BLOCKCHAIN TECHNOLOGY AND ARTIFICIAL INTELLIGENCE IN THE MANAGEMENT OF INTELLECTUAL PROPERTY RIGHTS

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Abstract.

The article presents a comprehensive study of the potential use of blockchain technologies in the management and protection of intellectual property rights in the context of rapid digitalization and technological progress. The key characteristics of blockchain are outlined—namely, its decentralized, transparent, and immutable nature—which enables a high level of trust, reduces transaction costs, and eliminates the need for intermediaries in the process of copyright registration. Particular attention is paid to current challenges associated with the rise of generative artificial intelligence, which complicates the control over the use of intellectual property objects and undermines traditional approaches to authorship.

Both international and domestic experiences in implementing blockchain solutions in the intellectual property sphere are analyzed, particularly in regard to the creation of digital registries, rights registration platforms, and mechanisms for monitoring content usage (such as musical works, photographs, videos, texts, etc.). It is noted that Ukraine currently lacks a clear legal mechanism to regulate the operation of such services, which hinders the implementation of innovative technologies at the state level. The article emphasizes the need to develop a relevant regulatory and legal framework that would grant legal force to records stored on blockchain networks, define liability for violations, and provide a clear interpretation of the status of digital evidence. The feasibility of establishing specialized blockchain-based platforms in Ukraine for effective intellectual property management is substantiated. The article concludes that the integration of blockchain and artificial intelligence could become a key element in shaping a modern digital infrastructure for IP protection. However, its successful implementation requires an interdisciplinary approach, legal clarity, and governmental support.

Keywords: Blockchain, artificial intelligence, platforms, intellectual property, rights management, technologies, innovations, copyright, protection, digitalization.

1. Relevance

Digital transformation is rapidly changing both everyday life and business processes, while posing challenges to traditional legal systems. Industry 4.0, which is based on the latest technologies such as the Internet of Things, cloud computing, Big Data, blockchain, and artificial intelligence (AI), is opening up new horizons for managing knowledge, data, and intangible assets. This is especially true in the field of intellectual property, where technologies are becoming tools not only for creating but also for protecting rights [1;2;3].

Blockchain and AI are the fastest growing technologies that have the potential to radically transform approaches to the registration, management and enforcement of intellectual property rights. The blockchain, with its decentralized nature and immutability of records, allows for transparent recording of IP rights, their tokenization, and automation of contractual relations. At

the same time, AI is changing legal practice by optimizing data analysis, detection of violations, and registration procedures.

Today, as Ukraine seeks to integrate into the EU's Digital Single Market, the issue of legal support for new digital solutions is becoming particularly relevant.Ukraine is actively moving towards harmonization of its national legislation with that of the European Union, in particular in the field of intellectual property protection.This process requires a deeper understanding of the role of the latest technologies in the legal protection system and updated approaches to IP management.

We consider the potential of using blockchain and AI in intellectual property management, taking into account both foreign and Ukrainian experience, as well as the current challenges faced by specialists due to the rapid evolution of technology.

The use of blockchain technologies and AI for the management and protection of intellectual property has been studied by both foreign and Ukrainian scholars:Damij N. Egaji Oche A., Griffiths Mark G., Modic D., Hafner A., Cehovin Zajc, Hugendubel J., Swan M., Kizilov A., Saveliev A., Terenyak I., Yavorsky V. and others.

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2. Understanding Blockchain: Definitions and Classifications

Blockchain is a decentralized distributed ledger technology (DLT) that ensures the immutability, transparency, and reliability of data without the need for centralized control. This makes blockchain ideal for recording, managing and tracking intellectual property rights: copyrights, patents, license agreements, contracts, etc [4].

Blockchain technology was described in 1991 by researchers Stuart Haber and Scott Stornetta [5]. They developed the system using the concept of a cryptographically secure chain of blocks to store time-stamped documents. The evolution of blockchains has been steady and promising. The number of patent and trademark applications related to blockchain technology is growing rapidly. Currently, there are 200 261 patents in the European Patent Organization's databases that mention the word “blockchain” [6]. In a few years, these breakthrough patents could prove to be very valuable.

As M. Swan (founder of the Institute for blockchain studies) notes in his book: “Blockchain is a multifunctional and multi-level information technology designed to for reliable accounting of various assets.Potentially, this technology covers all areas of scientific and technological activity without exception and has many applications.These include finance, economics, and monetary settlements, as well as transactions with tangible (real property, real estate, cars, etc.) and intangible assets (voting rights, ideas, reputation, intentions, medical data, personal information, etc.).Blockchain creates new opportunities for searching, organizing, evaluating, and transferring any discrete units.In fact, it is a new organizational paradigm for coordinating any kind of human activity ” [7].

