Social Risk Analysis of Smart Grid Based on Emerging Technologies in the Chinese Context: A Review Based on CiteSpace

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Abstract. Social risk is one of the important topics in the world today. It is constantly being discussed by scholars. As the largest developing country, China's analysis of the social risks brought about by the development of smart grids is worth learning from. However, few Chinese scholars have explored the social risks involved in the emerging concept of the Smart Grid (SG). Due to the close integration of smart grids with emerging technologies such as artificial intelligence, this paper intends to provide a general direction and logic for the social risks of SGs by discussing the social risks brought by emerging technologies. Therefore, this paper uses CiteSpace to conduct author cooperation network analysis, keyword co-occurrence analysis, and keyword clustering analysis on Chinese social risk literature based on the CNKI database. The keywords are sorted into five categories, namely risk categories, risk sources, governance tools or means, results or purposes, and related terms. The risk sources are further subdivided into three categories: technical, social issues, and events. Then the technical part is carried out, combined with the characteristics of the SG to explore its impact mechanism on social risks and put forward corresponding countermeasures.

Keywords: Smart Grid · Social Risk · CiteSpace

1 Introduction

Social risk is the possibility of threats and uncertainties arising from social modernization, which will cause irreversible harm to all individuals [1]. In a narrow sense, it can be considered that social risk refers to the possibility that the behavior of individuals or groups will cause the destruction of social order [2]. With the acceleration of the modernization process and the continuous improvement of the level of science and technology, the possibility of social disorder and social chaos caused by a trivial incident of an individual or group has increased sharply with the blessing of high technology and advanced communication technology. Few Chinese scholars have explored the social risks involved in the emerging concept of the smart grid. Since the smart grid is closely integrated with emerging technologies such as artificial intelligence, this paper provides

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a general direction and logic for the social risks of smart grids by discussing the social risks brought by emerging technologies.

Smart grids are grid systems that are upgraded with the development of emerging technologies. As defined by the U.S. Department of Energy, a Smart Grid (SG) uses digital technology to improve reliability, security, and efficiency (both economic and energy) of the electric system from large generation, through the delivery systems to electricity consumers and a growing number of distributed-generation and storage resources [3]. With the increase of the interaction between the external environment and the power system, under the background of the continuous increase of the scale of the power grid system, the enhancement of system nonlinearity, and the constant increase of operating modes, the data source, and data volume are constantly increasing. The analysis and control of the power grid are becoming more and more difficult. Challenges are also increasing. With the development of emerging technologies such as artificial intelligence, the four aspects of "source network load storage" have been greatly improved, and then the power grid can realize the transformation process from the passive control of the traditional power grid to the active response of the SG so that to a large extent avoid risk. Because the smart grid has the characteristics of large-scale distribution, strong system integration, and obvious intelligence, the social risks it brings are worth discussing by scholars. As in the case of the cyberattack on the Venezuelan national grid in 2020, which resulted in the malignant consequences of a massive national power outage.

Exploring the research status of social risks in SG is helpful to empower risk management from a theoretical level. However, in developing countries, including China, the development of the SG is later than that of European and American countries, and there are few studies on SGs and social risks. Exploring the social risks of China's smart grid is conducive to providing theoretical and practical references for other developing countries. Since less research has been done on the social risks associated with SGs, which are closely integrated with emerging technologies such as artificial intelligence, this paper focuses on exploring the possible social risks associated with the emerging technologies behind SGs to provide a general direction and logic for the study of social risks associated with SGs. Therefore, this paper selects the CSSCI social risk research literature based on CNKI, uses CiteSpace for visual literature analysis, sorts out the research status and research hotspots of China's social risk, and explores the social risk source and formation mechanism of the SG based on emerging technologies.

2 Literature Review

According to the US Department of Energy, "A Smart Grid uses digital technology to improve reliability, security, and efficiency (both economic and energy) of the electric system from large generation, through the delivery systems to electricity consumers and a growing number of distributed-generation and storage resources" [3]. The application of new technologies aims to help the traditional grid improve efficiency and reliability, making the whole power system more economical [4]. However, with the interaction of more elements, the Smart Grid (SG), as a new generation of grid system, is bound to bring more forms and complex risks on top of the traditional grid system, including risks

from digital communication and computer systems, in addition to human, policy, and political risks [5]. Scholars have also mentioned the social nature of these risks in their research. Gunduz and Das argue that disruption of the communication system of the SG can lead to social disorder and national security issues [6]. In the Chinese context, "strong SG" is the choice for development. A strong SG is one of the characteristics of a secure, high-quality, and reliable power supply [7].

Social risk has different definitions in several professional fields such as sociology, geography, psychology, law and social security, economy and public policy [8]. The reason why there are different definitions of social risk in various fields is that the concept of social risk itself is formed by combining the concepts of several different fields [9]. The term "risk" itself is the definition of insurance, while "social risk" can be understood as the social dimension of "risk", thus reflecting the multidisciplinary intersection of social risk. In addition, a series of concepts closely related to "social risk", such as "risk society", "social governance", "social security", and "emergency management" is defined in the field of sociology and even public administration. The interconnection of terms from multiple disciplines has resulted in the broad concept of "social risk. In brief, social risk in sociology refers to the uncertainty of social loss, which is narrowly defined as a system alongside politics, economy, culture, etc.; social loss accordingly refers to a loss alongside politics, economy, culture, etc., which can be considered as a disruption of social order; furthermore, social risk in a narrow sense is defined as a risk alongside politics, economy, culture, etc. cultural risk, etc., rather than a risk in a broad sense, involving multiple disciplines; meanwhile, the social risk here differs from political risk, economic risk, cultural risk, etc., but under certain conditions, political risk, economic risk, cultural risk, etc., may be transformed into social risk [2].

