other major urban transport vehicles in many major cities every year, causing heavy casualties and property losses and even triggering a chain reaction. China's bridges, tunnels, and highways are ranked first in the world, and rail transit spans more than 10,000 km.

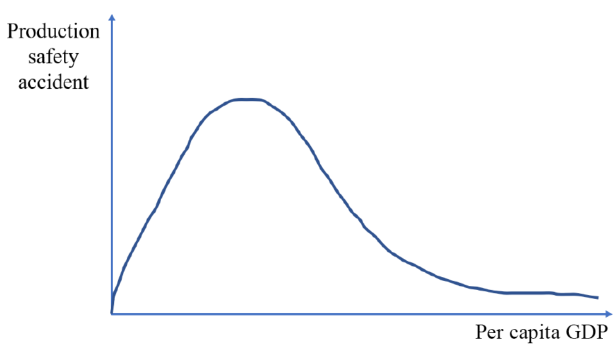

Fig. 2 Kuznets curve.

Moreover, traffic accidents, electrical accidents, fires, building collapses, floods, explosions, toxic gases, and other factors lead to frequent traffic safety risks. The mileage of municipal gas pipelines in China is close to one million kilometers, which has become a typical risk to urban lifeline safety. In addition, with the rapid advance of information technology, the physical world and the network world are interconnected, which promotes online and offline interactions and increases the complexity of risk prevention and emergency response. China's security emergency response still faces severe challenges. Therefore, advanced technologies such as big data and artificial intelligence are urgently needed to carry out research on complex system scientific models to improve the accuracy of various disaster predictions and predictions and strengthen the efficiency of emergency rescue.

Relying on the development of a new generation of information technology, remote sensing technology, sensor technology, monitoring and detection technology, and other sensing technologies are becoming increasingly perfect, and the adaptability of various complex environments and the reliability of detection and monitoring are constantly increasing, which provides technical support for the whole region, the whole process of monitoring and early warning, and early prevention of risks (Liu et al., 2024). With the development of edge computing technology, the latest features of sensor devices include digitization, intelligence, precision, miniaturization (micro/nano), multifunctionality, systematization, and networking. The remote sensing satellite system, which is based on aperture radar (SRA), optics, infrared, and other precise sensing methods, has formed a multilevel and high-density system of high-orbital, medium-orbital, and low-orbital, which monitors the security risks of the whole land and even the world in real time and warns in time. Low-altitude telemetry monitoring equipment such as ordinary aircraft, fixed-wing, and rotor-wing UAVs can accurately obtain risk information in designated areas; space satellites such as communication, remote sensing monitoring, and navigation can provide information support and communication guarantees for the whole process of disaster prevention, disaster relief, safety production, and emergency rescue in emergency management (Zhen et al., 2024).

The development of mobile communication technology provides an efficient means for emergency communication and data transmission. In particular, 5G technology provides innovative means such as large-throughput digital transmission, low-latency, and high-speed mobile communication. In 5G technology, through information sensing devices such as radio frequency identification, various sensors, global positioning systems, and laser scanners, any item is connected to the internet according to the agreed protocol for information exchange and communication to achieve intelligent identification, positioning, tracking, monitoring and management of items (Zhou, 2024). On the basis of the sixth version of the internet protocol, the industrial internet gives the unique identity of the connected items through two-dimensional codes, wireless video identification tags, etc. In the field of security emergencies, the massive data transmission, identification, and processing generated by the interconnection of the sensing network, infrastructure, and equipment of both space and earth can be transmitted smoothly and quickly on the data highway of the basic platform of the 5G + industrial internet, which is the basic project of intelligent emergencies. As the brain of intelligent emergencies, big data and cloud computing provide advanced data deep mining and analysis methods for the informatization and intellectualization of safety emergency management. Considerable datasets are so large that they are far beyond the capabilities of traditional database software tools in terms of acquisition, storage, management, and analysis. It has four characteristics: massive data scale, rapid data flow, diverse data types, and low value density. The relationship between adult data and cloud computing is inseparable (Chandra and Chakraborty, 2024). Extensive data mining analysis must rely on distributed processing of cloud computing, distributed database and cloud storage, virtualization technology, etc. Cloud computing provides a new computing platform for big data mining.