According to A. I. Savelyev, blockchain is a technology that is a decentralized register of data on transactions, based on cryptographic algorithms that protect it from fraud [8].

In the scientific literature, there are two main approaches to the definition of blockchain technology.According to the first approach, blockchain is seen as a distributed database that can be accessed by all network participants.The second approach interprets the blockchain as a continuous, chronologically ordered chain of blocks, each of which contains recorded information.Additions occur approximately every 10 minutes. Blocks are recorded in the network in a linear, chronological order, which ensures their precise ordering over time. In a broader sense, the blockchain is perceived as a dynamic, constantly growing digital register to which only new entries are allowed. At the same time, it is technically impossible to edit or delete data that has already been entered, which ensures the immutability and reliability of information [9].

A copy of the entire blockchain is stored on each full node (node) of the network - a computer connected to it through a specialized client. This client is responsible for verifying, processing, and transmitting transactions.After a miner or a new node is connected to the network, the full history of blocks is automatically synchronized, starting with the so-called "genesis block" - the first block in the chain, to the very last.

The blockchain framework allows anyone to send information to the network, but only the owner of the corresponding key has the ability to perform operations with this data.The defining features of this system are its decentralization, openness, and high reliability.All these properties are guaranteed by the use of cryptographically secure mechanisms that exclude the possibility of data manipulation or forgery [10].

A blockchain is an application model that encompasses decentralized terminal transmission and cryptography, mass storage, and other computer technologies borrowed from the distributed bitcoin technology. Any blockchain architecture model can be divided into five stages: 1) initiation of a new transaction, 2) distribution of the P2P network, 3) node verification, 4) verification and distribution throughout the network, and 5) recording of the transaction [11].

Blockchain technology is a product of the third generation of information technology. One of the key characteristics of the blockchain is open access to information for all network participants in the absence of centralized control. There is no hierarchical structure in the system: all nodes (nodes) have equal status, and there is no master or controlling node. Each transaction is open and viewable by all network users, which ensures a high level of transparency. The level of trust in a blockchain is directly proportional to the number of participants who support its operation.

The blockchain builds trust because each network participant has access to a full copy of the blockchain with recorded transactions. This is realized by creating a cryptographic hash for each digital object stored in the distributed network.

A unique hash code is formed as a result of a mathematical algorithm and is a digital "fingerprint" of an object that ensures its identification and protection.

A blockchain is a data structure that allows only the addition of new records, but not their modification or deletion. Each block is linked to the previous one by means of a hash. If one of the hashes changes, it immediately changes the hashes of all subsequent blocks, making data tampering virtually impossible. This architecture increases the transparency, reliability, and accountability of the system.

The blockchain ideology and architecture provides for different levels of access to information, which are used as criteria for classifying the types of the technology in question. One of them is the Canadian and British versions of the blockchain classification.

The Canadian classification provides for three types of blockchain: a) Public blockchain - fully decentralized chains of blocks that are accessible to anyone, protected by a combination of

economic rules and cryptographic verification mechanisms (proof-of-work/proof-of-stake). b) Consortium blockchain is a partially decentralized blockchain in which the approval process is controlled by predefined trust nodes. c) Fully private blockchain is a blockchain characterized by a limited level of access to data [5].

The British version, described in the report "Distributed Ledger Technology: beyond block chain", is also divided into three types of blockchain: a) Unpermitted public ledgers - closed public ledgers. b) Permissioned public ledgers - open public ledgers. c) Distributed ledgers - open private ledgers [12].

A common classification is as follows [13]:

1.Open blockchain - there are no restrictions on the use of blocks, despite the fact that block data can be encrypted, as well as on sending transactions for inclusion in the blockchain. A type of open blockchain is a permissionless blockchain - a blockchain in which there are no restrictions on users who can create blocks and conduct transactions.

2. Closed blockchain (private blockchain, consortium blockchain platform) - access to data and transactions is limited to a certain range of entities. A closed blockchain is cheaper and faster than an open one.

3. A permissioned blockchain is not always a type of closed blockchain. This is a blockchain in which information is posted and transactions are processed by a specific list of entities.

These types of blockchain systems allow the technology to be adapted to specific tasks, in particular, in the field of intellectual property - from ensuring copyright transparency to confidential patent portfolio management.

