

The Transformation, Application, and Challenges of Trademark Protection under AI and Blockchain Technologies

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Abstract: The development of science and technology has led to industrial innovation and, at the same time, provided a lot of convenience for human life. Artificial intelligence and blockchain technology, as representatives of emerging technologies, inject innovative vitality into the trademark system. This paper talks in-depth about how artificial intelligence and blockchain technology are being used in trademark law. For example, artificial intelligence is being used to make the trademark system more efficient, and blockchain technology is changing the way that well-known trademarks are found and unregistered trademarks are protected. At the same time, the challenges that trademark protection faces with the rise of artificial intelligence and blockchain are looked at. These problems include the destruction of trademark functional value and the risk of unfair competition under the application of artificial intelligence, as well as the difficulties of blockchain in trademark registration modification and cross-border protection.

Keywords: Trademark law, Artificial intelligence, Blockchain

1. Introduction

In the digital age, trademarks serve as essential business assets, playing a crucial role in identifying the sources of goods and services. However, with the rapid expansion of the Internet, trademark infringement has become increasingly prevalent, posing significant challenges to rights protection. Traditional trademark registration, enforcement, and protection mechanisms suffer from inefficiencies, high costs, and evidentiary difficulties, making it challenging to address complex and evolving infringement behaviors effectively. To tackle these issues, scholars in trademark and international law have begun exploring the application of emerging technologies, such as artificial intelligence (AI) and blockchain, in trademark protection. Artificial intelligence (AI), for instance, can enhance trademark and domain name systems by automating the evaluation of domain name availability and identifying potential conflicts with existing trademarks, thereby streamlining the registration process [1]. Meanwhile, blockchain technology, characterized by decentralization, timestamping, and resistance to tampering, has profound implications for intellectual property protection. For example, blockchain can be effectively utilized in areas such as copyright management, registration, and trading in the digital era [2].

This paper conducts an in-depth analysis of the application and current challenges of AI and blockchain technology in various aspects of trademark law, covering key areas such as trademark registration, usage, infringement determination, and dispute settlement. Furthermore, it explores the limitations of existing trademark laws in adapting to advancements in information technology. By

providing insights into the intersection of trademark law and digital innovation, this study aims to contribute to the development of more adaptive legal frameworks, promoting the integration of trademark law into the digital era and strengthening trademark protection.

2. The Impact of AI Technology on Trademark Law

2.1. Application of AI in Enhancing Trademark System Efficiency

In trademark design and registration, AI empowers trademark applicants to streamline style retrieval and design processes. By analyzing variables such as trademark attributes, geographical constraints, market goodwill barriers, and existing similar trademarks, AI conducts big data screening to identify registration risks. For instance, machine learning algorithms can detect semantic similarities between trademarks, reducing conflicts during application [3]. Leveraging consumer preferences, brand equity metrics, and language complexity data, AI generates tailored recommendations for trademark applicants. This enables the selection of marks with higher registrability and market appeal, consequently enhancing the overall efficiency of trademark strategy formulation.

In the trademark examination process, trademark administrative departments now employ a "dual accountability framework" that involves both artificial intelligence and human examiners. By utilizing the consistent examination standards and minimal error rates of AI, it supports examiners in making decisions, providing technical assistance for trademark examination. This reduces the proportion of subjective judgments by examiners, diminishes their over-reliance on professional ethics, and ensures the objectivity and reliability of the decisions [4]. Secondly, the implementation of AI has substantially diminished the workload associated with reviews by streamlining the formerly cumbersome review process. This not only enhances administrative efficiency but also bolsters the confidence of reviewers, thereby fostering a virtuous cycle.

2.2. The Challenges Posed by AI Technology to Trademark Protection

2.2.1. AI's Impact on "Digital Consumers" and the Erosion of Trademark Functionality

Trademarks derive their value from core functions such as source identification, advertising and promotion, quality assurance, and asset attributes. Consumers, as the ultimate arbiters of brand value, play a pivotal role in maintaining the stability and integrity of the trademark system. Furthermore, trademarks protected by law transcend mere numerical sequences or patterns; they embody consumer-perceived meaning and commercial significance. The function of a trademark in identifying the source of goods is only established once consumers accept and recognize its status as a reliable source identifier. The advertising and promotional efficacy of a trademark depends on consumers' recognition of its intangible significance [5]. As the evaluators and co-creators of brand value, consumers have the power to alter a brand's value when their assessment criteria evolve.

The rise of AI-driven voice commerce is fundamentally altering consumer interactions with trademarks. According to Nestlé's Head of Sales and E-commerce at Nestlé, over 50% of product searches will be voice-based within five years [6]. Empirical data underscores this shift: one-third of the U.S. population utilizes voice search, with 71% preferring it to typing; 40% of online shoppers employ voice commands monthly, and 43% of voice-device owners use them for purposes [7]. This implies that, by definition, when the majority of product or service searches shift to voice-based queries, the visual impact of brands will be significantly diminished, if not entirely eradicated. Currently, most online shopping activities involve typing on a keyboard or mobile device, followed by browsing through search engines or completing transactions on e-commerce platforms. However, the growing prevalence of voice search suggests that within the "trinity" of trademark comparison—particularly for voice-activated purchases—the significance of auditory

elements will increase, while the conceptual influence and visual impact of brands will diminish, relegating the latter to a secondary role. Given that the visual aspect of trademarks is a primary factor in consumer brand recognition, any reduction in visual prominence can lead to diminished brand recall, potential trademark confusion, blurred brand identity, and ultimately, erosion of brand value.