As one of the theories closely related to the study of social risk, there are three major theoretical orientations of risk society, namely the institutionalist school, the realist school, and the culturalist school. The representatives of the institutionalist school are Ulrich Beck and Giddens, who believe that the current globalized society, with the continuous development of modernity and science and technology, has become a risk society and that none of the individuals in the society is immune to the risks it contains; and that with the development of science and technology, the prevalence of globalization, and the rapid evolution of modernization, risks and their potential destructiveness have become unparalleled. Further, Beck defines social risk as to the possibility of threats and uncertainties arising from the modernization of society, which will cause irreversible harm to all individuals [1]. In contrast to Beck, who is more concerned with technological risks, Giddens prefers to emphasize the social risks posed by institutions. Giddens argues that human interventions in society and nature have continuously shaped social risks, of which the four institutional pillars of modernity, namely the world nation-state system, the world capitalist economy, the international division of labor system, and military totalitarianism, are the source of the risks [10]. Further, Giddens divides risks in modern societies into two categories, "external risks" and "man-made risks", based on the sources of risk generation. External risks consist of emergency contingencies that occur frequently and are usually planned for, such as natural disasters and social conflicts in the traditional sense. Man-made risks, on the other hand, refer to the risks that arise from the growing knowledge that human beings acquire through their continued

exploration of the world through knowledge and practice, especially the risks that arise from the constant changes in science and technology.

Social problems and emergencies, as a source of social risk, have led to many studies and discussions on their impact on social risk. In addition, technology, as one of the sources of social risk according to Beck, and also as one of the sources of man-made risk, its impact on social risk has also triggered many scholars' studies and discussions. George S. Day and Paul J.H. Schoemaker define emerging technologies as "having the potential to remake entire industries and obsolete established strategies" and characterize them as "traumatic" [11]. Scholars have discussed the multiple forms of societal risks associated with new mining technologies that bring efficiency and economic benefits, such as the enhancement of existing risks, the expansion of the scope of existing risks, and the possible emergence of entirely new risks [12]. The possible social risks perceived by researchers of Genetically Modified (GM) food have also been explored, and it is suggested in the article that the ethical and moral risks associated with GM food first affect consumers' attitudes towards the technology, which in turn has an indirect effect on social risk perceptions, i.e. how audiences perceive the ethical and moral risks of GM food affects their perceptions of GM technology, which further affects their risk perceptions of GM food [13].

In the world's smart grid construction as well as the construction of a strong SG in the Chinese context, AI technology exists as a supporting technology for the smart grid, helping to upgrade the power system in terms of data processing [14, 15]. In the Chinese context, some scholars have explored the impact of AI technologies on social risks, and the study concluded that AI technologies can trigger ethical and moral aberrations, the polarization of social structures, alienation of technological development, high difficulty in regulation caused by algorithmic black boxes, and difficulty in determining responsibility for accidents caused by the unknown status of AI as a status [16]. Some scholars have also discussed the possible social risks brought by the virtual reality-based immersive platform "metaverse" and given aspects that need attention; on the one hand, attention should be paid to the negative effects of the highly addictive nature of the "metaverse"; on the other hand, attention should be paid to. On the other hand, it is important to pay attention to the oppression of employees due to the telecommuting property of the "metaverse", i.e., the invisible violation of employees' labor rights [17].

The focus on the social risks associated with the SG can be focused on the paths of social risks associated with high technologies such as artificial intelligence. Summarizing how Chinese scholars view the social risks associated with various types of high technologies, including artificial intelligence technologies, can help inform the study of social risks associated with the development of the SGs based on high technologies. The framework and focus of Chinese research on social risks, as well as the sources and mechanisms of social risks in China, can provide a reference for research in other countries and for developing countries to deal with social risks brought about by high technologies.

3 Research Methodology and Data Sources

This paper uses CiteSpace 5.8.R3 (Expires June 30, 2022) to conduct a visual literature analysis to capture the overall research on "social risk". CiteSpace is an information visualization literature analysis software developed by Professor Chaomei Chen of Drexel University. The software is able to find some hidden connections among a large amount of related literature based on keywords, citations, authors and institutions, and present the connections in a visual way. Further, the software can sort out the research lines, research hotspots in different time periods, and key literature connecting different research directions based on the literature data, simplifying the process of searching and filtering important literature and reducing the difficulty of overviewing the current status of research [18].

In order to sort out the sources and formation mechanisms of "social risk" in China, the CNKI (National Knowledge Infrastructure) database is used as the source of literature data in this paper. In order to collect the literature on "social risk" as accurately and comprehensively as possible, the statement "(SU = "social risk" OR TI = "social risk") AND KY = "social risk" was entered into Professional Search, where "SU" means "Subject", "TI "SU" means "Subject", "TI" means "Title", "KY" means "Keyword", and select "Synonym Search", "Dates" select "All", select "Academic Journals", and limit the "Source Type" to "CSSCI" (Chinese Social Sciences Citation Index), in order to collect as much authoritative literature on the topic of "social risk" as possible. The search yielded a total of 442 articles, with a publication year range of 1998–2022 and a total of 20 disciplines.