Digitization, networking, and intellectualization in various industries and fields and cross-integration with customary industry technologies have led to revolutionary technological changes and even disruptive innovations (Sahoh and Choksuriwong, 2022). With the profound learning algorithm giving artificial intelligence supercomputing power, the era of artificial intelligence has advanced (Zhang et al., 2022). The development speed of artificial intelligence technology exceeds people's expectations. It can not only communicate with human beings normally but also help people write and even assist programmers in writing code. The rapid development of machine translation, fingerprinting and facial recognition, as well as various robot technologies, has increased the empowerment of artificial intelligence in various fields, and the revolutionary and subversive changes brought about by extensive penetration and application have emerged one after another. For example, in February, 2024, a group of post-00s researchers launched the SORA Vincent Video Big Model System, which increased the computing power of ChatGPT by thousands of times (Zhou et al., 2024). In the field of safety emergencies, artificial intelligence will greatly improve the observation and monitoring ability, analysis and early warning ability, risk prevention ability and efficient rescue ability of safety emergency science and technology workers and provide more unconventional means for conquering safety risks. Therefore, we should not only regard the rapid development of artificial intelligence as a challenge but also integrate artificial intelligence technology with existing emergency technology, accelerating the upgrading and development of safe emergency technology to greatly improve the level of scientific and technological support for production and urban and social security.

3 AI empowers and upgrades key areas of security emergency technology

AI-enabled upgrading of security emergency technology is manifested mainly in promoting the comprehensive upgrading of the existing security emergency technology system. In view of the current interdisciplinary and cross-industry characteristics of safety emergency technology, as well as its unbalanced and uncoordinated development, AI enables the upgrading of safety emergency technology needs to design a suitable technology upgrading path. First, it compensates for the lack of digitization and networking and achieves comprehensive coverage of advanced sensing systems. Second, the 5G + industrial internet support system should be improved, big data and cloud computing systems should be connected and integrated, and a database and cloud for data resource sharing should be established. AI applications are subsequently applied throughout the whole process and multiple facets of safety supervision and emergency management, and an AI model in the fields of safety and emergencies has gradually formed. Finally, the subsystems are comprehensively upgraded. Specifically, it includes the following:

(1) Safety production risk monitoring and early warning systems

Create a network supervision platform. Existing safety production data, platforms, and systems should be integrated, and an enterprise-level and industry-level industrial internet safety production supervision platform with functions such as safety perception, monitoring, early warning, disposal, and evaluation should be built to achieve the connection and supervision of the whole process, all factors, and entire industrial chain of safety production, thereby enhancing cross-departmental and cross-level safety production linkage control capabilities.

Improve data service capabilities. With the help of the national industrial internet extensive data center, the industry subcenter and data support platform of "industrial internet + safety production" are established, and tool sets of standardized data exchange interfaces, analysis modeling, and visualization are developed. Moreover, on the basis of the industrial internet safety production supervision platform of key industries, data support services are utilized to accelerate the online aggregation, orderly flow and value mining of safe production data resources.

Improve fast perception. Focusing on personnel, equipment, production, warehousing, logistics, environment, and other aspects, the safety risk perception plan is promoted in industry. First, professional smart sensors, measuring instruments, and edge computing equipment are developed and deployed; then, the device protocol and data format are used; and finally, the situation awareness ability of the industrial internet is constructed.

Establish real-time monitoring capabilities. Develop online implementation guidelines for industrial equipment, industrial video and business systems; develop and deploy real-time analysis software, tool sets, and semantic models for safety production data; and use "5G + intelligent inspection" to high-risk, high-energy, high-value equipment and online equipment such as ERP, MES, SCM, and safety production-related systems. Cloud aggregation and real time monitoring of strategic safety production data.

Deepen the application of digital management. Safety production management uses digital twin technology to build industrial enterprises and key parks into the industrial internet to realize the digitization, visualization and transparency of the whole life cycle of key equipment and the whole production process and then improve the safety production data management ability of enterprises and parks.

Improve the ability of advance warning. Using the massive amount of data of the industrial internet platform, the risk feature database and the failure database are constructed, and then the safety production risk model of each industry is promoted. By encouraging the development of edge clouds, 5G + edge computing capabilities and sinking computing capabilities, precise prediction, intelligent early warning and advanced early warning are realized.

