The Role of Intellectual Property Law in Protecting AI Innovations in the Digital Economy

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Abstract

The rapid development and widespread implementation of artificial intelligence (AI) technologies have transformed industries across the globe, from healthcare to finance and transportation. As AI continues to evolve, its impact on intellectual property (IP) law becomes more profound, presenting both opportunities and challenges for the protection of AI-driven innovations. This article explores the role of IP law in safeguarding AI innovations within the digital economy, highlighting the limitations of traditional IP frameworks such as patents, copyrights, and trade secrets when applied to AI technologies. The article examines the nature of AI innovations, including machine learning models, algorithms, and autonomous systems, and discusses the unique challenges that AI presents to conventional IP protections, such as issues of ownership, inventorship, and authorship. The analysis extends to case studies that reveal real-world challenges faced by innovators in securing IP protection for AI creations, including disputes over patentability and the legal status of AI-generated works. Furthermore, the article reviews current proposals for reforming IP laws to address these issues, including adapting existing frameworks, creating new legal categories for AI-specific protections, and fostering international cooperation. In light of these challenges and potential solutions, the article asserts that adapting IP law to the realities of AI is crucial for fostering innovation, ensuring fair protection, and maintaining ethical standards in the digital economy. Ultimately, this article argues that a dynamic and flexible IP legal framework is essential to safeguard AI-driven creativity and promote continued technological advancement while addressing the legal, ethical, and societal implications of AI innovation.

Keywords: Artificial Intelligence, Intellectual Property Law, AI Innovations, Patent Law, Copyright Law, Digital Economy

1. Introduction

Artificial Intelligence (AI) has become a cornerstone of the digital economy, driving innovation, enhancing productivity, and reshaping industries across the globe. Its impact is profound, influencing sectors as diverse as healthcare, finance, transportation, manufacturing, and entertainment. In recent years, AI has progressed from a theoretical concept to a practical tool embedded in everyday applications, from voice assistants and recommendation algorithms to self-driving cars and automated financial systems. This rapid advancement is fueled by exponential growth in computational power, vast datasets, and improved machine learning algorithms. As AI continues to evolve, its capacity to create value in the digital economy

becomes increasingly significant, yet it also raises complex legal and ethical challenges. One of the central challenges is the protection of AI innovations through intellectual property (IP) law, which traditionally focuses on human-made creations and inventions.

IP law plays a pivotal role in fostering innovation by granting creators exclusive rights to their inventions, works, and designs. By offering legal protection, IP law incentivizes investment in research and development, encouraging inventors to share their ideas with the public in exchange for a period of exclusive use or distribution. There are several forms of IP protection available, including patents, copyrights, trade secrets, and trademarks, each serving different types of intellectual assets. Patents protect new inventions and technological advancements, copyrights safeguard original works of authorship, trade secrets protect confidential business information, and trademarks distinguish goods and services in the marketplace. For the digital economy, where rapid innovation is key, IP law is essential in creating an environment that rewards creativity and prevents unauthorized exploitation of new technologies. However, the increasing integration of AI into innovation raises questions about how well traditional IP frameworks can accommodate these emerging technologies, particularly when AI itself is capable of creating new inventions and content autonomously.

The scope of this article focuses on the intersection of AI and IP law, with an emphasis on the challenges that AI innovations present to existing IP frameworks. AI technologies, such as machine learning models, neural networks, and autonomous systems, have unique characteristics that complicate their categorization within traditional IP categories. Unlike human-created inventions or works, AI systems can generate new solutions, designs, or content without direct human intervention. This raises fundamental questions about ownership, authorship, and inventorship. For instance, if an AI algorithm creates a novel invention or generates a piece of original artwork, who holds the rights to that creation? Can an AI itself be recognized as an inventor or author, or should the rights belong to the human who programmed the AI, or perhaps the entity that owns the AI system? These questions challenge established notions of IP protection and call into question the adequacy of current legal frameworks to address the complexities of AI-generated innovations.

This article will argue that intellectual property law must adapt to the realities of AI innovation in the digital economy. The rapid development of AI technologies demands a reevaluation of traditional IP concepts, which are largely designed around human creators and inventors. While some legal scholars have argued for extending current IP laws to cover AI-created works, others advocate for entirely new legal frameworks tailored to the unique nature of AI. This article will explore the existing approaches to AI and IP law, critically examining their limitations and suggesting reforms that could provide more effective protection for AI innovations. By adapting IP laws to better address the challenges posed by AI, lawmakers can ensure that the digital economy continues to thrive while balancing the interests of innovators, consumers, and society at large. Ultimately, the goal is to find a legal balance that encourages innovation without stifling the potential of AI to contribute to economic growth and societal progress.