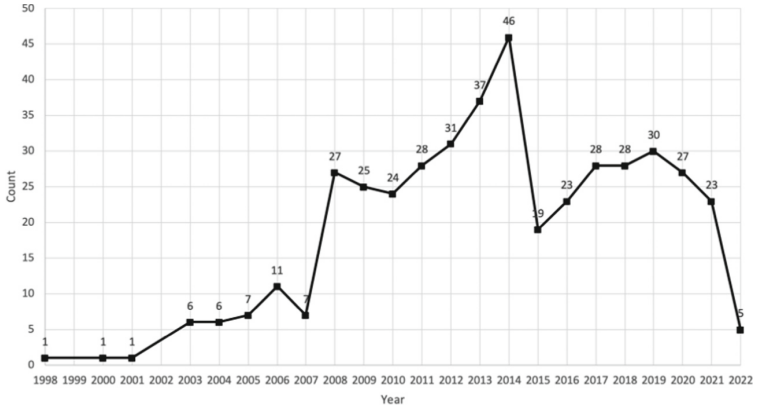

Fig. 1. China Social Risk Annual Posting Data.

Since 1998, the research intensity of "social risk" has been increasing year by year, reaching a peak in 2014, when 46 papers were published, and then In 2015, the popularity dropped, and although it rebounded, there are still fluctuations (see Fig. 1). In other words, despite the decline in research enthusiasm, there are still scholars in China who are concerned with the research on "social risk".

4 Visualization Analysis

CiteSpace was used to analyze the literature data samples visually. The literature data downloaded from the CNKI database was imported into CiteSpace for format conversion, and 442 valid data were obtained. The time span of the literature data was from 1998 to 2022, so the "Time Slicing" was set to "From 1998 JAN To 2022 DEC". In the panel, the settings related to "Text Processing" were kept as default, and "Author" and "Keyword" were selected in the "Node Type" section according to the type of analysis. In the "Links" section, select "Strength" as "Cosine" and "Scope" as "Within Slices" by default. In the "Selection Criteria" section, "g-index" is selected by default, and the default k value is 25. "Pruning" is selected differently according to different node types.

In the visualization part, this paper analyzes the literature samples item by item, because CiteSpace for CNKI literature data source only supports the analysis of author and institution cooperation network and keyword co-occurrence analysis, because the cooperation between institutions is less, so only present the visualization analysis about author cooperation network and keyword co-occurrence. In the keyword analysis section, in addition to keyword co-occurrence analysis, keyword clustering analysis was also conducted to obtain the general direction of social risk research.

4.1 Author Collaboration Network Analysis

Table 1. Author Posting Data.

Author	Count	First Year	Last Year	Author	Count	First Year	Last Year
Tong, X.	15	2006	2016	Liu, Y.	3	2006	2014
Zhang, H.B.	9	2006	2022	Wen, Z.Q.	3	2016	2019
Wu, Z.M.	8	2005	2020	Zhang, X.L.	3	2017	2018
Zhang, L.	6	2008	2016	Mo, H.L.	3	2019	2021
Bai, W.J.	5	2009	2018	Mo, F.	3	2012	2013
Li, S.Z.	4	2010	2018	Zhong, Z.J.	3	2021	2022
Xie, J.G.	4	2016	2019	Hu, B.	3	2012	2012
Chen, Y.H.	3	2015	2015	Lu, H.W.	2	2008	2009
Chen, S.J.	3	2001	2014	Tao, P.	2	2013	2016
Xia, Y.Z.	3	2008	2016	Chen, J.W.	2	2009	2009

The analysis of research collaboration networks can help to understand the collaboration between authors over time and the intensity of collaboration. The analysis of the authors' publications in the original literature data are summarized in Table 1, which lists the publications on "social risk" since 1998, including the names of scholars, the number of publications, their affiliation, and the year of the first and last publication. It can be observed that Tong X. has published the most articles, with 14 articles related to

"social risk" since he first published them in 2006. Zhang H.B., who shares the same affiliation with Nanjing University, has also published 9 articles on the topic of "social risk" since 2006. Compared with Tong X., whose last article on "social risk" was published in 2016, Zhang H.B. has been studying "social risk" for a longer period of time and is still publishing in the field of "social risk" in 2022. The last article on "social risk" was published in 2016. In addition to these two scholars, there are other scholars who focus on the topic of "social risk", such as Wu Z.M. (8 articles), Zhang L. (6 articles), and Bai W.J. (5 articles).

Using CiteSpace software, the nodes were set as authors based on the default threshold to explore the collaborative relationships among authors. Software calculations yielded the number of critical nodes 403 (N = 403), 167 critical paths (E = 167), and the largest CC: 8. Figure 2 shows the analysis of the author collaboration network formed by CiteSpace, in which all Chinese characters are marked with English translations below the Chinese, and synonyms may be used to refer to the original academic terms due to translation problems. The visual analysis of the collaboration network shows that there are mostly collaborative relationships among authors who publish more articles.