Deepen networked collaborative applications. The industrial internet safety production supervision platform promotes networked connections, agile response, and automatic deployment of safety production factors such as personnel, equipment, and materials; realizes collaborative linkages across enterprises, departments and levels; accelerates risk reduction and emergency recovery; and minimizes the loss of safe production.

Intensify the application of intelligent control. On the basis of the industrial internet platform, software precipitation and intelligent application of safety management experience and knowledge in key industries are carried out, and the promotion of industrial applications and solutions such as process optimization, predictive maintenance, intelligent inspection, risk early warning, fault self-healing, and grid safety management is accelerated to realize predictable and controllable safe production.

(2) Natural disaster risk comprehensive monitoring and early warning system

Fully implement the information project of natural disaster risk monitoring and early warning; accelerate the sharing of disaster monitoring and early warning information concerning natural resources, water conservancy, agriculture, forestry, meteorology, and other departments; and establish a natural disaster perception network for all kinds of disasters. First, through the construction department monitoring integrated management system, multidisaster and disaster chain monitoring and early warning system, disaster comprehensive risk assessment system, global disaster monitoring and analysis system, disaster comprehensive research and judgment system and comprehensive early warning information release management system and other related business application systems; second, based on the monitoring information data of various professional departments, which are flexible, fast, and relatively accurate advantages of drones for regional detection and early warning, and according to the principle of efficient resource sharing, the organic combination of emergency special satellites and general satellites is used to build a real-time information data aggregation platform for natural disasters. Finally, space–air–ground monitoring and an early warning perception network before, during and after a disaster are integrated to realize rapid and flexible mobilization and fixed-point monitoring during emergencies.

(3) Urban security risk monitoring and early warning public information platforms

Figure 3 shows the framework of the comprehensive monitoring and early warning system for urban safety risk (2.0). By paying attention to the main problems and outstanding problems of urban lifelines and focusing on the three functions of monitoring, early warning and disposal, a map of risk hidden danger and security situations is established, which is equipped with a perfect closed-loop disposal mechanism of risk hidden danger throughout the whole process, to realize unified network management and map perceptions of urban lifeline engineering safety risk.

Through materialized operation, professional support, and information empowerment, we can enhance the ability of risk monitoring, analysis, and early warning and linkage disposal in the region, industry, and field. From the four aspects of establishing digital early warning response instructions, automatically distributing early warning information, improving response and disposal capabilities, and implementing closed-loop management of early warning and disposal, we can improve the efficiency of linkage disposal and create a new model of innovative comprehensive monitoring and early warning platforms for sea, land, air, and space and integrate efficient disposal scheduling in superlarge cities.

The city spatiotemporal information platform (CIM platform) is used to superimpose urban lifeline data such as water, electricity, oil, and gas, as well as surrounding risk sources, the environment, and protection object information, combined with real-time monitoring and early warning information from sensing equipment, to achieve an urban risk "one map". A large-scale artificial intelligence model of urban security with integration, interconnection and efficient coordination is constructed, and the large-scale model is integrated with the artificial intelligence model of industry and field, which has both emphasis and interaction and coordination, to realize intelligent and accurate research and judgment of perceived information data and efficient early warning. Moreover, block chain technology is used to ensure the data security of urban safety monitoring and early warning systems.

(4) Improving the scholarly level of the emergency rescue command system

With the help of the "emergency brain" and "one map" of the emergency command, the unified display of the catastrophe situation, comprehensive prediction of the disaster trend, intelligent generation of the rescue plan and dynamic tracking of the rescue progress are gradually realized, as shown in Fig. 4. Through the combination of artificial intelligence and information technology and the integration of online and offline methods, the use of information technology to deeply mine the value of massive amounts of data increases the timeliness, accuracy, and effectiveness of disaster accident information acquisition. Moreover, we will step up the construction of large-scale databases, strengthen business model research, create universal intelligent products, and provide strong support for business innovation. In addition, sensing data, reporting data, video data, internet data, and other data are converged and integrated, and intelligent large-scale models such as hazardous chemical leakage and diffusion simulation, explosion intelligent early warning, typhoon disaster assessment, and flood inundation analysis are used to provide scientific decision support.

