

Identification of Tort Liability in Human-Machine Collaboration

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Abstract. Human-machine collaboration deeply empowers industrial upgrading and innovates social governance models, but it also brings complex challenges in the identification of tort liability. Practical factors in human-machine collaboration, such as algorithmic opacity, diverse participating subjects, vague tort causal chains, and difficulties in determining subjective faults, pose fundamental challenges to the application of the traditional tort liability system. At present, China mainly handles such disputes based on the *Civil Code* and relevant supporting rules, but there are still prominent problems in practice, including vague definition of liability subjects, unclear imputation principles, great difficulty for parties in adducing evidence, and imperfect rights relief channels. Based on ethical norm construction and real social scenarios, this paper proposes to build a stepped obligation allocation system based on risk levels; improve evidence rules and litigation procedures by relying on technical means, and promote a compliance system that integrates legal requirements with technical standards; and establish a diversified risk sharing mechanism and socialized relief paths at the same time, so as to build a tort liability system adaptable to the development trend of human-machine collaboration, and achieve a dynamic balance between promoting technological innovation and protecting civil rights and interests.

Keywords: human-machine collaboration, identification of tort liability, risk classification, social context perspective, multi-stakeholder governance

1. Introduction

With its advantages of empowerment, innovation and inclusiveness, human-machine collaboration has become an important means to promote industrial upgrading and improve the efficiency of social governance [1]. At present, this model has been widely used in manufacturing, medical and health care, transportation and other fields in China. This collaboration mode can greatly improve efficiency, but at the same time, the complexity and dynamic characteristics of its technology have brought new tort risks, which not only give rise to various jurisprudential crises, but also pose a new test to the existing legal liability framework. Professor Li Jingbao profoundly expounded the impact of artificial intelligence technology on traditional jurisprudence, arguing that it has shaken the foundation of liability imputation centered on human behavior, and the traditional tort liability system is facing challenges [2]. At the theoretical level, the academic community mostly studies the identification of tort liability in human-machine collaboration from the perspectives of legal

imputation and technical governance, but lacks a systematic discussion on ethical construction and social context. The governance nature of human-machine collaboration at the legal level determines that its supervision direction is a pre-emptive, dynamic and diversified tort liability identification model for risk prevention and control and rights protection. Its implementation requires continuous improvement of the tort liability system to realize the legal guidance of human-machine collaboration [3]. The full-life-cycle governance framework proposed by Huang Wei et al. emphasizes the importance of pre-incident risk prevention and control and in-incident dynamic supervision, which is consistent with the pre-emptive, dynamic and diversified liability identification model advocated in this paper [4]. Therefore, constructing a corresponding rule system and liability framework has unique advantages for realizing the modernization of the national governance system and governance capacity.

At the national policy level, the importance of legal regulation of artificial intelligence has gradually emerged. In 2023, the Cyberspace Administration of China promulgated the *Interim Measures for the Administration of Generative Artificial Intelligence Services* (hereinafter referred to as the *Interim Measures*), requiring the promotion of technological development and governance, and the strengthening of service standardization and supervision and management [5]. In 2025, the Cyberspace Administration of China and other departments jointly issued the *Measures for the Identification of Artificial Intelligence Generated and Synthesized Content* (hereinafter referred to as the *Identification Measures*), which remind users of the source of content through "explicit identification" and help trace the origin and supervision through "implicit identification", and clarify the responsibilities of service providers, platforms and users [6]. It aims to effectively respond to challenges such as false information and infringement caused by AI-generated content, so as to build a more credible and healthy AI application ecosystem. At the level of local practice, various regions have carried out judicial practices involving artificial intelligence, but there are still many problems such as difficulties in ascertaining technical facts, imperfect platform judgment mechanisms, and difficulties in dividing the responsibilities of multiple subjects. Professor Zhang Xin systematically analyzed the challenges brought by generative artificial intelligence to algorithm governance, and pointed out that platform judgment mechanisms and the division of responsibilities of multiple subjects are difficult points in current practice [7]. At present, China has not yet issued a unified legislation specifically targeting tort liability in human-machine collaboration. The identification of its liability mainly relies on the existing legal framework such as the *Civil Code*, relevant administrative regulations and exploratory cases of local judicial practice, and is committed to dynamic and diversified liability allocation according to specific application scenarios [8].