According to D. Alabi, for many organizations, the use of public blockchain is unacceptable due to increased requirements for confidentiality and control. At the same time, in his opinion, it is impossible to establish universal rules for choosing the type of blockchain system. In practice, everything depends on the specific context: in different cases, one or another option is chosen based on a number of factors, such as compliance with contractual terms, the need for integration with existing data sources, security, transaction speed, etc. That is, the choice of blockchain type is always situational and based on a comprehensive analysis of the needs of the system or business model [14].

The decentralized nature of blockchain technology combined with cryptographic algorithms opens up wide opportunities for effective management of information systems.

The consensus mechanism is a key element in the functioning of any distributed application based on the blockchain. Its main function is to determine the node that has the right to generate a new block in accordance with the established rules. This ensures data consistency between all network participants.

However, most of the existing consensus algorithms in public blockchain systems rely on the availability of cryptocurrency, which makes it difficult to use such technologies in contexts unrelated to financial transactions. The absence of consensus mechanisms independent of cryptocurrencies hinders the development of applications focused on other areas, including intellectual property.

What is called "consensus" in the blockchain system is actually the acceptance of a public offer that cannot be revoked, and this is an advantage over other systems for controlling behavior or fulfilling obligations, whether legal, moral or religious.

One of the alternative approaches is the one proposed in the consensus mechanism called Proof of Contribution (PoC) [15]. In this approach, users' actions are evaluated according to certain metrics that form an indicator of their contribution. The node with the highest value in a particular

round is entitled to create a new block. Since this model is not based on the use of cryptocurrency, it can be effectively applied in digital IPR management systems where real contribution to the system is important, rather than financial participation.

In addition to Proof of Contribution (PoC), there are other consensus mechanisms that can work effectively in environments not related to cryptocurrency transactions, including in the field of intellectual property [16]:

- Proof of Authority (PoA) is a consensus based on trust in a limited number of authoritative network participants.New blocks are created only by verified nodes that have special authority. PoA provides high transaction processing speed and reliability, making it suitable for enterprise solutions or government platforms with clearly defined participants.

- Delegated Proof of Stake (DPoS) is a modified version of the Proof of Stake (PoS) algorithm in which users delegate their votes to selected validators responsible for creating blocks. This approach combines efficiency, decentralization, and community control and can be used in platforms where user participation in decision-making is important.

- Practical Byzantine Fault Tolerance (PBFT) is a mechanism designed to ensure consensus in environments with potentially unreliable nodes. PBFT allows you to reach agreement without the need for energy-intensive mining and provides high fault tolerance. It is used in private or consortium blockchains where security and speed are important.

All of these models demonstrate the flexibility of blockchain technology and its ability to adapt to specific needs, including in systems for accounting, registration, and monitoring of intellectual property.

3. Blockchain Applications in Intellectual Property Rights Management

Startup cases and software applications based on blockchain technology can be used in the following areas:

1) Copyright protection, management and reporting

2) New business models of content management through tokenization and community.

Currently, researchers are also focusing on such a type of blockchain as the art blockchain, which is associated with digital art assets - NFT. In recent years, Europe has seen an active growth of WEB 3.0 technologies, in particular the market of non-fungible tokens (NFTs), which is projected to grow by more than, will grow by USD 84.12 billion by 2029 [17]. NFTs are widely used in everything from real estate to digital art. One of the most promising areas is the use of NFTs for copyright protection, as each token is a unique digital asset that certifies the ownership and origin of content [18]. The most promising areas of NFT implementation are art and collecting, video games, and metaverse applications. Today, a model for representing patents in the NFT format has even been developed as a reliable, decentralized form of managing intellectual property on a global level [19;20].

A non-fungible token (NFT) is a unique identifier that is recorded on the blockchain and used to prove ownership and authenticity. It cannot be copied, replaced, or divided into parts. NFTs can serve as an effective means of documenting and proving ownership of digital works. The advantages of NFTs are ensuring authenticity through blockchain, immutability of information, and the ability to use smart contracts to securely regulate legal interactions [21;22]. NFTs are sold on specialized trading platforms such as Open Sea, Axie Marketplace, and Rarible. On these platforms, investors can also exchange ownership of the asset underlying the NFT. And because NFTs use smart contract technology, they can be set up so that the original artist can receive a

percentage of all subsequent sales. However, NFTs are non-fungible, which means that an NFT cannot be exchanged for another, as each unique. It is this uniqueness that allows NFTs to be used to authenticate ownership of digital assets. In addition, each NFT is stored in a public and transparent blockchain (often Ethereum). Thus, NFTs are decentralized applications with a high level of verification, resistance to unauthorized access, ease of use, atomicity, and traceability.