2.2.2. AI's Impact on Trademark Infringement and Liability Challenges

The inherent complexity of AI algorithms and operating frameworks complicates adjudication in trademark infringement cases involving AI technologies. A prominent example is *Getty Images v. Stability AI*, which illustrates systemic challenges in attributing liability.

Getty Images is one of the world's leading digital content creators and distributors. They possess a vast collection of numerous visual assets, predominantly comprising still photographs. The defendant has developed an image-generating model known as Stable Diffusion that employs AI to generate computer-synthesized images. In addition to this, the defendant provides a lucrative user platform called Dream Studio and charges for its services. The defendant infringed upon the plaintiff's collection by copying over 12 million photos without obtaining Getty's agreement. When it comes to trademark infringement, the utilization of Stable Diffusion's output featuring a modified version of Getty Images' watermark can potentially lead to confusion regarding the image source and erroneously associate it with the plaintiff. While some outputs from Stable Diffusion may possess aesthetically pleasing attributes, others exhibit subpar quality and unconventional characteristics. For these reasons, Getty eventually filed a lawsuit. However, since the case pertained to jurisdiction and the defendants persistently raised jurisdictional objections, although all were rejected by the court, the case is still under review. It is obvious from this case that the complexity of AI itself has provided infringers with ample space for infringement and excuses to evade liability. For consumers, they definitely do not wish to find that the images they purchase on the website are illegal. Consumers have no desire to be involved in an infringement case. Therefore, to overcome the harm inflicted on trademark protection by the inherent features of AI, it is essential to keep abreast of the times and update the trademark law, establishing clearer and more specific criteria for determining liability as well as preventive and response measures.

2.2.3. Autonomous AI as a Catalyst for Unfair Competition

The rise of fully autonomous AI systems risks reshaping consumer markets into oligopolistic landscape dominated by algorithmic manipulation. Under the "ship first, shop later" model proposed by Harvard Business Review, consumers increasingly delegate purchasing decisions to AI assistants, diminishing their awareness of competing brands. This shift enables AI to curate choices that prioritize corporate interest over genuine consumer preferences, consolidating market power among a handful of "uber-brands" that exploit AI to manufacture demand [8]. If this model gains widespread adoption, it may precipitate unfair competitive practices. This is due to the fact that AI leverages big data analysis to disseminate product information to consumers and generate sales rankings. Consequently, unscrupulous enterprises could exploit this functionality to illicitly acquire competitors' proprietary business data through advanced data mining techniques. These data represent critical assets for enterprises. In the event of theft, such data may be exploited for targeted marketing activities or sold to rival entities, thereby compromising the competitive advantage of legitimate businesses and disrupting market equilibrium.

Furthermore, certain enterprises may acquire these data through illicit means, including hacking attacks or malicious web scraping. Once obtained, these data can be leveraged with artificial intelligence algorithms to rapidly adjust business strategies, conferring unfair competitive advantages.

Additionally, the extensive and complex nature of data on artificial intelligence platforms complicates the attribution of responsibility for illegal activities, thus creating opportunities for unscrupulous enterprises to exploit legal loopholes.

3. The Impact of blockchain Technology on Trademark Law

3.1. The Transformative Impact of Blockchain Technology on Trademarks

3.1.1. The Role of Blockchain in the Identification of Well-Known Trademarks

Blockchain technology possesses inherent characteristics such as timestamping, tamper-resistance, and decentralization [9], ensuring that trademark information remains complete and immutable throughout its lifecycle. These features provides robust technical support for trademark registration, protection, and infringement determination.

In practice, when a well-known trademark is involved in an infringement dispute, its identification requires an application and supporting evidence from the trademark owner. The Court or the Trademark Office then reviews the disputed trademark before determining its well-known status. However, this process is often cumbersome due to the extensive documentation required, leading to significant resource consumption and the risk of document loss. Additionally, for reviewing institutions, the workload is substantial, and the evaluation process is costly, time-consuming, and prone to errors.

The application of blockchain technology can effectively address these challenges. By leveraging its timestamping and immutability features, blockchain can comprehensively record trademark information from registration through use to review on a distributed ledger. This significantly mitigates the difficulties faced by reviewers due to complex trademark information, streamlines the review process, and enhances efficiency.

3.1.2. The Protective Role of Blockchain for Unregistered Trademarks

In China, the Trademark Law of the People's Republic of China generally prohibits the sale of goods bearing unregistered trademarks. However, unregistered trademarks are not entirely devoid of legal protection. While China adopts a pre-registration system, commercial marks that have been used and have gained significant visibility in society cannot be preemptively registered in bad faith. In such cases, the original users or interested parties may petition the Trademark Office for invalidation to safeguard their legitimate interests [9].