Therefore, this paper aims to examine the problems of the tort liability system in human-machine collaboration and put forward targeted improvement ideas, give play to the normative and guiding role of the legal system in the identification of tort liability for human-machine collaboration, and promote the coordinated development of the tort liability system and the human-machine collaboration model.

2. General theories of tort liability identification in human-machine collaboration

2.1. Basic understanding of tort liability identification in human-machine collaboration

In the scenario of human-machine collaboration, the current tort liability system faces many difficulties in the identification of tort liability, and its core challenges lie in the algorithmic black box, diversity of subjects, complexity of causality and difficulty in fault identification [9]. To solve the above problems, the mainstream ideology of the academic community and judicial practice at

present is to allocate liability based on scenarios. Sun Weiyu pointed out through law and economics analysis that scenario-based liability allocation is an effective path to balance rights protection and freedom of conduct [10]. Dr. Xia Qingfeng proposed the "balance test" model for tort liability of autonomous AI, which also reflects the idea of scenario-based analysis [11]. Scenarios are summarized into high-risk scenarios and low-risk scenarios; and the liability subjects are classified into three categories from the traditional dual-subject structure, and a diversified imputation system is applied. For the difficult problem of proving causality, the academic community tends to adopt "inversion of the burden of proof" or "presumption of causality", that is, once damage occurs, it is presumed that the participation of artificial intelligence is causally related to the damage, and developers, producers and other parties with technical advantages are required to prove that they are not at fault or that the technology is not defective. When discussing the boundary of platform intellectual property tort liability, Huang Yuye and Bai Yiyang also emphasized the importance of multi-stakeholder governance [12]. On the whole, it always revolves around the value orientation of balancing rights protection and freedom of conduct, presenting a tort liability identification path based on the existing legal framework, with scenario-based analysis as the core and multi-stakeholder governance as the direction.

The basic understanding of the identification of tort liability in human-machine collaboration in the academic community has gradually shifted from "investigating fault" to "allocating risk". Its purpose is no longer simple imputation, but to encourage the party best able to prevent risks to take actions and fulfill their duty of care through reasonable institutional design, and to ensure that victims can obtain effective relief when damage occurs. At the same time, it should not excessively restrain technological innovation and promote the healthy development of human-machine collaboration. This view is consistent with the risk control theory and the principle of "least cost avoider" in law and economics [10].

2.2. Basic principles of tort liability identification in human-machine collaboration

The identification of tort liability in the scenario of human-machine collaboration is mainly to coordinate the protection of human rights in technological innovation and technology application scenarios. For the exertion of artificial intelligence autonomy, the risks derived in this process need to be qualified and refined to guide the direction of rule application. First, the principle of risk control-interest balance. This principle is the basic logic of liability allocation under human-machine collaboration, that is, corresponding duty of care and liability scope should be set for those who have the ability to foresee risks, control risks and benefit from technological achievements. Second, the principle of scenario-based differentiation. Human-machine collaboration scenarios are changeable, complex and diverse, and the risks brought by different scenarios are quite different. Typified regulation should be carried out according to different risk levels, human intervention degree and technological maturity. Third, the principle of multi-stakeholder governance and liability sharing. Human-machine collaboration scenarios involve various types of participating subjects, and liability is no longer only attributed to one person or one group of people. The liability scope and burden should be shared by multiple participating subjects according to factors such as risk damage and fault degree. Fourth, the principle of technical transparency and traceability. To solve the problem of difficult proof under the "algorithmic black box", technology research and development should meet the requirements of the "algorithmic black box", provide interpretability, and provide a factual basis for tort identification; Fourth, the principle of protecting the interests of victims. The fundamental purpose of tort law is to relieve and compensate the victims for their losses, which

requires institutional tilt protection for victims in a weak position, rather than treating both parties in the same way.

