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The Characteristics and Systematic Optimization of Scientific and Technological Legal Liability

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Abstract: While technology brings convenience to human society, it also many risks. In risk society, the improvement of science and technology legal liability is of great significance for the legal governance of the science and technology, the construction of a science and technology legal system, the breakthrough of the traditional legal liability system, the construction of a strong science and technology country, and the development of science and technology standardization. Based on the analysis of the existing primary legal texts of science and technology, it can be seen that the current legal responsibility of science and technology is the integration of the traditional three kinds of legal responsibility, which is far from enough. In the current legal responsibility system of science and technology, administrative legal responsibility dominates and cannot deal with the science and technology risks and achieve its legal governance. This paper suggests changing the concept of administrative regulation of science and technology to private law autonomy in order to strengthen the protection of the rights of scientific research personnel. Meanwhile, for comprehensively strengthening the construction of the legal responsibility system for science and technology in the process of scientific and technological activities, this paper suggests the control strategies of technology standardization and patent licensing at every stage of scientific research and development, transformation and application of achievements to supplement and improve the legal responsibility of science and technology in risk society. This would achieve the fundamental value objective of adjusting science and technology activities possessed by science and technology law.

Key words: science and technology risk; science and technology law; legal liability; characteristics

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1 Introduction: Phenomenon, Problems, and Methods

1.1 The Phenomenon

With the development of new technologies such as artificial intelligence and gene editing, technology has brought convenience to human society, but it has also brought some new risks. For example, at the 18th China Hi-tech Achievement Fair in November 2016, a robot named "Xiao Pang" started moving without staff instructions and smashed the booth's glass, causing damage to some booths and eventually injuring passers-by. Another example is the gene-edited baby incident in November 2018, in which a Chinese scientist named He Jiankui announced the birth of China's first genetic baby. However, it was eventually verified that the activity

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was a state-banned human embryo gene-editing activity for reproductive purposes without regulatory approval. The occurrence of such incidents not only reveals the weakness of the ethical regulatory system for research and application of science and technology in China but also shows the weakness of the legal, regulatory system and risk control measures in the process of research and development of science and technology in China^[1]. The society of risks has placed strict requirements on scientific and technological work, which plays a vital role in promoting scientific and technological progress. Strengthening the legal governance of science and technology activities is crucial to addressing the risks posed by science and technology activities and reducing science and technology's adverse effects. Therefore, a sound system of science and technology legislation and legal liabilities is a prerequisite and an essential guarantee for realizing science and technology activities' legal governance.

1.2 The Problems

Although China has formed a relatively complete science and technology legal system, there are still many questions about the relationship between science and technology legal liability and traditional legal liability, as well as the specific ways of realizing science and technology legal liability. As science and technology law is an emerging cross-discipline, the analysis and interpretation of science and technology law legal liability, from a theoretical level, is a key issue.

Foreign scholars have focused on the interaction between science and technology and law. Lee Loevinge argues that the first and most significant contribution of technology to the law may be the art of writing, and that the most critical question in the relationship between law and science in the technological age is what kind of control should be exercised over science and technology^[2]. Kuldeep Singh shows the impact of science and technology on law and society from the dimension of new challenges of cyber security. He argues that the expanded concept of science and technology is dealing with beneficial innovations, but another is concerned with the dangerous relationship to cybersecurity and all other allies^[3]. In terms of how to control the risks arising from science and technology, John S. Applegate advocates the precautionary principle of risk, arguing that according to the precautionary principle, scientific uncertainty should be excluded as a reason for taking precautionary measures and that the burden of proof for the safety of biotechnology and its products should be on the producer of research and development to prove it^[4]. Regarding the nature of legal liability, H.L.A. Hart argues that legal liability is the penalty or compensation that the violator must pay by law^[5].

Domestic scholars mainly analyzed the background of China's science and technology legislation at that time and proposed to add a chapter of legal liability to the existing law. For example, Professors Chen Naiwei and Lü Hongbing proposed to add a section on legal liability to the *China's Science and Technology Progress Law* in 1991^[6]. Prof. Jiang Hongyi evaluated the contents of legal liability stipulated in the *China's Science and Technology Progress Law* in 1993^[7]. Professor Cheng Yongshun elaborated his views on the legal responsibilities stipulated in the *China's Science and Technology Progress Law* in 1994^[8]. Professor Wang Chunheng studied legal responsibility to appraise scientific and technological achievements in 1995^[9]. Prof. Ou Lin studied the legal liability stipulated in the *China's Scientific and Technological Achievements Promotion Law* in 1997^[10]. Prof. Shen Zhenhong studied the legal responsibilities stipulated in the *China's Science and Technology Progress Law* in 2008^[11]. These articles were published and mainly analyzed the background of China's science and technology legislation at that time and put forward some suggestions to add a chapter on legal liability to the existing law, however, the relationship between the legal liability of science and technology and other legal liabilities was not discussed in the existing literature.