To increase the scientific accuracy of emergency commands, we can adopt innovative communication technology. On the one hand, we can guarantee that in the event of an emergency, even if there is a power outage, circuit outage or network outage, the communication is still smooth. We can use UAVs as relay platforms for mobile communication and exploit the advantages of vehicle dynamic communication, individual wireless

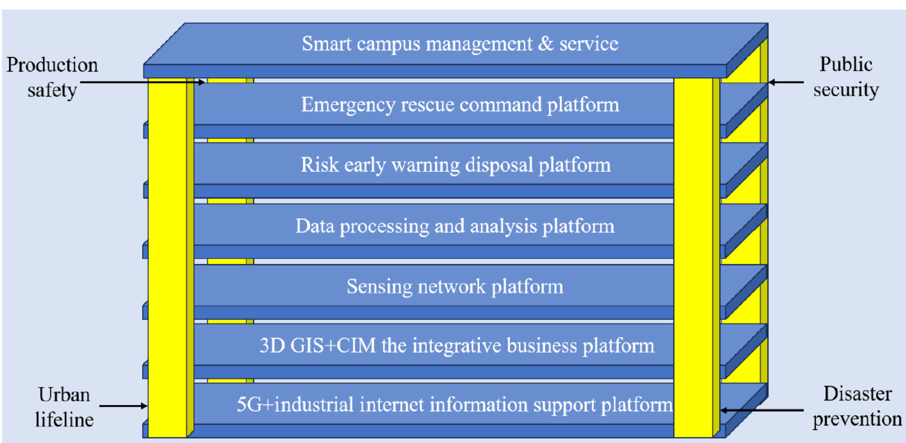

Fig. 3 Urban security risk comprehensive monitoring and early warning system (2.0) framework.

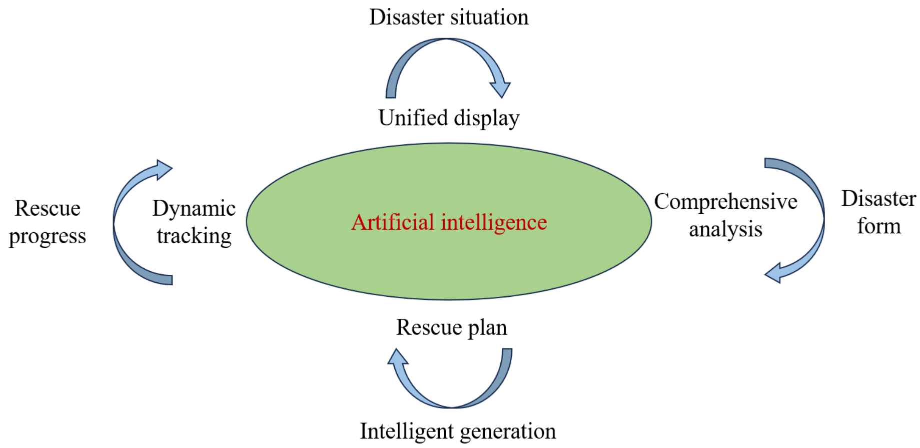

Fig. 4 "Emergency brain" and "one map" of an emergency command.

communication equipment, satellite communication and the BDS message system to realize the smooth flow of information between accidents and disaster sites and intelligent platforms. On the other hand, we can implement a next-generation satellite communication network system to guarantee real-time and secure transmission of voice and video under various difficult conditions.

(5) Improving the judicious level of safe supervision

The focus of safe production is prevention and supervision. Intelligent technology is a useful tool for enhancing scientific, professional, intelligent, and meticulous levels of supervision and law enforcement via information technology. Embedding the data of safety production standards and regulations and illegal operation behaviors of various related industries into the intelligent law enforcement terminal of "internet + supervision" is conducive to allowing law enforcement personnel to quickly and accurately judge compliance and violations and significantly improves the intelligent level of supervision and law enforcement and the accuracy of intelligent analysis and judgment of violations. In terms of increasing the efficiency of enterprise services, intelligence plays an irreplaceable role. For example, in "internet + supervision", with the support of software packages such as databases and generative artificial intelligence special models, online remote consultation, declaration, approval, and other functions can be realized, which not only improves efficiency but also better prevents fraud and fraud and can also trace responsibility.