NFTs are of interest in the music industry and require further educational efforts. It is worth noting that "Ukrainian pop and rock bands and soloists also have NFTs in their assets: Svyatoslav Vakarchuk, Tina Karol, KAZKA, Alyona Alyona, Iryna Bilyk, who focus on both commercializing their own star brand and paying attention to charity and social projects in the context of the ongoing war in Ukraine. With the absence or limited opportunities to organize traditional concert and touring tours in Ukraine, NFT auctions have become seen by producers and artists as a new economic activity environment that can support both creative industries and promote socially important volunteer initiatives" [21;22].

In addition to pop performances, experiments with NFT have also reached the world of the fashion industry. Today, fashion brands such as Carolina Herrera, Carlings, Fabrikant, and others are creating digital clothing collections.

The world's leading museums are increasingly using NFT technologies in their activities. For example, the British Museum produces digital postcards in NFT format, and the Pompidou Center has added 18 blockchain artworks by French and international authors to its collection. Specialized NFT museums are also appearing, such as the NFT-ART Museum and others. Starting in 2022, Ukrainian museums will join this trend: The National Art Museum of Ukraine, Kharkiv Art Museum, and the Andrey Sheptytsky National Museum. They are creating their own NFT collections both for sale at auctions and for virtual exhibitions using VR technologies. Ukraine has also seen the emergence of fully digital museum projects - METAHISTORY Museum of War and the virtual museum of the deportation of Crimean Tatars "Tamırlar@".

Their activities are aimed at preserving the historical memory of the crimes of the Stalinist regime and documenting the current military events taking place in Ukraine since 2014.

Blockchain-based platforms, such as CopyrightLY [23;24], implement a decentralized system for managing rights in social media.

Among the solutions already implemented are:

- Copyright Bank [25] - a service for registering and verifying copyrights using the NEM blockchain. It provides digital fingerprints, time stamps, and documents confirming ownership.
- Ujo Music [26] is a decentralized Ethereum-based platform for music licensing, distribution, and automatic royalties.
- Verisart [27] - a tool for authenticating works of art with the ability to create digital certificates.
- LuxTag [28] - a blockchain solution for digital labeling of luxury goods with the provision of authenticity and anti-counterfeiting certificates.

At the same time, it should be borne in mind that most platforms specialize in certain types of content (music, art, collectibles) and may have limited functionality for other intellectual property, such as patents, industrial designs, or utility models. Moreover, the issue of registering titles of protection using blockchain has not been resolved or is only partially resolved.

The growing popularity of generative AI raises the question of protecting the intellectual property it uses. This is where the blockchain, which allows you to record the origin of content by creating immutable records of its creation.

Developers can release NFTs with built-in smart contracts that regulate the use of content: whether it is free use, attribution, or payment for reuse, all of this can be embedded in the code.

Blockchain systems also reduce the risk of accidental copyright infringement: each transaction or use of content is accompanied by a payment, which ensures fair compensation to authors. In addition, it makes it possible to accurately record ownership rights before the content enters AI models.

In the field of copyright, blockchain is gaining popularity due to the non-registered procedure for copyright creation in most countries that are parties to the Berne Convention. Today, there are a number of blockchain platforms, such as Proof of Existence, Keybase, Storj, Blockchain Apparatus, Binded, Monegraph, Verisart, which provide an opportunity to work with documents confidentially, offering various services to copyright holders [29].

Proof of Existence [31] platforms allow the creators of copyrighted works, computer programs, and other digitally stored objects to easily prove their authorship and the date of creation of documents. The cryptographic operation of creating a hash takes place on the client side, and this hash is included in the transaction, and the transaction is included in the block.

The use of BlockAI-type [32] platforms gives rights holders the ability to control the circulation of intellectual property on the Internet and enter into contracts with third parties.After registration, the creator receives a digital certificate confirming the copyright, which allows third parties to identify the owner of the rights to the object.

For example, programs such as Binded, Monegraph, or Verisart can be used to save works. They make it possible to create a permanent record of digital content (data), such as photos and texts, as well as track the history of views, changes, and other actions. Activity logs that are protected from editing can serve as evidence whose authenticity cannot be challenged. In addition, these platforms allow users' activities to be tracked, including by law enforcement agencies and courts.

Trademarks also benefit greatly from blockchain. This technology can provide an immutable record of trademark ownership and use, reducing the likelihood of infringement and ensuring that businesses protect their brand assets. Because blockchain is global in nature, it allows for effective protection of trademarks on an international level, which traditional systems may not always be able to achieve.