In general, although there are many research results on science and technology law and legal liability by domestic and foreign scholars, the existing literature does not conduct detailed research on the relationship between science and technology legal liability and other legal liabilities. There is still a gap in particular research on the legal liability of science and technology. Therefore, scholars of science and technology law must strengthen the research on the legal liability of science and technology.

1.3 The Methods

Given this situation, this paper intends to use the textual analysis method to analyze the difference between the legal liability of science and technology and the traditional legal liability by taking the legal liability norms in the current basic legal system of science and technology as the research material. This paper explores the characteristics of science and technology legal responsibility by starting from the differences mentioned above. This paper puts forward some suggestions for shaping and improving the legal liability of science and technology, to provide an ideological basis for the legal governance of science and technology activities in risk society.

2 The Research Value of Legal Liability of Science and Technology

Science and technology promote the development and progress of human society and bring many hidden dangers. The life of law lies in implementation, and the effect of implementation depends on the scientific rationality and perfection of legal liability^[12]. Therefore, it is essential to strengthen the technical management of science and technology activities and establish a perfect legal liability system for science and technology in risk society. Simultaneously, it is conducive to realizing socio-legal governance and the construction of science and technology legal system. It is conducive to breaking through the traditional legal liability system, constructing a strong science and technology country, and ultimately to the development of science and technology standardization.

2.1 Meeting Demands for the Construction of Science and Technology Law System

Studying the legal liability of science and technology can help meet China's science and technology legal system construction needs. Science and technology jurisprudence is an interdisciplinary discipline. There exists in China formally a group of scientific and technological norms, constituted technological norms constituted by laws and regulations other than the basic legal system of science and technology^[13]. Among them, the basic legal system of science and technology is mainly composed by seven basic laws, which include the *China's Standardization Law*, *China's Science and Technology Progress Law*, *China's Scientific and Technological Achievements Promotion Law*, the *China's Science and Technology Popularization Law*, the *China's Patent Law*, the *China's Science and Technology Secrecy Provisions Law*. For science and technology law to mature, it is necessary to conduct a particular study of our science and technology law from the perspectives of its ontology, causes, operation, norms, and categories, and form a unified system based on the concept and values of law. As a part of legal norms, legal liability is an essential means to punish and correct violations. Science and technology legal liability is a kind of liability that people must bear for violating the relevant provisions of the science and technology law in their scientific and technological activities. Strengthening the study of legal liability of science and technology is conducive to promoting the exploration of the theory of legal norms of science and technology and meeting the science and technology law's practical operations. It also helps to clarify the normative measures and sanctions of science and technology, build a complete legal system of science and technology, and finally ensure the realization of the value objectives of science and technology activities adjusted by the science and technology law.

2.2 Breaking the Confinement of Traditional Legal Liability Theory System

The study of science and technology's legal liability helps break the traditional legal liability theory system's confinement. The essence of legal liability is to protect specific legal interests through a disciplinary mechanism. However, the contents of legal liability protected by different legal departments in different historical periods are diverse. Any discussion of legal liability without a specific legal system and background has no practical legal significance, and the study of scientific and technological legal liability is no exception. Generally speaking, the traditional legal liability system mainly contains three kinds of legal liability, which

includes civil legal liability, criminal legal liability and administrative legal liability. However, there is no clear conclusion in academic circles about the specific relationship between traditional legal liability and science and technology legal liability, whether science and technology legal liability is a collection of three kinds of traditional legal liability or there exists a relatively independent form of liability belonging to the science and technology law. Science and technology law is a law based on the requirements of adjusting the social relations formed in the process of scientific and technological activities, and its legal norms are comprehensive legal norms including civil legal norms, criminal legal norms and administrative legal norms and so on. Therefore, the science and technology law's liability subjects are characterized by diversity, including science and technology managers, technology users, and service intermediaries. The traditional legal liability system is based on the traditional industrial society. However, the modern risk society and the various legal relations and diversified subjects involved in scientific and technological activities have posed new challenges to the traditional legal liability system. In other words, the traditional legal liability system cannot effectively cope with the risks brought by the current technological society. Therefore, this paper will use the textual analysis method to conduct a comparative analysis of the differences between the legal liability of science and technology and the traditional legal liability, and explore the legal liability of science and technology and its characteristics, to realize the reflection and breakthrough of the traditional legal liability system.