3. Analysis of the dilemmas in tort liability identification in human-machine collaboration

3.1. Subject dilemma: diversity and vagueness of liability subjects

The human-machine collaboration ecosystem includes developers, operators, users and other subjects. Multi-layer chain liabilities arise from the interlaced duties and functional cooperation among them, making it difficult to trace the ultimate responsible source; From the current reality, some regulatory norms such as the *Interim Measures* and the *Identification Measures* do not make specific provisions for the obligations and liability identification of relevant subjects, and only provide principled guidance for each subject, most of which are preliminary institutional design results. Therefore, under the current lack of statutory rules, the basic ideas of judges in adjudication are as follows: first, judges attach importance to the "scenario-based" analysis method, and allocate the duty of care and burden of proof of the parties according to the application risk level of the scenario, whether human users can control the risks in the specific scenario, and the foreseeability degree after damage; second, flexible evidence rules are adopted in litigation disputes involving parties with professional and technical advantages, and more and more judges tend to adopt the inversion of the burden of proof to require parties with technical advantages to bear the proof of fault presumption and the causal relationship between the result and the act; third, expansive interpretation is carried out. For example, some courts will apply the principle of the *Product Quality Law* to treat defective AI models as "products", and then conduct strict liability identification for developers, providers, etc. [13]. This method can temporarily alleviate the current dilemma, but it is carried out without clear legal authorization, and the adoption of this method itself will cause great controversy [14].

Compared with the current relevant provisions such as the *Interim Measures* and the *Identification Measures*, the *Interim Measures* and the *Identification Measures* are the first normative documents that set obligations from the perspective of multiple subjects. Under these measures, AI providers are responsible for the safety assessment, algorithm filing, data compliance and content management of AI providers. The "provider-platform-user" forms a complete chain of identification liability, breaking the shackle of the thinking of "he who acts is responsible", and recognizing that human-machine collaboration of AI is a normalized social ecosystem.

However, there are a large number of uncertain legal concepts such as "necessary measures", "effective avoidance" and "obvious identification". However, when trying relevant cases, it may be difficult to specifically judge whether the provider has fulfilled its legal obligations. Many situations have also occurred in real life. In the process of using generative AI, users induce AI to create some infringing works by inputting prompt words. Such cases are vague concepts when specifically analyzing the subject of imputation and necessary measures, and it is difficult to form a unified result [15]. Some cases of Beijing Internet Court are exploring this boundary, but no unified standard has been formed so far, and judges need to make specific judgments according to the facts of the case.

3.2. Imputation dilemma: difficulties in proving constitutive requirements

At present, there are still problems in the identification of constitutive requirements of tort liability in human-machine collaboration, which are mainly reflected in two aspects: proof of causality and

subjective fault. To respond to the above dilemmas, the judicial and theoretical circles have carried out active exploration and achieved initial breakthroughs. First, in judicial practice, the adjustment of the burden of proof and the presumption of causality have been carried out. Firstly, the exploration of inversion of the burden of proof has been carried out. In some cutting-edge cases, judges began to transfer part of the burden of proof to the party with technical advantages; secondly, the theory of "risk realization" is applied. If the act belongs to the foreseeable risk of the system, it is determined that there is a legal causal relationship between the act and the damage. Zhang Jianwen and Jia Zhangfan believe that the application of the theory of "risk realization" here means that if the damage falls within the scope of risks that the system design should have prevented, causality can be determined [16]. Second, in theoretical innovation, the objectification of fault standards and the expansion of imputation principles have been carried out. Firstly, the objectification of fault identification. The theoretical circle proposes that fault should be identified based on the conduct standard of a "reasonable person" under the same technical conditions, or directly based on whether industrial technical standards and laws and regulations are violated, without exploring subjective psychology; secondly, the principle of product liability is introduced, AI is regarded as a product defect, and once it is proved that the defect exists and causes damage, no-fault liability can be applied to the producer without proving subjective fault. But there are still problems at present.

First, the break of causality. The "algorithmic black box" interrupts the causal chain. It is difficult for even the perpetrator and the judge to figure out why AI makes decisions. It is extremely difficult to technically prove how the harmful consequences of tortious acts committed by AI are caused by certain algorithms, certain data or user instructions. In the process of human-machine collaboration, the occurrence of damage results is often the result of the joint action of multiple parties. In medical accidents caused by misdiagnosis of AI-assisted medical diagnosis systems, the damage result may be caused by the doctor's incomplete input of the patient's condition, or by the inherent bias of the AI model itself, and it is not easy to separate the core cause [17].