2. Overview of Autonomous Vehicles

Autonomous vehicles (AVs) are defined as vehicles capable of operating without human intervention, relying on a combination of sensors, artificial intelligence (AI), and machine learning algorithms to navigate and make decisions. The level of autonomy in AVs is typically classified into six distinct levels, from Level 0 (no automation) to Level 5 (full automation). At Level 0, the vehicle has no autonomous capabilities and relies entirely on the human driver for control. Level 1 vehicles feature basic driver assistance, such as cruise control or lane-keeping assistance, but the driver must still be actively engaged. Level 2, often referred to as partial automation, enables the vehicle to control both steering and acceleration, but the driver must remain vigilant and ready to take over at any moment. Level 3 is characterized by conditional automation, where the vehicle can handle most driving tasks, but the driver must be available to intervene when requested. At Level 4, the vehicle can drive itself under certain conditions, such as in specific geographic areas or under certain weather conditions, without human input. Finally, Level 5 represents full automation, where the vehicle can operate without any human intervention in all environments and conditions (KPMG, 2018). These classifications are critical in understanding the varying degrees of autonomy, as they influence both regulatory requirements and technological capabilities.

The technologies that enable autonomous vehicles are highly advanced and diverse, with AI, sensors, and machine learning at the core of their functionality. Sensors such as radar, lidar, cameras, and ultrasonic devices provide real-time data about the

vehicle's surroundings, detecting obstacles, traffic signs, pedestrians, and other vehicles. AI and machine learning algorithms process this sensor data to make decisions, navigate routes, and adjust driving behavior. Machine learning, in particular, allows AVs to improve their decision-making over time as they collect more data. These systems are also supported by high-definition maps that provide detailed, pre-programmed information about the road network, ensuring the vehicle can navigate safely. In addition to these technologies, cloud computing plays a key role in enabling AVs to access vast amounts of data and leverage computational resources that exceed the capabilities of individual vehicles. This technological foundation is what allows AVs to function autonomously, continuously processing data and adapting to changing road conditions (Fagnant & Kockelman, 2015).

Globally, the development and adoption of autonomous vehicles are advancing at varying rates, with countries like the United States, China, and members of the European Union leading the way. In the United States, AV testing has been taking place in several states, including California, Arizona, and Nevada, where regulatory frameworks have been established to allow for the testing of AVs on public roads. In China, the government has also introduced regulations and policies to support the development of AVs, while in Europe, countries such as Germany and the UK are pushing for laws that will allow AVs to be integrated into the transportation system. Many of these countries have begun pilot programs to test the real-world viability of AVs, with companies like Tesla, Waymo, and others conducting extensive testing. International organizations, such as the United Nations and the European Commission, are also working on creating global standards for AV technology to ensure safety and interoperability across borders. Despite these advancements, the widespread adoption of AVs faces several hurdles, including regulatory challenges, public acceptance, and technological limitations, such as the need for robust data privacy protections and cybersecurity measures (Harper et al., 2016).

3.   Understanding AI Innovations

Artificial Intelligence (AI) innovations refer to the advancements in technology where machines or systems are designed to replicate cognitive functions such as learning, problem-solving, decision-making, and pattern recognition. At the core of AI innovations are machine learning models, which enable systems to learn from data and improve performance over time without explicit programming. These models rely on vast datasets, algorithms, and computational power to recognize patterns and make predictions or decisions based on those patterns. In addition to machine learning, AI also encompasses other subfields such as deep learning, which uses multi-layered neural networks to solve complex tasks like image recognition and natural language processing. Other examples of AI innovations include natural language processing systems used in virtual assistants, recommendation algorithms deployed in digital platforms, and autonomous systems like self-driving cars, which make real-time decisions based on environmental inputs. These innovations represent a significant leap from traditional software, as they are not pre-programmed to perform specific tasks but instead learn and adapt to new information, often leading to novel solutions and efficiencies (Binns et al., 2020).