Nevertheless, in practice, it is challenging to determine whether an unregistered trademark has been effectively used or has established legal influence. This difficulty arises primarily because trademark registration inherently provides a public notice function, which unregistered trademarks lack, leading to more complex legal evidence gathering. During the confirmation process, factors such as the scope of trademark use and advertising reach must be carefully considered. Given the current traditional methods of proof, which are neither sufficiently accurate nor comprehensive, statistical results may contain errors and incur high costs.

Blockchain technology, leveraging its unique timestamping, immutability, and transparency features, can comprehensively record information about commercial marks from the outset of their use, including usage scenarios, scope, and advertising efforts, thus forming a robust chain of evidence. In practice, this not only reduces costs and enhances administrative efficiency but also better protects the legitimate rights and interests of unregistered trademark holders.

3.2. The Challenges Posed by Blockchain Technology to Trademark Protection

3.2.1. The Unalterable Nature of Blockchain: Challenges for Trademark Registration and Modification

Blockchain is a shared, distributed, and tamper-evident digital ledger that records transactions and tracks assets within a peer-to-peer network [10]. One of its most significant features is immutability, meaning that once trademark information is recorded on the blockchain, it cannot be altered. However, this characteristic poses challenges when errors occur in the initial registration process or when subsequent changes, such as ownership transfers, become necessary. Since blockchain requires complex procedures and multi-party verification for any updates, common trademark modifications, such as company name changes or minor adjustments to trademark designs, become resource-intensive and time-consuming.

This immutability conflicts with the legal requirement for flexibility, leading to substantial time and resource consumption. Furthermore, given the high operational complexity and cost associated with blockchain, coupled with the fact that initial trademark information must be registered and entered by the trademark owner, the practical applicability of blockchain in this context remains uncertain.

3.2.2. The Cross-border Protection of Trademarks Under Blockchain.

Trademark regulations exhibit significant variation across jurisdictions. For instance, in China, trademark registration is achieved through an application process, and prior use of a trademark does not preclude others from registering it. In contrast, in the United States, prior use can serve as a basis for establishing trademark rights. When determining trademark infringement, some jurisdictions prioritize the likelihood of confusion, while others base their judgments on actual instances of confusion. This highlights the pronounced regional characteristics inherent in intellectual property systems. Furthermore, when assessing trademark infringement, certain countries emphasize evaluating the potential for confusion, whereas others stress judgments based on documented confusion. Consequently, it is evident that regional distinctions are deeply embedded in the legal frameworks governing trademarks.

However, the advent of blockchain technology has facilitated the transcendence of geographical boundaries for trademarks, fostering global connectivity. Currently, there is no unified standard or coordination mechanism for cross-border protection of blockchain-based trademarks worldwide. The regulations concerning trademark registration, protection, and related aspects differ significantly between countries, and there is a lack of consensus among nations regarding the application of blockchain technology, data sharing, and evidence recognition. This situation poses challenges to cross-border trademark protection and may result in inconsistent outcomes when addressing trademark infringement cases across different jurisdictions, thereby impacting the efficacy of trademark protection.

4. Conclusion

AI and blockchain, as representatives of internet technology development, demonstrates great potential in the trademark field. However, due to the advanced and complex nature of these technologies, the challenges posed by AI, blockchain, and other cutting-edge innovations cannot be adequately addressed within the existing framework of trademark law. As elaborated above, AI has the potential to diminish the visual impact of trademarks, increase the complexity of infringement determination, and, in a fully autonomous AI paradigm, may likely give rise to unfair competition practices. While the immutability of blockchain technology offers significant advantages in

safeguarding the security of trademark information, it simultaneously introduces challenges in modifying such data. Moreover, the absence of unified global standards and coordination mechanisms for blockchain-based protection creates substantial obstacles in cross-border trademark enforcement. Consequently, to effectively address these emerging challenges, trademark law must evolve and adapt to the rapid developments of the internet era, ensuring its relevance and efficacy in the face of technological advancements.

To efficiently address these emerging challenges, trademark law must evolve and adapt to the rapid developments of the internet era, ensuring its relevance and efficacy in the face of technological advancements. Legislators should conduct thorough research to define liability in cases of AI-related trademark infringement. For instance, when AI-generated content leads to trademark confusion, clear guidelines must be established to determine responsibility—whether it lies with the AI developer, the user, or both parties. Regarding blockchain, international cooperation is essential. Countries should collaborate to establish harmonized cross-border trademark protection standards, ensuring equal protection of trademark rights on a global scale. Moreover, trademark offices and relevant entities should intensify research and development efforts to enhance the flexibility of blockchain-based trademark registration and modification processes while preserving the inherent security features of blockchain trademarks. Only through these comprehensive measures can trademark law effectively address the challenges brought by AI and blockchain and better protect trademark rights.

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