2.3 Consolidating the Legal Basis for Building a Powerful Country with Science and Technology in the World

The study of the legal liability of science and technology can lay a solid foundation for achieving the strategic goal of a strong science and technology nation. The strategy of a strong science and technology country should adhere to the principle of sustainable development of science and technology. At the same time, while pursuing and enhancing innovation capability, the means should be applied to manage science and technology activities. On the one hand, science and technology governance is conducive to stimulating the innovative power of researchers and protecting scientific research achievements; on the other hand, it is important to improve the institutional mechanism of science and technology and provide a strong guarantee for the realization of innovation-driven development. In addition, it also helps to lay the legal foundation for the ultimate realization of the strategy of a strong science and technology nation. The governance of modern science and technology social cannot be separated from the support of a complete scientific and technological legal system. According to this, the science and technology law should not only play a positive role in promoting science and technology, but also effectively avoid the negative effects brought about by scientific and technological progress^[14]. Also, as an essential part of the legislative work, discussing the issue of legal liability from the overall framework and specific background of the legislation will help the regulation and realization of legal liability^[15]. What's more, in the context of the strategy of comprehensively following the rule of law and building a strong science and technology country, science and technology legislation urgently needs to make a positive response while intervening in social reality. Looking at the construction of science and technology legislation in China, with the introduction of basic laws such as the *China's Science and Technology Progress Law* and the *China's Scientific and Technological Achievements Promotion Law*, the legal environment to encourage scientific and technological innovation has been continuously improved. However, the shortcoming is that the current basic laws and regulations of science and technology mainly focus on encouraging scientific and technological research and development, and lack regulatory measures for illegal acts and negative impacts of science and technology. Therefore, exploring and improving the legal liability of science and technology and its characteristics are conducive to speeding up the formation of a legal and regulatory system for safeguarding and promoting science and technology innovation. At the same time, it helps to narrow the gap between China's science and technology legal system and advanced foreign countries, improve the level of the rule of law in the field of science and technology, and ultimately promote the realization of the goal of a world science and technology power through institutional and practical efforts.

2.4 Promoting the Standardization of Science and Technology

The study of the legal liability of science and technology can help promote the standardization of science and technology. Science and technology activities must be carried out in strict accordance with the relevant provisions of the national standardization policy in risk society. Mandatory standards must be observed, while recommended standards are encouraged to be used by enterprises. At the same time, enterprises should disclose the number and names of mandatory standards, recommended standards, group standards and enterprise standards they have adopted. Therefore, it is necessary to study the legal responsibilities involved in scientific and technological activities, which is conducive to the supervision and reasonable regulation of scientific and technological activities in China. Besides, it is of great significance to promote scientific and technological progress and achieve scientific and technological standardization.

3 Research Approach: Three Thinking Transformations for the Research of Legal Liability of Science and Technology

Legal liability is an integral part of legal norms. It is of great significance to analyze the status of sectoral law in our legal system and clarify the relationship between the liability of legal subjects and specific legal responsibilities, legal norms and legal responsibilities, for the development of science and technology law and the study of liability of science and technology law. At the same time, this is also the key and challenging issue that needs to be clarified in the process of exploring the legal liability of science and technology. Therefore, the research of the legal liability of science and technology and its attribute needs to change thinking to solve the doubts above.

3.1 Defining the Orientation of the Science and Technology Law

To study the legal liability of science and technology, we must first clarify the basic position of science and technology law in the legal system. There are many voices in academia, but no consensus has been reached on the positioning of sectoral laws in science and technology law. In reality, scholars mainly judge the status of science and technology law from the perspective of rights and obligations, and five different theories have been formed. The first theory is that the science and technology law is a branch of administrative law, which is composed of a large number of administrative regulations of scientific and technological activities in administrative law, and its legislative purpose is to promote the development and progress of social economy and serve the social and economic construction. The second theory is that the science and technology law is a branch of economic law because its legislative purpose is to promote the development and progress of social economy and serve the social and economic construction. The third theory holds that the social relations regulated by the science and technology law include many aspects. Accordingly, the science and technology law contains many legal norms, such as civil, criminal, and administrative. Therefore, it advocates that the science and technology law is not a specific sectoral law, but a comprehensive law. The fourth theory holds that the science and technology law is a general term for the legal norms that regulate the social relations of science and technology and has developed into an independent legal sector, which is highly evaluated by most science and technology jurists in China^[16-18]. The fifth theory holds that the law of science and technology is a special sectoral law whose purpose is to develop advanced productive forces and adjust the relationship between society and nature^[19]. The science and technology law includes civil rights and administrative and criminal rights, and the rights and obligations relations formed by its adjustment are characterized by pluralism. Therefore, the study of the sectoral law status of the science and technology law should not be limited to the perspective of rights and obligations relations, but should change the way of thinking. From the conceptual basis, the strategic idea of building a strong and innovative country in science and technology provides a rich cultural awareness and ideas for the legal department status of science and technology law. From the perspective of practical needs, the problems of science and technology abuse, science and technology risk, and science and technology misuse need to be solved. They are the necessary conditions for science and technology

law to become an independent legal department. From the viewpoint of legislation, the increasingly improved science and technology legislative system provides the quantitative accumulation for the branch of science and technology law^[20]. Given the multiple rights and obligations contained in science and technology law and the conceptual basis, practical needs, legislative status and legal norms of science and technology law, it can be considered that science and technology law in China is an independent legal sector with special knowledge. Science and technology law has cross-relations with traditional legal departments in China, such as civil law, criminal law and administrative law.