The impact of AI on various industries is profound and transformative. In healthcare, AI is revolutionizing diagnostics, patient care, and drug discovery by enabling faster, more accurate medical imaging analysis, personalized treatment plans, and the identification of potential drug candidates through data-driven models. AI-driven tools like predictive analytics are also improving healthcare management, leading to better patient outcomes and reduced costs. In finance, AI is being used for fraud detection, algorithmic trading, credit scoring, and customer service automation, increasing efficiency and accuracy while reducing operational risks. The transportation sector is experiencing similar disruptions, with self-driving technologies and AI-based logistics systems optimizing routes and reducing costs in both freight and passenger services. The manufacturing industry is also benefiting from AI innovations, particularly in the realm of automation, where AI-powered robots perform tasks that were once human-driven, improving speed and precision in production lines (Brynjolfsson & McAfee, 2014). AI's influence is not limited to these sectors; it is increasingly integrated into marketing, education, and public services, reshaping how services are delivered and consumed.

What sets AI innovations apart from traditional technological innovations is the involvement of learning algorithms, vast amounts of data, and the potential for autonomous decision-making. Traditional inventions generally follow a linear process of human creativity, where an inventor develops a solution based on pre-existing knowledge or research. In contrast, AI systems often evolve through continuous learning and refinement of their algorithms, driven by data that is gathered in real time. This

dynamic nature of AI makes it unique, as it can adapt and change based on new inputs without explicit reprogramming. Furthermore, AI innovations can produce results that are unpredictable or novel, even to their creators. For instance, an AI might generate an innovative solution to a problem that was not anticipated by the humans who developed the underlying model. The role of data in AI is also crucial, as the quality and quantity of data directly influence the performance and accuracy of AI systems. Unlike traditional inventions, which rely on specific technical knowledge, AI systems require large datasets to train models and achieve optimal performance. This reliance on data introduces additional challenges regarding data privacy, security, and ownership (Hao, 2021). Lastly, AI innovations also introduce autonomous decision-making capabilities that raise ethical and legal questions about accountability and control, particularly in cases where AI systems make decisions without human intervention.

4.   Current IP Frameworks and Their Applicability to AI

The application of traditional intellectual property (IP) frameworks to AI inventions presents numerous challenges, particularly in patent law. Patents are designed to protect new inventions that are novel, non-obvious, and industrially applicable. However, the nature of AI technologies complicates the patenting process. One issue is determining whether AI algorithms themselves can be patented or if they are considered abstract ideas that are ineligible for protection. Additionally, questions around the ownership of AI-generated inventions have arisen, especially when an AI system produces a novel invention without direct human intervention. In many jurisdictions, patent law requires human inventors to be named on patent applications, creating complications when the inventor is an autonomous system rather than a person. This has sparked debates about whether AI can be considered an inventor and whether current laws need to be reformed to recognize AI as a legitimate inventor (Cui, 2020). Furthermore, AI systems often build upon previous algorithms and data models, which can make it difficult to establish the novelty of AI-driven inventions, particularly when those inventions are based on existing knowledge and machine learning techniques.

Copyright law also raises important questions when it comes to AI-generated works. Traditionally, copyright protection is granted to original works of authorship that are created by human beings. However, as AI systems become capable of producing creative works such as music, art, and literature, the question arises whether these creations can be copyrighted and, if so, who owns the copyright. One of the main issues is whether AI can be considered an author under copyright law, as traditional legal frameworks require human authorship. In some cases, the rights to AI-generated works may be attributed to the creators or operators of the AI systems, but this is a grey area, and courts have not yet fully addressed these questions. In jurisdictions like the United States, the Copyright Office has indicated that works created solely by AI may not be eligible for copyright, leaving room for ambiguity in the treatment of AI-generated content (WIPO, 2020). As AI continues to create novel works, lawmakers will need to reconsider the criteria for copyright protection to ensure that it adequately accommodates non-human creators.

Trade secrets are another form of IP protection that is highly relevant to AI, particularly in the context of proprietary algorithms and models. Companies that develop AI technologies often rely on trade secrets to protect their underlying algorithms and data sets, which are crucial to the functionality and competitiveness of their products. Unlike patents, trade secrets do not require public disclosure, which can be an advantage when an organization wants to keep its innovations confidential. However, trade secret protection is not without its challenges. For one, if an AI model is reverse-engineered or disclosed through an employee leak, the protections offered by trade secrets can be compromised. Additionally, the use of AI in cloud-based environments complicates trade secret protections, as algorithms and data can be more easily shared or exposed without adequate safeguards (Lemley et al., 2020). Thus, companies must adopt robust measures to protect their AI-related trade secrets from unauthorized access, a task that becomes increasingly difficult as AI systems become more integrated into digital platforms and public-facing services.