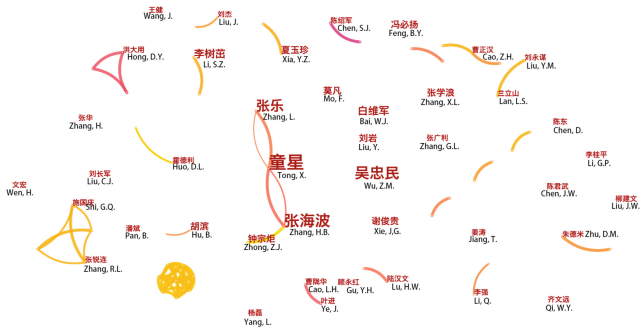

Fig. 2. Author Collaboration Network.

For example, Tong X. collaborated with Zhang H.B. and Zhang L., respectively. In addition, Zhang H.B. and Zhong Z.J., who had three publications, also had collaborative relationships. Based on the literature data, Zhong Z.J.'s first research paper on "social risk" was published in 2021, and he has published three articles in just over a year, which can be regarded as one of the more dedicated scholars in this field in China. It can also be seen that many scholars have conducted independent research, i.e., they have not collaborated with other scholars, such as Wu Z.M., Bai W.J., Xie J.G., Liu Y., Zhang X.L., and Mo F. In addition, there are also scholars who have made some collaboration with other scholars, such as Li S.Z., Chen S.J., Xia Y.Z., Mo H.L., Lu H.W., etc.

Specifically, Tong X. is the director of the Center for Societal Risk and Public Crisis Management Studies, Nanjing University, Jiangsu Province, China, and the director of Jiangsu Province Social Risk Research Base. He has published many papers on "social risk". "As one of his main research areas, he has conducted many collaborative studies

with other scholars in the field, such as Zhang H.B., Nanjing University, Zhang L., Shandong.

University, and Tao P., Among them, Tong X. and Zhang H.B.'s paper on the governance of the mass unexpected incidents is widely recognized by the academic community. They discussed the classification and nature of mass unexpected incidents and conducted a case study of the more iconic mass unexpected incidents in China, summarized the dynamic model of Unorganized mass unexpected incidents, and proposed many new ideas related to mass unexpected incidents, which provided a theoretical basis for subsequent scholars to study mass unexpected incidents [19].

Zhang H.B. is a professor at the School of Government Administration, Nanjing University, and a researcher at the Center for Societal Risk and Public Crisis Management Studies, Nanjing University with Tong X. His research interests include social risk, emergency response, and emergency management. His research areas include social risk, emergency management, crisis management, and public safety. He has collaborated with Tong X., Zhong Z.J., and Yan J. In the area of social risk research, Zhang H.B. has co-authored many papers with Tong X. In addition to the above-mentioned research papers on mass unexpected incidents, many other studies have received attention from other scholars. For example, Zhang H.B. is the first author of a research paper exploring the structure of emergency management in China, in which Zhang H.B. and Tong X. focus on the internal structure of emergency management practice in China, based on the major disasters that have occurred in China in the past two decades, such as the 2003 atypical disaster. Disaster events in China in the last two decades such as atypical pneumonia in 2003 and the Lushan earthquake in 2013 for case analysis, summarizing the changes in the framework of emergency management practice in China and adding a theoretical basis for related research [20].

4.2 Keyword Analysis

By using CiteSpace to set the node type as "Keyword" for keyword co-occurrence analysis, we can observe the frequency of different keywords in the article and then discover the research hotspots. Figure 3 shows the keyword co-occurrence network formed by CiteSpace, in which all Chinese characters are marked with English translations below the Chinese, and due to translation problems, synonyms may be used to refer to the original academic terms. In addition, to make the visualization graph more concise and clear, the #Years Per Slice in Time Slicing was set to 3, Pruning was set to "Pathfinder" and "Pruning sliced network", and the number of key nodes in the visualization result was 321 (N = 321), and the key paths The size of the nodes or the Chinese font size represents the frequency of keywords, while the line between the nodes represents the presence of two keywords in the same paper at the same time. The font size shows that scholars focus on "social risk" as well as "risk society", "social governance", "public crisis", "risk governance", "risk", "social security", "social management", and "emergency management". "and "emergency management". In addition to the keywords related to "governance", "management" and "protection", we can observe the keywords of "artificial intelligence", "social transformation", and "social transformation".", "social transformation", "migrant workers", "emerging technologies", "ethnic regions The keywords

of “artificial intelligence”, “social transformation”, “migrant workers”, “emerging technologies”, “ethnic areas” and “globalization” have also received more attention from scholars. Among them, some scholars believe that the social risks caused by artificial intelligence should not be underestimated. Taking the highly cited paper of scholar Ma Changshan as an example, he argues that AI can trigger ethical and moral deformation, the polarization of social structure, alienation of technological development, high difficulty in regulation caused by an algorithmic black box, and high difficulty in determining the responsibility of accidents caused by the unknown status of AI as a status [16].