3.2 Clarifying the Relationship between Legal Liability of Science and Technology and Liability of the Subject of the Science and Technology Law

The study of the legal liability of science and technology should clarify the difference and connection between the legal liability of science and technology and the legal liability of science and technology subjects. Since the legal subject is a kind of role subject, the relationship between the legal subject and the legal liability undertaken is one-to-many rather than one-to-one. A legal subject may bear multiple legal responsibilities for violating multiple legal provisions. However, when it comes to a specific law, the legal liability as one of its legal norms must be the legal consequence to be borne by the legal subject for violating the mandatory or prohibitive norms stipulated in the law. Thus, there is no one-to-one correspondence between the legal liability of a legal subject and the legal liability of a certain law^[21]. For any member of society, factors such as 'violation of the law' and 'risk' motivate them to become legal liability subjects. Generally speaking, the legal subjects of the science and technology law include managers of scientific and technological activities, implementers of scientific and technological activities, and scientific and technological intermediary service agencies. While they assume the rights and obligations under the science and technology law, they may also become subjects of law in other legal sectors. Therefore, the managers, users and intermediaries of science and technology activities may touch multiple laws in the process of science and technology activities and are likely to bear multiple legal responsibilities such as criminal liability and civil liability. The legal liability of science and technology discussed in this paper refers to the part of the necessary legal system of science and technology that is different from the traditional legal liability and belongs to the science and technology law by analyzing the critical legal system of science and technology. Therefore, it is necessary to clarify the difference and relationship between the liability of science and technology subjects and the legal liability of science and technology, and take the primary legal system of science and technology in China as a breakthrough to explore the legal liability of science and technology and its characteristics.

3.3 Distinguishing the Differences between Legal Norm and Legal Liability

The study of the legal liability of science and technology should distinguish the difference between legal norms and legal liability. From the point of view of legal norms, the Science and Technology Law is a collection of all legal norms used to adjust the rights and obligations formed in scientific and technological activities. The social relations of science and technology regulated by the law involve a wide range of complex comprehensive social relations, which contain the social relations formed by the state, enterprises and individuals in a series of activities in promoting the development of science and technology, engaging in scientific research and invention creation, as well as the promotion and application of science and technology^[22]. Therefore, it is difficult to say that a single law can be used to regulate the social relations of science and technology. Moreover, as far as the fundamental law of science and technology established to regulate the social relations of science and technology is concerned, the legal norms contained in the law of science and technology are not all single; it is a collection of laws that regulate the activities of science and technology in the current legal system. There can be civil legal norms, administrative legal norms and criminal legal norms, so the legal norms of the basic law of science and technology can include civil liability, administrative liability and criminal liability at the same time. To this end, we should identify the legal norms used to punish violations from the introductory legal provisions of science and technology, and conduct a comparative analysis of the forms

of legal liability they provide with the traditional forms of legal liability, and finally make specific arguments about the legal liability of science and technology and its characteristics.

4 The Specific Elaboration of Legal Liability of Science and Technology in the Basic Legal Liability System of Science and Technology

Legal liability is associated with legal obligations, and a person is legally liable for legal sanctions when he performs an act contrary to it^[23]. Legal liability is based on the fact that the legal subject has committed an act contrary to his obligations. Therefore, to explore the legal liability of science and technology and its properties, it is necessary to analyze the fundamental law of science and technology in our country regarding both illegal acts and forms of liability.

4.1 The Form of Legal Behavior Stipulated by the Basic Legal System of Science and Technology

Based on the analysis of China's current basic legal system of science and technology, according to the chronological order of science and technology activities, the current basic legal system of science and technology violations can be divided into six areas.

First, the illegal acts in the process of scientific and technological research and development. The study of science and technology is the starting point for generating new science and technology. It requires both the support of Natural Science Foundation and the use of specific instruments and equipment. As such, it plays a vital role in enhancing the management of science and technology funds and resources. At the same time, scientific research personnel should enjoy the freedom of scientific research; any unit or individual who deprives or infringes upon this right should be punished by law. In this regard, Article 69 of *China's Science and Technology Progress Law* specifically stipulates the illegal acts of abusing power, restricting and suppressing scientific and technological research and development activities. Also, since financial funds play an essential role in promoting research and development activities in science and technology, science and technology management and other related departments should strengthen the supervision of financial funds, clarify whether the declaration of financial funds complies with legal regulations, specify the purpose of the funds and the objects of use, and prevent the occurrence of misrepresentation, embezzlement and misappropriation. In this regard, Article 67 of *China's Science and Technology Progress Law* stipulates the illegal acts such as misrepresentation, fraud, embezzlement, misappropriation and retention of financial funds for scientific and technological progress. The rights enjoyed by scientific researchers, and the obligations undertaken by them are relative. While enjoying financial support, scientific research institutions and their scientific researchers also assume the legal obligation to use and share financial funds and state-owned capital to purchase large scientific instruments and equipment and other scientific and technological resources. In this regard, Article 68 of *China's Science and Technology Progress Law* provides for the violation of the law on the use of financial funds and the violation of the obligation to share scientific and technological resources. Also, scientific and technological activities contain activities to explore objective truth, which should follow the principle of authenticity and carry out specific activities under the articles of association. Article 70 of *China's Science and Technology Progress Law* stipulates the illegal acts of scientific research institutions and their researchers in making false behaviors in scientific and technological activities.