(6) Promoting intelligent science popularization, training, and emergency information release

For both safe production supervision and natural disaster prevention and control, timely release of information and guidance of public opinion after emergencies are indispensable means to cope with disasters and accident disasters. The quality of emergency information release and public opinion guidance on the network should be improved. Network technology and big data perceptive analysis can be utilized to improve the timeliness, accuracy, and public opinion analysis ability of emergency information release. The informatization level of popular science education and training should be improved. The construction and dissemination channels of popular science content should be integrated, the intelligent development of popular science education should be promoted, the information level of relevant channels and practice carriers should be strengthened, public safety awareness and emergency response capabilities should be improved, and the goal of "everyone knows safety and everyone can respond to emergencies". The construction of an emergency broadcasting system should be strengthened. The grassroots emergency broadcasting infrastructure should be improved, mobile internet warning information release channels should be expanded in a timely manner, a comprehensive early warning information release management system should be established, and accurate orientation and rapid dissemination of risk early warning information and popular scientific knowledge should be achieved.

(7) Improving the modernization level of emergency equipment

The modernization and intellectualization of rescue equipment is an essential requirement to improve the efficiency of emergency rescue and reduce the loss of life and property. Research and development of new intelligent emergency rescue combat equipment vigorously promotes the application of scholarly machinery such as drones and robots; participates in actual combat fire fights, communication support, reconnaissance and monitoring, logistics support and other tasks; and promotes the transformation from direct confrontation to unmanned intelligent rescue. An intelligent robot suitable for numerous complex dangerous scenarios is improved. Emergency delivery equipment, such as heavy helicopters, amphibious aircraft, multifunctional intelligent drones, and modern emergency equipment, such as special emergency rescue equipment, intelligent sensing equipment, and intelligent unmanned rescue equipment, should be actively promoted to improve unmanned rescue service capabilities. Establish an emergency equipment Internet of Things. The positioning information and operating status information of the principal emergency equipment can be sensed and networked in real time, and unified access to the integrated platform of the emergency command center can be confirmed to support leadership decision-making and command scheduling.

(8) Improving the intrinsic safety level of urban and rural enterprises

The intrinsic safety level of enterprises with substantial safety risks in the production, transportation and storage of unsafe chemicals, mines, and storage and transportation should be improved. By increasing the amount of cerebral equipment at production sites, such as hazardous chemical plants, coal mines and noncoal mines, and applying scholarly production devices, "intelligent equipment replaces manpower", thereby significantly reducing the labor demand of high-risk positions. The public's intrinsic safety level of bulk commodities should be improved. Promote the development and promotion of safe, cost-effective magnesium power and energy storage batteries and solid-state batteries to accelerate the process of replacing lithium batteries. Improve safety technologies such as magnesium hydrogen storage devices to improve the fire safety performance of innovative energy vehicles and electric bicycles. With the construction of a