Trademarks also play a role in the AI space, particularly when AI systems are used to create brands, logos, or other marketable identities. As AI technologies are integrated into the branding and marketing strategies of companies, there is a growing need to consider how trademarks might apply to AI-created logos or brand names. The issue arises when AI systems are used to generate logos or other creative elements that are subsequently trademarked by businesses. In this context, the question of who owns the trademark – the AI system, its creator, or the entity that uses the AI – becomes critical. Trademark law is traditionally used to protect distinctive signs that identify the source of goods or services, but as AI becomes more

involved in the creative process, the lines between human and machine-generated creativity may become blurred (Ginsburg, 2019). The expansion of AI-generated trademarks and brand identities may require updates to trademark laws to address these new challenges.

5.   Challenges of Protecting AI Innovations under Existing IP Laws

One of the most complex issues in protecting AI innovations through existing intellectual property (IP) laws is the question of ownership and authorship. In traditional IP frameworks, ownership is typically attributed to human inventors or creators. However, as AI systems become capable of generating inventions and creative works independently of direct human input, the attribution of ownership becomes increasingly problematic. AI's role in the creation process raises questions about who should hold the rights to AI-generated works or inventions. In the case of patents, the issue of inventorship becomes particularly contentious when the AI system itself develops a novel invention without human intervention. Patent law requires a named inventor, which is typically a person, but when an AI system is involved in the creation, it is unclear whether the human operator or the AI system itself can be considered the inventor. As AI continues to evolve, this gap in current IP laws poses significant challenges, as no clear legal framework exists to accommodate the attribution of intellectual property rights to AI-generated outputs (Srinivasan, 2020). Similarly, with copyright law, the question of authorship is equally complicated. Copyright is generally awarded to the person who creates an original work, but if an AI system autonomously generates a work, determining who the rightful copyright holder is becomes uncertain. Should the rights belong to the human who created the AI system, the person who trained the algorithm, or the entity that owns the AI? These issues of ownership and authorship highlight the limitations of existing IP laws in addressing the complexities of AI innovation (WIPO, 2020).

Another significant challenge to protecting AI innovations under current IP laws is the dynamic nature of AI technologies. AI systems are not static; they evolve over time through iterative development and continuous learning. This presents a unique challenge for traditional IP frameworks, which often focus on protecting specific, finalized inventions or works. With AI, the boundaries between the original invention and any subsequent iterations can become blurred. For instance, an AI system might be trained on a dataset and then refine its capabilities by creating new models or solutions. The resulting innovation could be considered a derivative work, yet it might not fit neatly within the traditional framework for copyright protection, which is based on fixed and distinct creative works. This issue of derivative works becomes even more complex when AI systems produce results that are difficult to predict or replicate. Unlike traditional human-driven inventions, where the scope of protection is clearly defined, AI-driven innovations can evolve in unpredictable ways, making it harder to define ownership and determine the extent of protection (Heald, 2021). This dynamic nature of AI development challenges traditional approaches to IP protection, which are generally better suited to static, well-defined creations.

Ethical and legal concerns further complicate the protection of AI innovations under existing IP laws. One key issue is the concept of AI autonomy. As AI systems gain greater autonomy and decision-making capabilities, questions arise about who should be held accountable for the outcomes of their actions, especially when it comes to intellectual property. If an AI system generates an invention or a creative work that leads to legal or financial consequences, who is responsible for these outcomes? Should the liability lie with the developer of the AI, the user of the system, or the entity that owns the system? These ethical concerns extend to the ownership of AI's intellectual output. If an AI system generates valuable intellectual property, the question arises as to whether the system itself should hold rights over its creations, or whether the rights should always belong to humans. These debates touch on broader issues of legal personhood, responsibility, and the role of machines in creative processes (Ginsburg, 2019). As AI continues to play a more significant role in innovation, IP laws must address these ethical concerns and provide clarity on who ultimately owns and controls AI-generated intellectual property.