Second, the illegal acts in the process of science and technology management. The development, promotion and application of science and technology, and the declaration and collection of science and technology awards, are inseparable from the supervision and management of the relevant departments. Any abuse of power, negligence, favoritism, will negatively impact scientific and technological activities, and seriously hinder the development and progress of science and technology in China. Article 49 of *China's Science and Technology Achievement Promotion Law*, Article 72 of *China's Science and Technology Progress Law*, Article 33 of *China's Science and Technology Popularization Law*, and Articles 34 to 35 of *China's Science and Technology Secrecy Provisions Law* make specific provisions for the illegal behaviors of the science and technology administrative departments and their staff.

Third, the illegal acts in the process of transformation of scientific and technological achievements. The research of science and technology cannot stay only at the theoretical level. Only when the final research and development results are transformed into real productivity that promotes the development of science and technology, promotes the increase of new products and the improvement of production technology, and effectively improves the economic efficiency of enterprises, can we promote scientific and technological progress and social and economic development. There are many subjects in the process of transformation of scientific and technological achievements, including not only research and development personnel, science and technology service institutions and their staff, science and technology intermediaries and their staff, and science and technology administrative departments and other related departments and their staff. Furthermore, in the process of the transformation of scientific and technological achievements, the principle of fairness and honesty should be followed. In view of this, Article 47 of *China's Science and Technology Achievements Promotion Law* clarifies the violation of this principle. What's more, science and technology service agencies and their staffs are responsible for providing information on the transformation of scientific and technological achievements, experimental testing and evaluation of scientific and technological achievements, etc. Article 49 of *China's Science and Technology Achievements Promotion Law* has specific provisions on the illegal acts of providing false information by science and technology service agencies and their staffs. However, although the scientific and technological research and development personnel have a rich professional ability, there are still some obstacles for them in the access and communication of market information. As a bridge of information communication between scientific and technological achievements research and development and the market, science and technology intermediaries and their staffs play an indispensable role in promoting the transformation of scientific and technological achievements. Besides, the bearers of science and technology projects established with financial funds also bear the obligation to submit science and technology reports, remit science and technology results and related intellectual property information. Accordingly, Article 46 of *China's Science and Technology Achievements Promotion Law* provides detailed provisions on the violations of the above obligations.

Fourth, the illegal acts in the process of scientific and technological application. The ultimate purpose of scientific and technological research and development is to transform the research results into practice. Only when science and technology are applied to the actual production of society and produces specific products, can it play its practical utility as the first productivity. In addition, in the development, improvement and production of new products in enterprises, the requirements of standardization should also be followed. Corresponding, Articles 36 to 39 and Article 43 of *China's Standardization Law* clearly stipulate the illegal acts that do not strictly follow the standards. Also, Article 63 of *China's Patent Law* stipulates the acts of infringing the legitimate rights and interests of the patentee and counterfeiting others' patents, in order to encourage the enthusiasm of scientific and technological research and development personnel, promotes the application of inventions and creations, and ultimately protects the legitimate rights and interests of the patentee.

Fifth, the illegal acts in the process of science and technology confidentiality. In science and technology, some specific matters involving national security and human interests will inevitably be involved. To achieve the protection of state secrets and commercial secrets, Articles 26 to 40 of *China's Science and Technology Confidentiality Provisions* make detailed provisions for not violating confidentiality provisions in the process of science and technology activities. As a bridge for the transformation of scientific and technological achievements, intermediaries and their scientific and technological personnel shall bear the obligation of confidentiality to the parties' state secrets or commercial secrets. In this regard, Article 48 of *China's Science and Technology Achievement Promotion Law* stipulate the violations of confidentiality obligations by service agencies and their staffs.

Sixth, the illegal acts in the process of popularization of science and technology. The ultimate goal of scientific and technological research is to improve social and economic benefits through the broad application of science and technology, rather than to stay theoretical. The popularization of science and technology is an essential part of scientific and technological activities. To standardize the process of popularization of science

and technology, the development of strict penalties for violations of the law and the promotion of science and technology application have an essential role. In this regard, Article 30 to Article 32 of *China's Popularization of Science and Technology Law* stipulate the use of science and technology in the name of popularization, disrupting the social order, damaging public interests and other illegal acts. Besides, there are also detailed provisions on the embezzlement, misappropriation, retention, misappropriation of financial funds for science popularization, the conversion of science popularization venues for other uses, the disruption of the order of science popularization venues and other illegal acts. Also, there are explicit provisions on state employee's illegal acts if they do not perform their duties in science popularization.

4.2 The Form of Legal Liability Stipulated by the Basic Legal System of Science and Technology

For the violations involved in scientific and technological activities, China's existing basic legal system of science and technology set up a particular chapter on its legal liability. According to whether there are explicit legal liability provisions, the legal liability in the primary system of science and technology can be divided into specific legal liability and abstract legal liability.