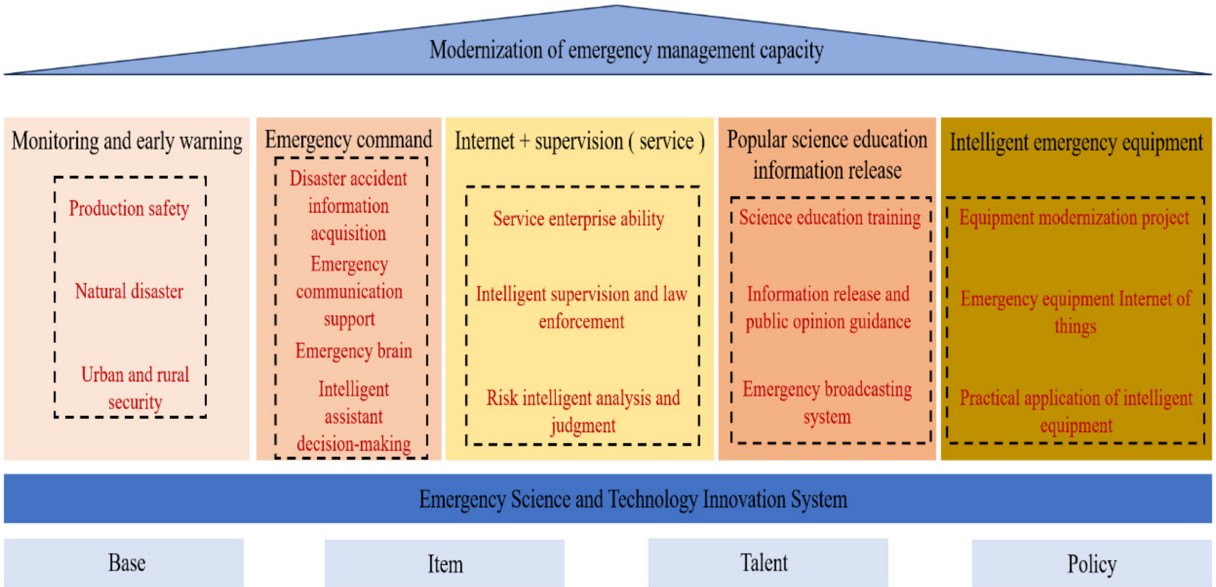

Fig. 5 Overall planning of intelligent emergencies.

"resilient city" as the foundation, the technical support of municipal safety should be strengthened. To improve and popularize urban safety monitoring and early warning systems, the application of a number of different technologies in high-rise buildings, large-scale complexes, public gathering places, bridges, and tunnels should be increased to improve the level of intrinsic safety. For example, seismic technology should be vigorously promoted, the seismic capacity should be improved, and municipal flood control standards should be further improved.

4 Strengthening safety emergency science and technology innovation systems and capacity building

Overall planning of intelligent emergencies is shown in Fig. 5 and consists of the following five main components.

(1) Improving and enhancing safety emergency technology management with systematic thinking

Conform to the characteristics of the new round of scientific and technological revolutions and systematic innovation concepts, integrate science and technology into the whole process and all-round of safety emergency work, and promote scientific and technological innovation and application in all aspects. This approach achieves practical results, places science and technology at the core of overall development, and truly plays a leading and driving role.

In view of this, we should vigorously develop key projects, such as safety production monitoring and early warning systems, urban safety monitoring and early warning systems, natural disaster prevention and control information systems, emergency rescue command systems, and safety supervision network intelligent systems, to comprehensively improve safety emergency science and technology innovation ability, overall level and safety prevention and emergency disposal ability.

(2) Using artificial intelligence and other technologies to increase the level of industry science and technology with the awareness of one step ahead

Artificial intelligence will promote various industries and fields to undergo profound technological changes and overall upgrading. Artificial intelligence not only provides more advanced and efficient technical means but also organically integrates with the scientific and technological systems of diverse industries and fields to form a new scientific and technological system. The artificial intelligence big model is actually based on the enormous database of the industry and the field, combined with advanced algorithms, which are based on the long-term accumulation of various cases and experiences for deep learning and model training, integrating more wisdom, and more accurately judging and dealing with risks. With the development of artificial intelligence technology, "application ecology" will become more important. As far as safety emergency technology is concerned, the artificial intelligence technology group will undoubtedly greatly improve the efficiency of safety risk prevention and emergency response and provide stronger security for people's lives and property. Therefore, it is urgent to accelerate the cross-integration of artificial intelligence technology and existing security emergency technology and build a security emergency technology system centered on artificial intelligence.

The development and application of AI technology will improve the quality of science and technology in all walks of life. Therefore, in terms of integrating data and technology from all walks of life, it is necessary to fully draw on the experience of various industries to improve the level of safety of emergency science and technology in various industries to increase the effectiveness of the national safety emergency science and technology system.

(3) Promotion of the construction of an industry innovation system with systematic thinking

In terms of hardware, improvements in safety emergency science and technology innovation ability are at the heart, and the system layouts of the base, project, talent, and policy are coordinated. The construction of national and ministerial scientific research bases such as national key laboratories, national technology innovation centers, national disaster field observation and research stations, and ministerial key laboratories should be promoted, and the national key research and development plan, national science and technology major projects and other national science and technology plan project layouts should be promoted.