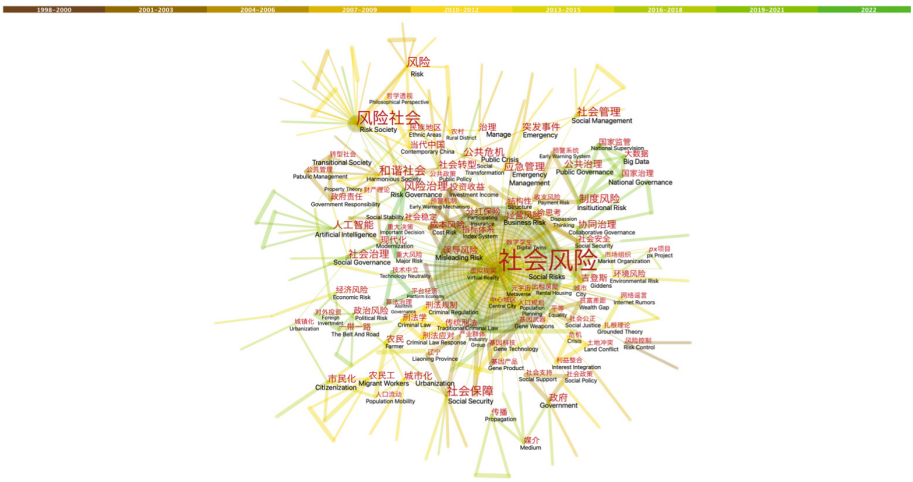

Fig. 3. Keyword Co-occurrence Network.

Further, keyword clustering analysis was conducted using CiteSpace based on the keyword co-occurrence network, as shown in Fig. 4, where all Chinese characters have English translations marked below the Chinese. In addition, different color blocks represent different categories formed after keyword clustering, and the ordinal number before the cluster indicates the size of the cluster, and the smaller ordinal number means the larger the cluster, i.e., the more keywords included.The CiteSpace visualization software formed a total of 41 clusters, of which only 25 clusters were shown, such as “#0 risk society”, “#1 risk”, “#2 social security”, “#4 public crisis” and “#5 communication” “#6 Artificial Intelligence”, “#16 Platform Economy”, “#18 Genetic Weapons”, “#19 Meta-Universe”, “#20 Genetic Weapons”, and “#21 Genetic Weapons”. “#19 Meta-universe” and “#28 Simulation Prediction” are relatively small clusters.

From the keywords, we can analyze that scholars focus on four main areas. First, scholars focus their attention on the mechanisms that explain the sources of risk that lead to social risks, such as “artificial intelligence”, “emergencies”, “ethnic regions”, “land conflicts”, and “land conflicts. “land conflicts”, “internet rumors”, and “social transformation. Secondly, scholars focus on the factors that influence social risk, such as “communication”, “media”, “cold thinking”, etc. Third, scholars focus on how to solve social risks, such as “state supervision”, “big data”, “criminal law regulation”,

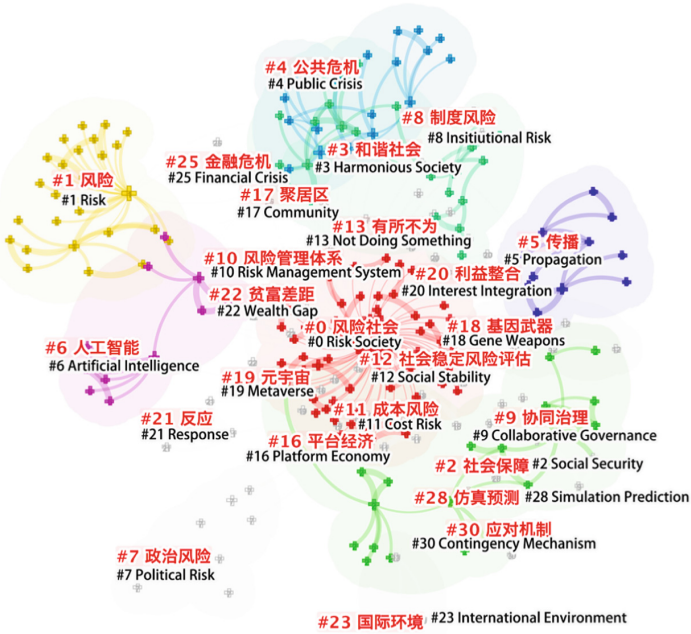

Fig. 4. Keyword Clustering.

"criminal law response" etc. Fourth, scholars have focused on the adverse consequences of social risks, such as "public crises" and so on. That is, scholars have explored the causes, influencing factors means to resolve, and adverse consequences of social risks based on different perspectives.

5 Analysis of Social Risk Generation Mechanisms

5.1 Identification of Social Risk Sources

In the part of identifying risk sources, first, based on the keywords identified by CiteSpace for manual classification, further, in the classification of risk sources to filter out technology-related keywords, such as "artificial intelligence", "network", "genetic technology", "big data", etc. Next, back to the original article to check whether it is a risk source or an important antecedent, rather than a category such as governance tools. Finally, the keyword-based classification, based on the specific content of the original article, reclassifies the screened keywords related to technology while being a source of risk to obtain specific technologies, such as classifying "gene editing", "gene products", "gene technology", "gene technology", "gene weapon" were combined into "gene technology", and the terms "universal era" and "Internet of Everything" into "Internet of Everything", or "IoE"; "Meta-universe" and "Virtual Reality" into "Virtual Reality Technology"; "Artificial Intelligence" and "AI Face Changing" into "Artificial Intelligence". The "artificial intelligence" and "AI face-swapping" are classified as "artificial intelligence", etc. At the same time, the keywords in the category of governance tools were also

filtered, and technology-related keywords such as "big data", "algorithmic governance" and "simulation prediction" were selected. The keywords in the category of governance tools were filtered to identify technology-related keywords, such as "big data", "algorithmic governance" and "simulation prediction". Further, when the keywords were retrieved from the original article, the differences in the roles of the keywords in some articles were also filtered. For example, "artificial intelligence" is considered by most scholars as a source or important antecedent of risk, but some scholars categorize it as a governance tool for social risk.