On the one hand, there is a specific legal liability under the primary legal system of science and technology. The basic legal system of science and technology includes seven laws. Through the analysis of the specific legal system, it can be seen that the basic legal system of science and technology provides for specific legal liability in only 14 ways, as follows. Fine, criticize and educate, order to refund within a certain period, order to stop infringement, restore the original state or compensate for damages, order to correct, recover financial funds, recover illegal income, announce its illegal behavior to the society, prohibit it from applying for national science and technology fund projects and national science and technology plan projects within a certain period, revoke the award and recover the prize, inform and criticize, suspend the recommended qualification, cancel the recommended qualification, cancel the award and honorary title.

On the other hand, there is the abstract legal liability stipulated in the basic legal system of science and technology. Through the statistics of the legal provisions of the legal liability part of the necessary legal system of science and technology in China, it can be seen that there are only four cases of violations of the provisions, which do not specify the specific sanctions but choose to be expressed in terms of general or legal liability under other laws. Specifically, the abstract legal responsibilities are the following: administrative penalties, civil liability and criminal liability.

5 The Characteristics of Legal Liability of Science and Technology

Science and technology legal liability is the second right and obligation relationship formed between specific subjects of science and technology law when the first right and obligation provided for and protected by the basic law of science and technology is violated, which must be realized to guarantee the realization of this relationship. To study the properties of the science and technology's legal liability, the first rights and obligations stipulated by the primary legal system of science and technology should be compared with the second rights and obligations. It is necessary to analyze whether the legal liability stipulated by the law provides detailed and comprehensive provisions on the violation of the first right obligation, whether specific forms of liability are stipulated for the violation of the law, and whether there are particular paths to the realization of legal liability. The examination of the critical legal system of science and technology in risk society shows that legal liability has the following characteristics.

Firstly, the form of illegal behavior is relatively comprehensive, while the prevention of scientific and technological risk is insufficient. Through the analysis of the basic legal system of science and technology it can be seen that China's fundamental law of science and technology research and development, promotion and application, results protection, transformation and application of the process of possible violations of the law has made more detailed provisions of the violation of the law with the characteristics of complexity. However, its shortcomings lie in the lack of consistency between illegal acts and obligatory norms and prohibitive norms in the first rights and obligations relationship. For example, according to Article 29 of *China's Science*

and *Technology Progress Law*, scientific research and development activities that endanger national security, harm public interests and cause personal injury, and violate professional ethics are prohibited by law. Article 3 of *China's Science and Technology Achievements Promotion Law* requires the protection of state and social interests in transforming scientific and technological achievements. However, the two laws above do not stipulate the legal liability for the violation of such obligatory norms and prohibited norms. In addition, Article 19 of *China's Science and Technology Achievements Promotion Law* stipulates that the person in charge of scientific and technological achievements shall neither hinder the transformation of scientific and technological achievements nor appropriate the relevant scientific and technological achievements and information for his own use, but there are no corresponding penalties in the section on legal liability. In addition, the existing basic law of science and technology in China lacks comprehensive prevention of possible risks in science and technology activities.

Secondly, there are various forms of legal liability, while the legal liability for scientific and technological risks is missing. Through the above analysis of China's basic legal system of science and technology, as well as the comparison of its provisions of specific forms of legal liability and traditional legal liability, it can be seen that there are a variety of forms of liability in China's basic legal system of science and technology. This includes not only administrative punishment, administrative sanctions, orders to correct, orders to return, fines and other forms of administrative legal liability, but also includes the cessation of damage, bearing of losses and other forms of civil liability. It also contains some necessary provisions, such as criminal liability for acts that constitute crimes in the process of scientific and technological activities. Some specific forms of legal responsibilities prohibit people from applying for the national science and technology fund projects and national science and technology program projects for a certain period. However, by comparing the legal responsibilities stipulated in the basic law of science and technology with the first rights and obligations, it can be seen that the legal responsibilities stipulated in the basic law of science and technology are not comprehensive. Not only can they not correspond to the obligatory norms and prohibitions one by one, but also they lack specific provisions on the legal responsibilities of scientific and technological risks in the process of scientific and technological research and development, evaluation, transformation and application. In particular, there is no clear definition of what kind of behavior belongs to the use of standards to hinder the free flow of goods and services, such as the exclusion and restriction of market competition, and it is not clear what kind of legal liability such behavior should bear.

Thirdly, the realization path of legal liability is not enough, and the effectiveness of science and technology law cannot be given full play. Combined with the analysis of the violations and specific forms of liability involved in scientific and technological research and development, popularization and application and results protection in the basic legal system of science and technology, it can be seen that the legal liability stipulated in the basic legal system of science and technology in China is reflected in the synthesis of three traditional legal responsibilities. Nevertheless, from the perspective of the realization path of legal liability, except for civil and criminal liability, the realization of other legal responsibilities almost all rely on administrative organs to use administrative means to sanction. At the same time, there is no unique procedural guarantee mechanism for science and technology legal liability. Also, the existing basic laws and regulations of science and technology focus on the setting of state liability, while the rights of researchers lack protection. The lack of procedural provisions between researchers' rights and the government's responsibilities makes it difficult to realize the legal liability of science and technology and play the science and technology law's role.