In terms of talent, we should strengthen the training and gathering of emergency management science and technology talent, establish high-level scientific research institutions such as national natural disaster prevention and control, safety science and engineering, and cultivate excellent emergency science and technology talent. The innovation source of the new generation of IT and AI technology lies in domestic enterprises, universities and scientific research institutions. We should build an emergency management science and technology innovation system, take full advantage of the advantageous innovation and talent resources at home and abroad, and attract and gather global talent for our use.

In terms of software, we strengthen close cooperation with enterprises and use IT and AI innovation entities and leading enterprises as suppliers of innovative security emergency technologies to expand the supply chain of advanced technologies.

(4) Cooperation with advantageous innovation resources with an open attitude should be strengthened

With the in-depth development and application expansion of artificial intelligence technology, various departments and industries will generally carry out large-scale model and application ecology. We should promote strategic cooperation with the National Development and Reform Commission, the Ministry of Science and Technology, the Ministry of Industry and Information Technology and other departments, continue to focus on "grasping policies and grasping services", and accelerate the introduction of relevant safety emergency science and technology innovation management policies. In the construction of big data centers and large-scale models of intelligent industries, relevant departments regard industry intelligent security and emergencies as equally important main tasks, provide service guarantees for scientific and technological innovations in emergency management, and establish large-scale models and intelligent centers of national artificial intelligence for security emergencies with interconnections and resource sharing.

Furthermore, the cooperation of departments, localities, enterprises, universities and scientific research institutions in the innovation of safety emergency science and technology should be strengthened, and the coordination and linkage with industrial information, housing construction, transportation, environmental protection, water conservancy, energy and natural resource departments should be strengthened to form a joint force and new pattern of safety emergency science and technology innovation. Among them, the local government is an influential force that promotes the innovation and application of safety emergency science and technology. Focusing on urban safety development and taking the construction of municipal safety monitoring and early warning systems as the entry point is conducive to promoting the common development of regional safety emergency science and technology innovation. Enterprises are the primary responsibility of safe production. By formulating plans and policies, stimulating the enthusiasm of enterprises to apply advanced science and technology to improve safety levels, mining the advantages of the safety technology of related enterprises, and then integrating advanced technology systems, it is helpful to promote and learn from all over the country.

(5) Strengthening the original innovation ability with the spirit of strengthening the source

The opportunity to compensate for the lack of creative innovation in the field of security, emergency science and technology should be seized, and the national science and technology management department should be actively called on to support basic research. Given the opportunity for the vigorous development of complex system science research, on the one hand, it is necessary to organize an in-depth study of strategic leading talent and determine the major basic research topics that need to be solved urgently in the field of safety emergencies. On the other hand, it is necessary to cooperate with domestic and foreign experts in complex system science to study the causes of disasters caused by global climate change, the far-reaching impact of new technology development and social change on production, urban and rural safety and public safety, and major basic scientific issues such as disaster mechanisms. These two aspects should be included in the national major science and technology special plan to enhance the singular innovation ability of safety emergency science and technology.

It is believed that safety emergency science and technology should have the courage to grasp the opportunities of a new round of scientific and technological revolution, especially the development wave of artificial intelligence technology, to provide a stronger impetus and reliable guarantee for high-quality development in the field of safety.

5 Conclusions

Built on the challenges faced by the security emergencies caused by the new round of information technology revolution, this paper analyzes the security risks of various industries and disciplines and proposes the purpose of AI-enabled security emergency technology upgrades. On the basis of the cross-integration database of multiple industry fields, artificial intelligence technology is employed as an advanced analysis method to quickly and effectively process security emergency information. Moreover, the framework of the safety emergency science and technology innovation system and the scope of safety emergency science and technology capacity building are specified. This paper provides theoretical guidance for the development and construction of safety emergency technology.

Declaration of competing interest

The authors have no competing interests to declare that are relevant to the content of this article.

References

Chandra, A., Chakraborty, A. 2024. Exploring the role of large language models in radiation emergency response. *Journal of Radiological Protection*, **44**: 011510.

Chen, Z., Lin, Z., Yang, J., Chen, C., Liu, D., Shan, L., Hu, Y., Guo, T., Chen, H. 2024. Cross-layer transmission realized by light-emitting memristor for constructing ultra-deep neural network with transfer learning ability. *Nature Communications*, **15**: 1930.