Furthermore, the challenge of objectification of fault identification. The main reason for artificial intelligence errors is the input of training data with large systematic deviations or systematic defects in the model during training, which is an organized and systematic error, not a single human error. This is why the fault identification in the personality liability of tort liability law based on the principle of fault liability cannot cope with new types of systematic risks. Wang Shaoyuan and Ren Yudong pointed out in *Ethical Design of "Transparency" for Artificial Intelligence Autonomous Decision-Making Systems* that problems such as bias in AI systems are often systematic and structural, rather than individual negligence [18]. How to impute such systematic risks and establish an objective standard of "reasonable duty of care" is undoubtedly a huge challenge to the current imputation theory.

3.3. Procedural dilemma: adaptive obstacles in litigation

In addition to procedural law, substantive law also faces many difficulties, such as being unable to get rid of the practical difficulties such as burden of proof and ascertainment of technical facts. From the new explorations in current judicial practice and theory, there are the following breakthroughs: first, flexible adjustment of the burden of proof. For AI autonomous driving accident cases, some courts adopt inversion of the burden of proof; for AI recommendation algorithm infringement cases, the proof standard can be appropriately reduced to a certain extent, and relevant statistical laws and relevant evidence can be recognized. Second, creatively establishing a technical fact ascertainment mechanism. As one of the earliest courts to handle AI painting cases, Hangzhou Internet Court will invite professional and technical personnel in the computer field to participate in the trial as jurors in

the trial of cases with the characteristics of digital products and technical facts. In addition, China has established a technical investigator system. For example, Beijing Intellectual Property Court has introduced technical investigators to provide technical support for judges in AI patent infringement cases, but there are still many problems to be solved in this system.

First, there is a logical conflict in the burden of proof. This situation has two disadvantages: on the one hand, information asymmetry, and on the other hand, it is difficult for consumers to meet the proof standard. The traditional principle of "he who claims proves" is almost powerless in the face of the algorithmic black box, because victims are actually often technically weak, so they cannot meet the highly professional proof standard; and the party who holds key technical evidence and has technical advantages is likely to have no real intention to disclose.

Furthermore, there are professional barriers to the ascertainment of technical facts. At present, most judicial appraisal institutions do not have the professional appraisal ability of AI, for example, they cannot judge whether the AI-generated infringing content is completely automatically generated by AI. As for AI-related evidence, there is no technical evidence identification standard at present, such as no unified identification and review standards for new algorithm models, training data, etc. From the perspective of algorithm discrimination cases, it is quite difficult to determine whether an algorithm is biased [19]. Even if the inversion of the burden of proof is introduced, it is still difficult for judges to conduct substantive review and judgment on the above professional reports due to lack of technical cognition, which is also one of the key bottlenecks in the ascertainment of technical facts. The Higher People's Court of Guangdong Province pointed out in *Opinions on Promoting the Scientific and Technological Innovation and Industrial Development of Artificial Intelligence through High-Quality Intellectual Property Trials* that the ascertainment of technical facts is a common problem in the trial of AI cases, and the technical fact ascertainment mechanism should be improved [20].

3.4. Relief dilemma: insufficient liability realization and socialized sharing

After clarifying the liability subjects and constitutive requirements, the realization of effective liability undertaking and relief is fundamental. Although there are many innovative provisions at present, they lack timely, effective and feasible relief. Existing norms and theoretical research have made a series of innovations on liability undertaking and relief, such as clarifying the progression of imputation principles and the distinction of scenarios; refining the responsibilities of multiple subjects; adding rules for inversion of the burden of proof, etc. However, there are still problems in the specific process of liability undertaking and relief realization.

First, the limited capacity of individual liability undertaking. In the event of large property losses, once an individual enterprise is unable to compensate, the compensation obligation of the liable person cannot be fulfilled, and the rights and interests of the victim cannot be truly relieved. In addition, China does not have mandatory AI liability insurance and industrial compensation funds as auxiliary relief means, resulting in the lack of real guarantee for the legally identified liability.

Second, the absence of a socialized risk diversification mechanism. At present, China has not yet established a mandatory special AI liability insurance system, nor lacks industrial compensation funds as supplementary relief means. This makes the legally identified liability lack a solid economic guarantee, and the social risk resistance capacity is weak.