Table 2. Keyword Classification.

	Keywords
Risk Categories	Social Risk; Economic Risk; Environmental Risk; Political Risk; Technological Risk; Ethical Risk; Cost Risk; Operational Risk; Revenue and Expenditure Risk
Source of Risk	Artificial Intelligence; Urbanization; Emergencies; Migrant Workers; Modernization; Ethnic Areas; Individualization; Gender Imbalance; Rural; Internet Rumors
Governance Tools	Government; Collaborative Governance; Technical Decision Making; Indicator Systems; Government Responsibility; Public Policy; Legal Regulation; Early Warning; Public Participation; Social Control
Results or Purpose	Public Crisis; Harmonious Society; Social Stability; Equality; Crisis Events; Social Justice; Social Crisis; Equity and Justice; Balance of Interests; Balance of Interests
Related Terms	Risk Society; Social Governance; Risk Governance; Risk; Social Security; Social Management; Emergency Management; Governance; Public Governance; Contemporary China

Based on the four research directions derived from the keywords, the 321 keywords summarized by CiteSpace were manually classified into five categories: risk category, risk source (or important antecedent), governance tool or instrument, outcome or purpose, and related terms. Among them, Table 2 shows the classification of the 10 keywords with the highest word frequency in each of the above five categories, and due to translation issues, synonyms may be used to refer to the original academic terms. In Table 2, the keywords are ranked in order of their frequency, i.e., the keywords ranked first to have the highest number of occurrences. The analysis shows that in the risk category section, except for social risk, scholars discuss economic risk and environmental risk most often together with social risk, followed by political risk and technological risk. Many Chinese scholars also focus on the impact of AI on social risks, including the types of social risks it may cause or how to use AI to mitigate social risks. In the process of urbanization, various types of social conflicts, such as land disputes and labor disputes, occur from time to time, and thus social risks emerge [21]. Emergencies as antecedents of social risks have also received much scholarly attention. Further, migrant workers as one of the highly Chinese-specific phenomena have also received attention from scholars.

In the part of governance tools or instruments, the role of government is clearly one of the most concerned and trusted instruments by Chinese scholars. The government-led risk regulation system is the top priority to counteract a large number of social risks [22]. In addition, a collaborative multi-subject governance mechanism is also quite recognized by Chinese scholars. How to start from the grassroots and form multi-subject collaborative governance to further effectively resolve social risks has been discussed by many scholars [23]. In the result or purpose part, a public crisis as a crisis event that threatens public safety and normal social order after the disruption of social club order is one of the malignant consequences of uncontrolled social risk, and every individual in society will be negatively affected by the public crisis, which may further cause panic to intensify the malignant consequences. The transformation of a social risk into a public crisis is only necessary if the overall system is vulnerable and the risk factors meet the disaster-causing conditions [24]. On the other hand, in contrast to the malignant consequences of the public crisis category, building a harmonious society and maintaining social stability is one of the many purposes of controlling social risks.

Overall, the sources of social risk can be divided into two broad categories, namely technology, social problems, and emergencies. Since the latter two belong to external risks as defined by Giddens, they usually possess preplanned plans to control and reduce social risks after they occur. And in the current era of various science and technology blowouts, more and more emerging technologies are constantly impacting daily life. While technology facilitates people's daily life and contributes to industrial development and even innovation, the consequences are also worth considering. Therefore, this paper focuses on the mechanism of the impact of science and technology on social risks.

5.2 Identification of Social Risk Sources

Types of Technologies Influencing Social Risks. Table 3 shows the keywords belonging to the technology category obtained after filtering based on the keywords categorized as risk sources, and the technologies to which they belong. The technology categories are divided into eight categories: artificial intelligence, Internet technology, genetic technology, virtual reality technology, nanotechnology, Internet of everything, information technology, and communication technology, based on the general categories of technology.

Based on the frequency of keywords, the impact of AI technology on social risk is more concerned by Chinese scholars. And scholars focus not only on the technology itself but also on the technology derived from AI algorithms. Taking face recognition technology supported by AI algorithms as an example, Sun D.R. focuses on the possible spoofing attack and the alienation of face recognition technology into the composite technology Leviathan, the former is the act of people with ulterior motives using fake identification information to deceive the face recognition technology system and gain access to it, which breaks the trusted access system and causes social risks. The latter represents the rapid development of technology that can develop uncontrollably without proper control, thus causing social risks [25].

In addition, gene technology is also of great interest to Chinese scholars, and the direction is not limited to genetic weapons, genetic products, gene editing, and gene technology. In the context of gene technology, scholars have also mentioned the risk of

Table 3. Technical Keywords.

Technology	Keyword
Artificial Intelligence	Artificial Intelligence
	AI Face Replacement
Internet Technology	Cyber
Gene Technology	Genetic Weapons
	Genetic Products
	Gene Editing
	Gene Technology
Virtual Reality Technology	Metaverse
	Virtual Reality
Nanotechnology	Nanotechnology
Internet of Everything	Internet of Everything Era
	Internet of Everything
Information Technology	Information Technology
Communication Technology	Communication Technology

alienation when discussing its social risks. For example, Yang J. discusses the inevitable off-target effect in gene editing, i.e., the risk of alienation that is difficult to control due to the inevitable mistakes in implementation [26]. In addition, Zhang J. argues that the risk posed by human gene editing is not only brought by uncontrollable technology but also poses a serious threat to the current stable and peaceful situation of human beings, i.e., the problem arises from the technical level to the social level [27].