Jalal, S., Parker, W., Ferguson, D., Nicolaou, S. 2021. Exploring the role of artificial intelligence in an emergency and trauma radiology department. *Canadian Association of Radiologists Journal*, **72**: 167–174.

Khatatbeh, I. N., Moosa, I. A. 2023. Financialisation and income inequality: An investigation of the financial Kuznets curve hypothesis am ong developed and developing countries. *Heliyon*, **9**: e14947.

Klahr, D. 2019. Learning sciences research and Pasteur's quadrant. *Journal of the Learning Sciences*, **28**: 153–159.

Lakkimsetti, M., Devella, S. G., Patel, K. B., Dhandibhotla, S., Kaur, J., Mathew, M., Kataria, J., Nallani, M., Farwa, U. E., Patel, T., et al. 2024. Optimizing the clinical direction of artificial intelligence with health policy: A narrative review of the literature. *Cureus*, **16**: e58400.

Liu, Z., Li, J., Ashraf, M., Syam, M. S., Asif, M., Awwad, E. M., Al-Razgan, M., Bhatti, U. A. 2024. Remote sensing-enhanced transfer learning approach for agricultural damage and change detection: A deep learning perspective. *Big Data Research*, **36**: 100449.

Rosenzweig, C., Solecki, W. 2019. New York city panel on climate change 2019 report chapter 1: Introduction. *Annals of the New York Academy of Sciences*, **1439**: 22–29.

Sáez, C., Ferri, P., García-Gómez, J. M. 2024. Resilient artificial intelligence in health: Synthesis and research agenda toward next-generation trustworthy clinical decision support. *Journal of Medical Internet Research*, **26**: e50295.

Sahoh, B., Choksuriwong, A. 2022. A proof-of-concept and feasibility analysis of using social sensors in the context of causal machine learning-based emergency management. *Journal of Ambient Intelligence and Humanized Computing*, **13**: 3747–3763.

Semin, M., Kormshchikov, D. 2024. Application of artificial intelligence in mine ventilation: A brief review. *Frontiers in Artificial Intelligence*, **7**: 1402555.

Siegenfeld, A. F., Bar-Yam, Y. 2020. An introduction to complex systems science and its applications. *Complexity*, **2020**: 6105872.

Tomur, E., Bilgin, Z., Gülen, U., Soykan, E. U., Karaçay, L., Karakoç, F. 2024. Intent-based security for functional safety in cyber-physical systems. *IEEE Transactions on Emerging Topics in Computing*, **12**: 615–630.

Yang, Y., Zhang, C., Zhao, K., Wang, Q. 2023. The shifting role of information processing and management in interdiscipline development: From a collection of tools to a crutch. *Information Processing & Management*, **60**: 103388.

Yin, W. 2023. Monitoring and early warning of artificial intelligence system in public health safety law. *Soft Computing*, https://doi.org/10.1007/s00500-023-08892-5

Zhang, F., Qiao, Q., Wang, J., Liu, P. 2022. Data-driven AI emergency planning in process industry. *Journal of Loss Prevention in the Process Industries*, **76**: 104740.

Zhen, Z., Li, Z., Wang, F., Xu, F., Li, G., Zhao, H., Ma, H., Zhang, Y., Ge, X., Li, J. 2024. CNN-LSTM networks based sand and dust storms monitoring model using FY-4A satellite data. *IEEE Transactions on Industry Applications*, **60**: 5130–5141.

Zhou, K. Z., Choudhry, A., Gumusel, E., Sanfilippo, M. R. 2024. "Sora is incredible and scary": Emerging governance challenges of text-to-video generative AI models. *arXiv preprint*, arXiv: 2406.11859.

Zhou, Y. 2024. Logistics security integrated communication system under the background of 5G artificial intelligence. In: *Proceedings of International Conference on Artificial Intelligence and Communication Technologies. Smart Innovation, Systems and Technologies, Vol. 368*. Kountchev, R., Patnaik, S., Nakamatsu, K., Kountcheva, R., Eds. Springer Singapore, 325–334.

Zhu, L., Chen, P., Dong, D., Wang, Z. 2022. Can artificial intelligence enable the government to respond more effectively to major public health emergencies? —Taking the prevention and control of Covid-19 in China as an example. *Socio-Economic Planning Sciences*, **80**: 101029.

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