4. System optimization of tort liability identification in human-machine collaboration

As mentioned above, the identification of tort liability in the scenario of human-machine collaboration is inconsistent with the structure of tort liability law in terms of subject, proof of causality, fault identification and relief realization, which is specifically reflected in the incompatibility of basic models, uneven proof capacity, rough imputation principles and dislocation of rule orientation. It is also not conducive to fully preventing the artificial intelligence security risks caused by highly autonomous, complex and unexplainable intelligent systems. Accordingly, based on the concept of risk control and the thinking of multi-stakeholder governance, this paper proposes to build an operable and forward-looking legal governance plan, striving to transition from post-incident relief to pre-incident prevention and control and in-incident regulation; and implement the goal of the rule of law into action through the effective combination of legal, technical and financial means.

4.1. Core: constructing a stepped obligation allocation framework based on risk classification

The root cause of the vague definition of current liability subjects lies in the lag of legal response to the increasingly complex human-machine relationship. Therefore, the primary task is to promote the refinement and forward-looking of legislation and set clear and predictable behavioral boundaries for all subjects.

First, divide the responsibilities of multiple subjects based on "risk control ability". Keep the traditional principle of fault liability unchanged, dynamically revise the principle of fault liability according to the social and economic development and the development trend of network social governance, form an imputation principle system based on fault liability, supplemented by no-fault liability, and determine the imputation method according to the risk level. ① High-risk scenarios adopt strict liability qualification. It is stipulated that direct users of artificial intelligence products are mainly in occasions involving personal safety and major public interests, and no-fault liability shall be applied to artificial intelligence producers, that is, as long as it can be proved that artificial intelligence products have defects and cause damage consequences, they shall bear compensation liability; the "defects" here include not only hardware failures, software errors, etc., but also should be interpreted broadly, such as inherent biases in algorithm design, systematic flaws in training data, and unforeseeable great dangers arising from autonomous decision-making, etc.) ② Refine fault liability in medium and low-risk scenarios [13]. For general commercial applications, we still adhere to fault liability as the main principle. For categories such as intelligent customer service and content generation that do not need to consider regulatory issues technically, we should specify and scenario-based the "reasonable duty of care" through legislation or judicial interpretation. For example, the fault of generative AI service providers should not be limited to not prohibiting obviously illegal information, but should also prohibit the failure to establish a sufficiently complete content review mechanism for the model and issuing relevant early warnings to users in a timely manner when their scale is equivalent to the risk. Expanding the interpretation of "defects" is a necessary move to deal with the complex risks of AI systems.

Second, formulate differentiated statutory obligation lists for different scenarios. Clarify specific and clear rules. Legislation needs to be behavior-oriented, and stipulate negative prohibition lists and positive obligation lists for subjects according to different risk levels. On the one hand, the obligation list for developers can stipulate the following: first, negatively list prohibited content, in addition to the requirements for natural person data protection, also protect the data of their internal staff to prevent human leakage; second, adopt different risk control measures for different scenarios,

define risk levels combined with industry characteristics and business characteristics, especially platforms in specific scenarios such as big data merchants and live streaming with goods, should pay more attention to risk level division; third, require the statutory obligation to provide algorithm security assessment, that is, before the product is launched or major updates are made, professional third-party institutions shall conduct tests in strict accordance with the specifications to ensure that the algorithm is safe within the specified operation design domain. In addition, clear requirements should be made on the legal source of training data, controllable quality of training data, and maximum avoidance of discriminatory bias; in addition, in the event of damage, it is required to provide the key logical basis for making decisions to regulatory authorities and judicial organs. At the same time, continuous monitoring and patching should be carried out, post-launch monitoring of products should be conducted, and immediate response should be made when product vulnerabilities or new risks occur, and patches or recalls should be launched as soon as possible. Second, the obligation list for operators should include: first, perform the identity identification obligation in the *Measures for the Identification of Artificial Intelligence Generated and Synthesized Content*, so that AIGC content can be identified; second, adopt corresponding technical measures, from the perspective of capability, establish infringing keyword databases, use watermark technology, develop anti-deep forgery detection tools and other ways to avoid and discover infringing acts by actors according to their actual technology; third, timely inform and take necessary measures. Establish an efficient complaint response procedure, and after receiving a valid notice, take a series of actions such as warning, traffic restriction or even deletion based on the preliminary basis of infringing facts; ④ User education obligation, inform and prompt the above users to make them understand the characteristics of AI tools and possible risks; ③ For professional users, additional care should be given: taking medicine as an example, for AI tools used by professionals such as doctors, lawyers and financial analysts, the degree of responsibility they bear should be stricter. Taking doctors as an example, if there is an error in using AI-assisted diagnosis, the standard of ordinary ordinary people should not be used as the penalty standard, but the standard of expert doctors in the same industry should be used as the reference to be careful and reasonable. Data governance obligation is the cornerstone of AI compliance [12].