In general, scholars have focused on the double-edged sword effect of technology, especially the social risks that may be brought by the alienation of technology. And as technology develops, the social risks it poses will continue to change in terms of content, form, and intensity [28].

Keywords Characteristics of Technologies that Pose Social Risks. First, there is the potential to reshape the industry and even benefit humanity. Artificial intelligence refers to a system in which machines can demonstrate intelligence to perceive the environment, make judgments, and take actions to achieve goals like humans. It can help humans to deal with problems and predict future trends to a certain extent, and in the process, without human assistance, artificial intelligence can analyze information from different sources through various sensors or data inputs and make real-time feedback. Currently, AI has been applied to many industries, including healthcare, smart transportation, smart city, finance and trade, etc. It contains a variety of application scenarios, including search engines, personalized recommendations for advertising, intelligent voice assistants, intelligent customer service, intelligent translation, driverless, etc., to achieve

empowerment for many traditional industries and add vitality to emerging industries. Nanotechnology also has this same characteristic. Nanotechnology is a technology that uses a single atom or molecule, a substance between 1 and 100 nm in size. As the basic science and technology of many advanced technologies, it empowers physics and computer technology and then gives rise to many scientific fields, such as nanophysics, nanobiology, nanochemistry, nanofabrication technology, etc. Nanotechnology is widely used in medicine, energy, aerospace, and even daily use of clothing fabrics, displays, etc. are all applied to some extent. Gene technology has also changed people's perceptions and is widely used in the pharmaceutical industry to achieve genetic identification of parentage, genetic diagnosis of genetic diseases, gene therapy for genetics, cloning technology, and various drugs, such as recombinant drugs and biological vaccines. The revolutionary disruption of these technologies has greatly improved people's lives.

Second, there are hidden dangers in the application process. These technologies, despite their long development time, still have many hidden dangers as of now. For example, artificial intelligence currently has problems such as data leakage, imperfect regulations, and technical defects that lead to abnormal work, such as driverless cars that cause traffic accidents for no reason. In 2018, researchers at the University of Oxford, the University of Cambridge, and the artificial intelligence organization Open AI published a study on the potential for AI to be manipulated for malicious purposes, enabling remote control of driverless cars, drones, and other AI-based devices, which in turn can carry out unlawful acts and create social risks [29]. The potential hazards of nanotechnology on human health and the environment are of concern to scholars. The human skin system can effectively prevent macroscopic particles from entering the human body to safeguard human health from the harsh external environment, however, the particles of nanomaterials are too small and can simply enter the human body in the form of diffusion or penetration through the skin, which can negatively affect human health [30]. Genetically modified food, for example, is a conservative food in many countries, and its entry into the market is subject to strict scrutiny by different agencies and levels, and the controversy caused by genetically modified food is constantly being discussed.

Third, what it can achieve is greater than people's ability to control it. Artificial intelligence, for example, is "technologically autonomous", meaning that artificial intelligence devices based on deep learning algorithms can "think" for themselves and generate corresponding behavior. In this case, it is difficult to judge the direction and size of the extension of its capabilities, which exceeds the expectations and cognition of the R&D personnel, so it is extremely difficult for the R&D personnel to effectively control the AI to prevent possible malignant results, which generates social risks; in addition, there is a possibility that the AI will evolve into Artificial Superintelligence, which will possess intelligence far beyond human imagination, which will inevitably generate corresponding social risks [31].

In general, the technologies that have received much attention in the study of social risks usually have the potential to change the status quo and reshape industries and even benefit humanity, but at the same time, there are still various hidden risks in their use, which involve every individual in society. As this technology develops further, it will become increasingly difficult for humans to control it. As a newly emerged power grid system, the application of artificial intelligence and other high technology is an

important reason for the SG's realization. The presence of artificial intelligence and other technologies allows the grid system to move from passive control to active response. The application of new technologies in this process also corresponds to the reshaping of the industry, the existence of hidden dangers, and the inability to fully control the characteristics. Therefore, the SG may indeed pose social risks in the application of emerging technologies.

Mechanisms of Technology's Impact on Social Risks and Countermeasures. Risk is an inherent property of science and technology [32], while it adds convenience to human life and achieves breakthroughs to reduce the cost of living or working, its complexity and destructiveness cannot be underestimated. From the perspective of consumers or users of technology-based products, in the process of consumption and use, there are factors that may contribute to social risks, such as the consequences of malicious control of technology-based products by others, or the potential for malicious consequences of improper operation during use, which have the potential to disrupt the social order and therefore generate social risks.

From the perspective of the overall process, first of all, in the research and development stage, the technology itself may have certain hidden dangers but also can not exclude the possibility of researchers with malicious intentions using technology to design products or services [31]. At the stage of use, there is a possibility that the process of use may go wrong, be maliciously controlled, or be difficult to control its negative effects, etc. [16]. Once these situations occur, the wide audience and media dissemination increase the possibility of social order being disrupted, thus creating social risks. Further, from the perspective of future design or use, the ability of human beings to control the rapidly developing technology becomes a potential risk [33], i.e., whether the products produced by the technology itself can be controlled and whether the consequences of the things or even the human body transformed by the technology can be controlled.