To sum up, although the primary legal system of science and technology in China provides for relatively perfect violations and specific forms of liability, the realization of legal liability still needs to be carried out through the path of administrative punishment, and there is no corresponding procedural safeguard mechanism. It can be seen that the status quo of the legal liability of science and technology makes the essential attributes of the science and technology law different from other laws cannot be given full play.

6 Proposals for Perfection of Legal Liability of Science and Technology

In recent years, the rise of artificial intelligence, gene editing and other technologies has brought significant challenges to the existing legal system. As there are many gaps in the legal regulation of technological risks in the current legal system, discussions on the impact of technology on modern law have been triggered in the legal community, especially in artificial intelligence. Some scholars believe that the modern legal system should be updated from civil law such as personality rights system, intellectual property protection, tort liability determination and liability^[24]. Some scholars claim that an intelligent robot should be a qualified legal subject^[25]. Some scholars believe that an intelligent robot has criminal subjects' status and will be criminally liable if it commit crimes^[26]. Also, most scholars advocate regulating the legal risks brought by AI from the perspective of criminal law and civil law. However, the above discussion cannot be separated from one core question: who should bear the legal liability for technology's risks? What kind of legal liability should be assumed? Under the rule of law, a society should respond to the changing society with unchanging laws^[27]. The emergence of new technologies should not lead to extensive modifications of existing laws and undermine the essential stability and fixity of existing laws, and the same should be valid for the legal governance of science and technology activities. It is the mission of science and technology law to strengthen the governance of science and technology activities, especially to strengthen the regulation of science and technology risks, which is also the essential attribute of science and technology law different from other laws. Therefore, this paper proposes taking the fundamental law of science and technology as the entry point to specify and shape the legal responsibilities of science and technology risks, to highlight the essential attributes of the science and technology law that are different from other laws.

6.1 Basic Principles: Shaping the Legal Concept of Risk Society and Adhering to the Standardization of Science and Technology

Science and technology risk is a manufactured risk^[28]. In order to avoid it, we should make a breakthrough in science and technology legislation. Current science and technology legislation is mainly aimed at promoting the progress of science and technology, improving social productivity and economic efficiency, and ultimately focusing on pursuing economic benefits of science and technology while neglecting the control of science and technology risks. The science and technology law, as the central governance instrument of science and technology should focus on the ex-ante prevention of science and technology risks rather than ex-post relief to reduce the adverse effects of science and technology. In modern society, with the rapid development of science and technology, strategies such as technology specialization, patent standardization and standard internationalization have become the consensus of international science and technology development. Strengthening the combination of technology and standards is a crucial way to promote science and technology in China. The legislative purpose of *China's Standardization Law* is to improve product quality, promote scientific and technological progress, and improve the level of economic and social development, which coincides with the development of science and technology needs. In order to improve legal liability of science and technology, it is necessary to change the legislative concept, adhere to the principle of science and technology standardization, and bring the awareness of science and technology standardization development and science and technology risk prevention into the science and technology legislation. It is also essential to clarify the legal liability of science and technology risks and their responsible subjects and improve the legal system of science and technology risks to promote the construction of the legislative system of science and technology risk prevention.

6.2 Basic Goals: Strengthening the Construction of Legal liability for Science and Technology and Improving the Effect of the Science and Technology Law

In the context of globalization, the adjustment of science and technology activities cannot be limited to science and technology policies only but should make use of science and technology laws and give full play to

its mediation function. However, there is no relevant provision on the legal liability of science and technology risks in the current legal system. The lack of legal liability of science and technology risks is related to the legislative system. As the current basic legal system of science and technology in China focuses on the affirmation, encouragement and advocacy of science and technology in adjusting science and technology activities, the national compulsory and universal characteristics of science and technology law are neglected^[29]. The legal responsibilities stipulated in the current basic legal system of science and technology mainly focus on promoting scientific and technological progress, protecting the scientific researchers' freedom of scientific research and intellectual property rights. However, there are no explicit provisions on the liability and scope of responsibility arising from the risks of selecting scientific and technological research and development projects, the evaluation of scientific and technological achievements, and the transformation and application of scientific and technological achievements. The legal prevention of science and technology risks should be the essential attribute of science and technology legal liability, different from the traditional legal liability. To maximize the positive effect of science and technology and the practical effect of science and technology law, the science and technology legal liability should be shaped and supplemented to improve the effective prevention of science and technology risks in China.

6.3 Main Strategies: Promoting the Standardization of Technology and Patent Licensing and Strengthening the Process Control of Science and Technology