4.2. Key: improving technology-enabled evidence and litigation rules

To respond to the technical fact of the algorithmic black box in the scenario of human-machine collaboration, judicial procedures must undergo adaptive changes, requiring the innovation of evidence rules to make up for the structural imbalance of the parties' proof capacity.

First, implement hierarchical transfer of the burden of proof and presumption of causality. In litigation procedures, the rigid principle of "he who claims proves" should be abandoned, and a more flexible allocation of the burden of proof should be adopted: first, implement inversion of the burden of proof in high-risk fields. For scenarios applicable to strict liability such as autonomous driving accidents, presumption of causality should be directly stipulated in law [21]. The victim only needs to prove that the damage occurred and the damage result occurred during the normal operation of the AI system, and then it can be presumed that there is a causal relationship between the defects of the AI system and the damage [18]. At the same time, the burden of proof is transferred to the producer. If the producer wants to be exempted from liability, it needs to prove that the accident is caused by the victim's intentional act, force majeure or third-party liability through sufficient evidence such as audit logs. This provision essentially allocates the litigation costs caused by technical asymmetry to the risk maker who is most capable and should bear the costs [22]. Second, apply mitigation of the burden of proof in general risk fields. In fault liability scenarios, the

obstruction of proof rule and evidence production order can be introduced, that is, if the victim can prove that the key evidence is in the hands of the defendant and the defendant refuses to provide it without justifiable reasons, the court can presume that the victim's claim about the content of the evidence is established. At the same time, the court may order the defendant to submit relevant technical data to ascertain the facts according to its powers or the application of the parties. The obstruction of proof rule helps to balance the proof capacity of both parties in litigation [23].

Second, construct a technical audit log and expert assistant system. To ensure real fairness and justice, more reliable means of ascertaining technical facts are needed. First, implement a mandatory audit log system. Through legislation, it is mandatory to stipulate that during the operation of high-risk artificial intelligence systems, there must be an tamper-proof and traceable audit log system, which is responsible for maintenance and records important parameters, input and output data, decision-making processes and status information during operation. The shelf life and format shall be standardized by the regulatory authorities. Logs can be used for litigation, whether it is the plaintiff suing the defendant or the defendant filing a counterclaim, these materials can be provided to the court for unilateral collection of materials; they can also be provided to technical institutions agreed by both parties for identification, both of which are acceptable. Second, improve the system of technical expert jurors or judicial appraisal. Recruit a large number of technical investigators with backgrounds in computer science, artificial intelligence and other disciplines, or set up a fixed team of technical experts, use their professional knowledge to help judges understand technical disputes, analyze and interpret audit logs, and make professional opinions to break through judicial obstacles. The Higher People's Court of Guangdong Province pointed out that judicial assistance from technical experts is an inevitable requirement to deal with technical complexity [24].

4.3. Support: promoting compliance standards integrating law and technology

At present, the objective identification of fault is a major trend, which requires the transformation of legal attention norms into quantifiable and verifiable technical standards.

First, formulate quantifiable national standards for safety and ethics. Led by the Standardization Administration of China, with the participation of regulatory departments such as industry and information technology, science and technology, cyberspace, associations and leading enterprises, accelerate the establishment of an artificial intelligence standard system. First, build performance safety standards, set key performance indicators in each application scenario, and at least reach a relative safety baseline. For example, autonomous driving should ensure perception accuracy, decision-making accuracy, expected functional safety, etc.; the diagnostic sensitivity and specificity of certain diseases in the medical field should be clinically verified. Second, build data and algorithm ethical standards, and set evaluation criteria such as data quality, algorithm fairness, and interpretability. For example, for applications in scenarios such as personal credit and recruitment, the statistical difference of results based on a certain factor should be within a certain range in credit and recruitment scenarios. Third, formulate safety test procedure standards, standardize different types of tests for AI systems, including adversarial tests, stress tests and boundary scenario tests. Only after such system tests are completed can the system be deemed to have passed full verification.