Although the SG uses machine learning, deep learning, and artificial intelligence technologies to achieve the majority of known and unknown cyber threats [34], there are still some cyber security problems [35] since the system is not perfect and the mechanism is not flexible enough. In contrast, there are social risks in the application of science and technology to the SG in the research and development phase, the operational phase, and the prospective phase.

Overall, as shown in Fig. 5, there are seven components that contribute to the creation of social risks in the process of creating products with technology and their use, namely, hidden dangers or defects in the technology itself, problems with the initial intention of people using the technology, errors in the methods used by people when using the technology, malicious control of technology-related products when used by people, side effects in the product itself, future products that cannot be effectively controlled, and the Consequences brought about by things or human bodies, where these consequences also include the consequences of things that technology can accomplish that are greater than people's ability to control.

In terms of countermeasures, the first step is to continuously improve the laws and regulations that govern emerging technologies such as artificial intelligence. Legal regulation to prevent certain social risks, give full play to the advantages and convenience of emerging technologies, to curb their risks and malignant consequences. However, legal

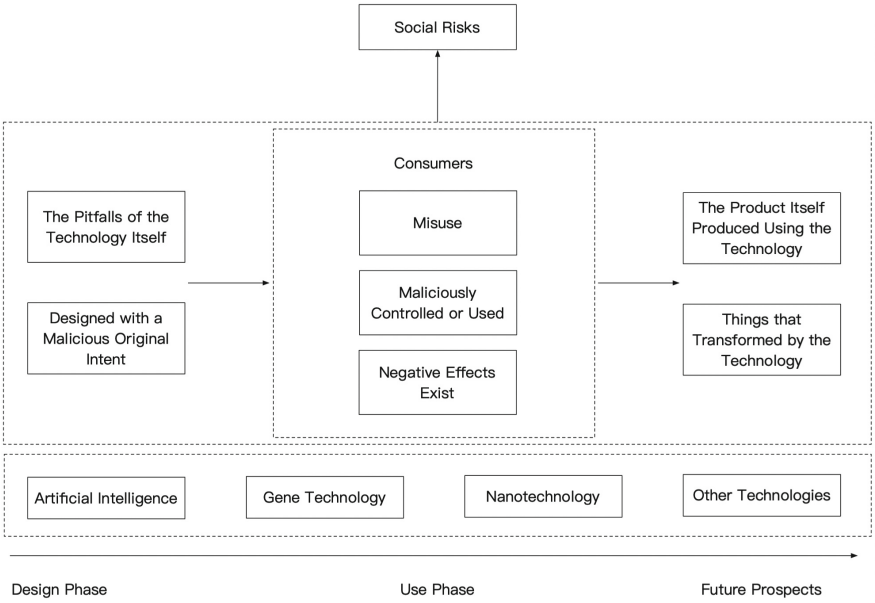

Fig. 5. Mechanisms by Which Technology Affects Social Risk.

regulation has lag and incompleteness, it is difficult to carry out prospective restraint, and there are also certain loopholes that cannot be completely covered, so it is necessary to constantly update the legal regulation, and play an active role in regulatory agencies, and constantly monitor the link of emerging technologies that may bring social risks, so as to control the social risks of emerging technologies at the national level. Secondly, at the enterprise level, especially the central enterprises involved in the national grid, they should actively fulfill their corporate social responsibility, adhere to corporate ethics, comprehensively examine and evaluate the social risks of applying various emerging technologies, continuously adhere to corporate values and principles, focus on the interests of corporate stakeholders, and reduce the possibility of malicious development at the R&D level. Third, in terms of scientific research institutions, we should continue to explore new technologies, study new technologies and new methods to reduce the hidden dangers of emerging technologies, continuously improve the theory and practice of emerging technologies, provide guidance for enterprise applications, and reduce the uncontrollability of future technological development. Fourth, from a network security perspective, it is important to adequately prevent external intrusions and, if they do occur, to use filing to reduce the negative impact on the grid system and thus reduce social risk.

6 Conclusion

This paper analyzed the main factors and countermeasures of social risk brought by the SG in China based on CiteSpace information visualization literature analysis software,

including author analysis, keyword co-occurrence analysis, and keyword clustering analysis, and classified all designed keywords into five categories: risk category, risk source or important antecedent, management tool or instrument, result or purpose, and related terms, and extracted keywords related to technology by classifying the risk source. The risk formation mechanism is analyzed and corresponding countermeasures are proposed for the emerging technologies associated with the SG. In general, Chinese scholars' research on social risk focuses on the impact of various social problems, emergencies, and emerging technologies on social risk. In the technology-specific section, scholars give different understandings, with some scholars positively viewing the turnaround of big data technology for social risk control and others cautiously observing the various risks that may be brought by artificial intelligence technology. In the section of social risk formation mechanisms, the impact path of emerging technologies on social risk is analyzed in the context of the SG, and corresponding countermeasures are proposed for different aspects. In future research, the current status of social risk research can be explored for other aspects of the SG, and the impact of other categories of emerging technologies involved in the SG on social risk can be extended to explore the impact mechanism of social problems or emergencies brought about by the SG on social risk, in order to expand the research related to social risk.

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