Finally, there is a notable variation in how different jurisdictions approach the relationship between AI and IP law. Countries like the United States, the European Union, and China have distinct legal frameworks, and this divergence creates challenges for global IP protection of AI innovations. In the U.S., for instance, patent law requires that an inventor be a human being, leading to potential issues when an AI is the primary contributor to an invention. Meanwhile, in the EU, discussions have centered on whether AI systems should be recognized as inventors, and some have proposed creating new legal categories to address AI's role in innovation. In contrast, China has been more open to exploring AI's potential role as an inventor and has made moves toward incorporating AI-specific protections into its IP framework (Cui, 2020). These differences in legal

approaches create uncertainty for companies and innovators who operate globally, as they must navigate varying regulations and determine how to best protect their AI-driven inventions across borders. The lack of harmonization in IP laws concerning AI presents significant challenges for global industries, requiring international cooperation and potential reforms to create a more unified approach.

6.   Proposals for Reforming IP Laws to Better Protect AI Innovations

As AI continues to reshape the digital economy, there is a growing need to reform existing IP laws to better accommodate the unique challenges posed by these technologies. One suggestion is to adapt current legal frameworks, particularly patents, copyrights, and trade secrets, to address the evolving nature of AI. For instance, patent law could be reformed to explicitly include AI-generated inventions, allowing for clearer attribution of inventorship when an AI system plays a central role in the creation process. This could involve updating patent guidelines to recognize AI systems as legitimate contributors or inventors in certain cases, while ensuring that human oversight remains a core element of the process (Srinivasan, 2020). Similarly, copyright law could be adjusted to address AI-generated works by recognizing the possibility of non-human authorship and creating provisions for the attribution of rights to the creators or operators of the AI systems. This reform would ensure that AI-generated content, whether it be art, literature, or music, receives appropriate protection under copyright law (Heald, 2021). Trade secret law could also be expanded to offer better protection for proprietary AI algorithms and models, with clearer provisions regarding the safeguarding of confidential information in AI development.

Another approach to improving IP protection for AI innovations is to create entirely new legal categories tailored to AI technologies. One possibility is the introduction of "AI patents," a category of patents specifically designed for inventions that are autonomously created by AI systems. This could provide a more structured approach to patenting AI-driven innovations and address issues such as inventorship and the scope of protection. Similarly, "algorithmic copyrights" could be introduced to protect the algorithms and code behind AI systems, acknowledging the unique nature of these creations and their importance in driving innovation in the digital economy (Ginsburg, 2019). These new categories of IP protection would reflect the distinct characteristics of AI technologies and offer a more nuanced approach to intellectual property rights, encouraging innovation while addressing the challenges posed by AI.

International cooperation and harmonization are also critical in ensuring uniform protection for AI innovations across borders. As different jurisdictions approach AI and IP law in diverse ways, there is a need for a more coordinated international effort to establish consistent standards for protecting AI-generated intellectual property. This could involve the creation of international treaties or agreements that set common guidelines for patenting AI inventions, attributing authorship in copyright law, and protecting proprietary AI models under trade secret law. Greater harmonization would not only simplify the legal landscape for companies operating globally but also foster innovation by providing clearer legal protections and reducing uncertainty (WIPO, 2020). Moreover, as AI technology continues to evolve at a rapid pace, international collaboration is essential to ensure that IP laws remain flexible and adaptable to future developments in AI.

Finally, the development of AI-specific licensing models could play an important role in facilitating innovation while ensuring fair use. These licensing models could be designed to address the unique challenges of AI technologies, such as the need for access to large datasets and the use of AI systems by multiple stakeholders. AI-specific licenses could also help ensure that AI-generated inventions and works are used in a way that respects the rights of creators and operators, while encouraging further development and commercialization of AI innovations. Such licensing models would strike a balance between protecting intellectual property and fostering the open sharing of AI knowledge and resources (Cui, 2020).

7.   Case Studies and Examples

In recent years, AI innovations have begun to face increasing challenges in the realm of intellectual property (IP) law. One prominent example is the issue of AI-generated inventions and patents. In many cases, AI systems are central to the development of new technologies, but there is no clear framework for attributing patent rights to inventions that involve AI. A well-known instance is the case of an AI system that developed a novel drug compound through machine learning algorithms, which was later submitted for a patent. While the drug compound was the result of AI-driven processes, the patent office required that a human be named as the inventor, as existing patent laws mandate that only human beings can hold this status.