Second, establish the legal principles of compliance presumption and compliance defense. Mandatory technical standards should be given corresponding legal effect. In litigation, enterprises whose products and services fully comply with national mandatory standards can be presumed to have fulfilled their "reasonable duty of care". Correspondingly, if they are lower than mandatory standards, their fault or product defects can be directly determined. In addition, enterprises can take

following higher industrial best practices or international standards as defenses. Stipulating whether there is fault through standards can effectively provide clear compliance guidelines for enterprises and objective and unified identification standards for judicial adjudication, so as to enhance the certainty and predictability of legal application.

4.4. Guarantee: improving diversified risk diversification and socialized relief mechanisms

The ultimate value of liability identification lies in the compensation for damage. A socialized risk diversification system beyond individual liability must be established to prevent the failure to realize judicial maintenance of justice due to the insufficient solvency of the liable person.

First, establish a mandatory artificial intelligence liability insurance system. Draw on the legislative model of compulsory motor vehicle traffic accident liability insurance, and promote the formulation of legislation related to AI compulsory liability insurance. Specifically, first, determine the policyholders and scope, requiring AI products in high-risk scenarios to compulsorily purchase insurance, and stipulate that the insurance scope includes personal and property damage risks caused by product defects, algorithm errors and other reasons; second, determine insurance rates and coverage amounts, and determine different insurance rates and minimum insurance limits for different products according to product types, enterprise safety conditions, insurance scope, etc., so as to force enterprises to improve safety awareness through the price leverage mechanism.

Second, set up industrial compensation funds as supplementary relief. This is an appropriate supplement to the insurance system. First, in terms of funding sources and management. Annual fees paid by enterprises in the industry according to operating income or risk level, taxes levied by the government on the AI industry, and repayments after accident recovery can all be used as sources of industrial artificial intelligence compensation funds, which shall be uniformly managed by independent non-profit institutions; second, in terms of usage scenarios. It is stipulated that the fund is mainly used for bottom-line relief, providing supplementary compensation when insurance compensation is insufficient, the liable subject cannot be confirmed, or solvency is insufficient, and can also be used for the research and promotion of AI safety technology.

5. Conclusion

The identification of tort liability in human-machine collaboration is a key issue in the construction of the rule of law in the intelligent era, which is related to the balance between technological innovation and rights protection [25]. With the continuous evolution of artificial intelligence technology from auxiliary tools to collaborative partners, the traditional tort law is facing structural challenges. To respond to this problem, China has initially constructed a liability identification framework through the *Civil Code* and relevant norms, and explored adjudication rules through relevant typical cases in judicial practice. A typical exploration is the civil judgment No. 19311 (2023) Jing 0491 Min Chu of Beijing Internet Court, which attempts to handle the tort liability of AI-generated content within the existing legal framework [9].

However, the relevant system is still in the development stage with insufficient maturity. Professor Zhang Xin also believes that the current governance framework of generative AI is still in the stage of "principled exploration" [7]. Through a series of analyses, this paper clarifies that the current dilemmas are concentrated in three levels: first, the vague definition standards of liability subjects among developers, operators and users; second, the difficulty in proving causality due to the characteristics of the algorithmic black box, and the lack of operability of fault standards due to unclear duty of care; third, the risk of compensation failure in the relief mechanism, which cannot

guarantee the rights relief of the parties. These problems stem from the deep contradiction between legal rules and technical characteristics. To this end, this paper proposes a systematic improvement path: in legislation, establish an obligation allocation framework based on risk classification and clarify the rights and responsibilities of all parties; in judicature, introduce burden of proof adjustment and technical support to solve the proof dilemma; in the guarantee mechanism, build a risk diversification system combining compulsory insurance and industrial funds. Driven by these measures, a new pattern of collaborative governance of law, technology and market will be formed. In the future, we need to continuously pay attention to new challenges brought by technological evolution and dynamically adjust relevant legal rules. Only by building a fair and effective liability system can we provide legal protection for the healthy development of artificial intelligence and ultimately realize the unity of scientific and technological empowerment and humanistic care.

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