The risk of scientific and technological is uncertain. There are risks within the science and technology system, as well as risks in the whole process of science and technology activities in trial production and construction, and more risks may appear in the actual application stage of science and technology results^[30]. Therefore, to control the risk of science and technology, all stages of science and technology activities should be carried out in strict accordance with the requirements of standardization, and the production of products should meet the technical requirements of standard disclosure. Then, by combining scientific and technological research and development with the transformation and application of scientific and technological achievements, a diversified and interactive legal prevention mechanism is established for scientific and technological risks at all stages of scientific and technological activities that sets the legal liability subjects and specific penalties for scientific and technological risks in the process of the scientific and technological project application, research and development, transformation of achievements and application. More importantly, a clear distinction should be made between the legal responsibilities of science and technology among science and technology research and development personnel, science and technology service providers, producers and users of science and technology products to achieve co-regulation of science and technology risks. Should technical standards involving others' patents be required in the process of science and technology research and development, researchers must negotiate in good faith with the patentee of the standard to obtain a license to use the patent and pay a reasonable license fee for this purpose in accordance with the principle of 'fairness, reasonableness and non-discrimination'. This would prevent the interests of the patentees of basic standards from being damaged and prevent the phenomenon of 'anti-patent hijacking' from occurring, *China's Patent Law* should specify the infringement standards under specific circumstances. Simultaneously, to prevent the phenomenon of patent hijacking, *China's Standardization Law* should make explicit provisions on the use of standards to prevent the free flow of goods and services and restrict market competition, to strengthen the process control of scientific and technological activities.

6.4 Specific Measures: Controlling the Risk of Science and Technology and Establishing Clear Legal Liability

The legal regulation of science and technology risks should combine technology research and development with technology application in terms of technology control, and set a transparent legal liability system for each science and technology stage from research to application.

First, to strengthen the review of scientific research projects, provide for strict legal liability for scientific

and technological research and development projects in the application phase, and strictly prohibit research and development activities that violate science and technology and threaten the peaceful order of humankind, such as the harmonious coexistence of human and nature. Institutions and individuals who violate the regulations on the approval of scientific research projects should be strictly held legally responsible and prohibited from carrying out relevant scientific research activities for a certain period.

Second, in science and technology research and development, a strict monitoring mechanism should be introduced to strengthen the supervision and management of the process of science and technology research and development. Moreover, the units or individuals who violate the fundamental laws of science and technology research and development as well as science and technology research and development objects to continue their research activities should be strictly held legally responsible. It is necessary to make additional provisions on the legal liability of the standard implementer for infringement of standard-essential patents without a license and to clarify the legal liability of the standard-essential patent owner who abuses injunctive relief to refuse a license or implements a license at an unfairly high price to exclude or restrict market competition.

Third, in the transformation of scientific and technological achievements, strict access conditions for transforming scientific and technological achievements. Scientific and technical personnel must provide a detailed report on the transformation of scientific and technological achievements. It is also forbidden to use scientific and technological achievements for subsequent experiments and development activities that endanger the personal safety and public social interests. Scientific and technological personnel must provide a detailed report on the transformation of scientific and technological achievements. In addition, it is prohibited to use scientific and technological achievements for subsequent testing and development activities that risk endangering personal safety and public interest of society.

Finally, in the practical application of scientific and technological achievements, a strict negative list of scientific and technological achievements should be established to strictly prohibit scientific and technological achievements in specific fields and strict legal responsibilities. Science and technology administrative departments and other relevant departments should increase the punishment for illegal units or individuals and require them to bear the corresponding legal liability.

7 Conclusions

In the future, an effective solution to the potential risks posed by science and technology is to address rather than avoid them actively. The risks that may arise from managing, distributing and preventing science and technology activities are the value objectives of science and technology law, the essential attributes that make science and technology law different from traditional law. In order to promote the legal prevention of science and technology risks, it is recommended to strengthen the shaping and improvement of the legal liability of science and technology, adopt the technology control strategy of technology standardization and patent licensing, and realize the process supervision of science and technology. Strict restriction mechanisms, prohibition mechanisms and punishment mechanisms in the research and development, transformation, application and promotion of science and technology, and to clarify the accountability system to achieve adequate control of science and technology risks should be established, so that science and technology and law can complement each other in the process of technology standardization and eventually provide a mirror for the reform of the legal system of science and technology. However, the law alone is not enough to solve all problems. It is impossible to altogether avoid the risks of science and technology by the legal system alone in risk society. It is necessary to also strengthen the construction of social liability ethics and build a comprehensive governance mechanism of science and technology, ethics and legal system in the whole society, to avoid the risks brought by science and technology innovation activities and maximize the positive effects of science and technology.

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科技法律责任的特性与制度优化

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摘要:科学技术在为人类社会带来便利的同时也带来了许多科技风险。在风险社会中完善的科技法律责任对科技社会法律治理、科技法律体系化建设、传统法律责任体系突破、科技强国建设以及科学技术标准化发展都具有重要意义。通过对中国现有主要科技基本法律文本的分析,可以看出中国现行科技法律责任体现为三大传统法律责任的综合,且其中行政法律责任占据主导地位。风险社会,行政法律责任主导的科技法律责任制度并不足以有效应对科学技术活动过程中产生的科技风险,致使无法实现科技活动的有效法律治理。为此,建议转变传统的行政法规制的科技立法理念,引入私法自治理念,加强科研人员权利保障。与此同时,为全面促进科学技术活动中的科技法律责任制度建设,建议在科技研发、成果转化以及成果应用等各个阶段严格遵循技术标准化和专利许可的控制策略,以对风险社会中的科技法律责任进行补充和完善,从而实现科技法所具有的调整科技活动的根本价值目标。

关键词:科技风险;科技法律;法律责任;特性