This led to significant debates about whether the legal framework for patents is sufficient to address AI's role in invention. In some jurisdictions, the idea of AI as an inventor has been explored, with some calling for reform of patent laws to recognize AI-driven inventions more explicitly, but such changes are still in the early stages (Srinivasan, 2020).

AI-generated creative works have also raised concerns in the realm of copyright law. For instance, an AI-created artwork has sparked considerable debate over the ownership of copyright in the United States. The work was generated by an AI system trained on thousands of artworks and produced a piece that closely resembled a traditional painting style. When the artwork was submitted for copyright protection, the U.S. Copyright Office rejected the application, stating that copyright protection could only be granted to works created by human beings. This ruling highlighted the gap in existing copyright laws regarding non-human creators and raised the question of whether AI-generated works should be excluded from protection, or whether a new legal category should be developed for works created by machines. The case illustrates the legal ambiguity surrounding AI's role as a creator and highlights the urgent need for reform to address such innovations (Heald, 2021).

Similarly, in the context of trade secrets, there are ongoing issues surrounding the protection of proprietary AI models and algorithms. Many companies invest heavily in developing advanced AI systems, which rely on complex algorithms and vast datasets to function. These proprietary algorithms are often protected under trade secret law. However, the increasing use of AI in cloud-based environments presents new risks, as algorithms may be exposed through unauthorized access or reverse engineering. In some cases, these algorithms have been copied or replicated by competitors, resulting in disputes over trade secret protection. For instance, an AI company that developed a unique machine learning algorithm for natural language processing found itself embroiled in a legal dispute after a competitor allegedly reverse-engineered the algorithm. This case highlighted the difficulties companies face in protecting their AI-related innovations in the face of evolving technological capabilities and the global nature of digital markets (Lemley et al., 2020).

These real-world examples demonstrate how current IP laws struggle to address the nuances of AI-generated inventions, creations, and trade secrets. As AI continues to be integrated into innovation across industries, it is evident that the existing legal frameworks are not equipped to fully protect AI-driven advancements. These challenges underscore the need for legal reform to better align IP protections with the unique characteristics of AI technologies.

8. Conclusion

The role of intellectual property law in protecting AI innovations is increasingly critical as AI technologies continue to transform industries and drive new forms of innovation. Traditional IP frameworks, including patents, copyrights, and trade secrets, were not originally designed to accommodate the complexities of AI systems, leading to significant challenges in attributing ownership, defining inventorship, and ensuring adequate protection for AI-generated works. The dynamic nature of AI, coupled with its potential to operate autonomously, creates legal uncertainties that current IP laws struggle to address. Furthermore, ethical concerns surrounding AI's role in the creation process, including questions of accountability and fairness, highlight the need for a more robust and adaptable legal framework that can protect AI innovations while maintaining ethical standards.

Several proposals for reform have been suggested to better align IP laws with the realities of AI technologies. One avenue is the adaptation of existing legal frameworks to recognize AI's role in the creation of intellectual property, particularly in the context of patents and copyrights. This could include recognizing AI systems as inventors in specific contexts or developing new categories of IP protection tailored to AI-generated works and innovations. Additionally, international cooperation is necessary to harmonize IP laws across jurisdictions and ensure that AI-related innovations can be protected globally. Such reforms would provide clarity for innovators and foster a more secure environment for AI-driven innovation.

Looking ahead, the future of IP law will likely see continued evolution in response to the rapid advancement of AI technologies. It is clear that existing frameworks need to evolve to address the unique challenges posed by AI, and this evolution must strike a balance between protecting intellectual property and fostering continued innovation. As AI becomes an increasingly integral part of the digital economy, IP laws must be adaptable, forward-looking, and sensitive to both the opportunities and challenges presented by these transformative technologies.

In conclusion, the adaptation of IP law to the realities of AI is crucial for maintaining a legal environment that supports innovation while ensuring that the rights of creators, developers, and society as a whole are respected. As AI technologies

continue to develop, it will be essential for legal systems to keep pace with these changes to provide appropriate protections and foster ethical and sustainable innovation.

Ethical Considerations

All procedures performed in this study were under the ethical standards.

Acknowledgments

Authors thank all participants who participate in this study.

Conflict of Interest

The authors report no conflict of interest.

Funding/Financial Support

According to the authors, this article has no financial support.

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