The benefits of blockchain for intellectual property management include the creation of a secure digital footprint of the author; automatic compliance with the terms of use; implementation of dispute resolution mechanisms through immutability of records; transparent digital branding and authentication. In addition, smart contracts that are automatically executed can be used to license trademark rights, and can greatly simplify the process of registering trademarks and designs by reducing steps and procedures. The technology also allows you to control and track the distribution of both registered and unregistered intellectual property rights [32].

The blockchain provides a reliable way to record transactions and digital interactions, guaranteeing their security, protection against unauthorized access, transparency, fault tolerance, and the ability to track and control.

The main advantages of using blockchain technology to protect intellectual property rights are the absence of intermediaries and cost reduction, protection of intellectual property rights. The blockchain ensures that the created chain of information is irreversible, which provides a high degree of protection against any interference, making it a significant advantage for this technology in the field of IP [34;35].

Despite its many advantages, blockchain has some disadvantages. One of the main ones is the inability to change information that has already been recorded in the blockchain. This can become a problem if a mistake is made during a transaction, because in this case, it becomes impossible to correct it due to the immutability of the blocks.

It is also worth mentioning 2025, when the Bybit cryptocurrency exchange suffered a large-scale hacker attack that resulted in the theft of almost $1.5 billion from its Ethereum cold wallet [36]. The company emphasized that customer assets are protected at the 1:1 level, and even if the funds cannot be returned, Bybit will cover the losses on its own and plans to take legal action against the hackers.

In addition, new forms of interaction between users of blockchain platforms, tokens, and the platforms themselves will need to be regulated. For example, the US Securities Commission has already raised the issue of regulating the issuance of tokens as securities, which emphasizes the need for legal regulation in this area.

Another problem is the inability to verify the ownership of digital objects, but this can be solved by using a digital identification system for the person hashing the document [37;38].

It is worth noting that in May 2020, the World Intellectual Property Organization (WIPO) introduced a new service for the electronic identification of intellectual property called WIPO PROOF [39]. One of the key advantages of this system was the ability to quickly obtain reliable digital confirmation of the existence of a particular digital object at a certain point in time at a relatively low cost. According to the information published on the official WIPO web portal, WIPO PROOF was positioned as a digital notary service that generated a timestamp in the form of a unique token. This token served as a proof that a certain digital file existed on a certain date and time, and also ensured the protection of the relevant information from unauthorized access. Effective February 1, 2022, WIPO Member States decided to discontinue the provision of WIPO PROOF digital time stamping services, given the rapid evolution of the market in this area and the reassessment of the economic feasibility of this service [40].

The introduction of an intellectual property rights register based on blockchain technology could have a significant positive impact in Ukraine. By analogy with the transition of the State Land Cadastre to a blockchain architecture, the government of Ukraine became one of the first in the European Union to adopt the relevant Resolution of the Cabinet of Ministers of Ukraine [41], which allowed the use of this technology to provide extracts from the State Land Cadastre.

The implementation of such a model in the field of intellectual property ensures a high level of transparency, data protection, and economic feasibility. It is also important to emphasize that blockchain-based solutions in this area have the potential to operate independently of government agencies, which further strengthens user trust.

However, the effective implementation of such a service requires the prior adoption of relevant legal and regulatory acts that will define the legal status, operational features, and liability for the improper use of the platform. The main goal of creating such services is to provide legally significant proof of authorship, as well as to simplify the monitoring of the use of intellectual property objects such as photographs, literary and artistic works, music, films, and so on. To enhance the efficiency of the industry, it is possible to create several specialized platforms based on blockchain technologies [42].

The level of efficiency and security of blockchain technologies largely depends on the digital awareness and competence of users. To improve this level, Ukraine has implemented the educational project “Crypto Literacy and Blockchain” on the Osvita. Diia platform.

At the same time, a number of aspects related to the implementation of blockchain solutions in various areas, including socio-economic activities, require further comprehensive scientific study. In the context of rapid digitalization, where innovation and creativity play a crucial role, the issue of copyright protection is of particular relevance. This applies primarily to the field of education and teaching, where the main mechanism for enforcing rights is currently the system of titles of protection, but there is a growing need for updated approaches adapted to the digital environment.

However, despite significant progress in the use of blockchain technologies for intellectual property protection, further improvement of these systems requires not only technical modernization, but also a comprehensive regulatory framework and active educational work. At the same time, blockchain remains subject to criticism due to a number of issues, the most discussed being the significant energy consumption caused by the mining process and technical limitations arising from consensus mechanisms.

As blockchain technology becomes more popular, industry participants and blockchain developers are increasingly collaborating to develop standards and interoperability protocols. Various government agencies and intellectual property registries, such as the European Union's Intellectual Property Office, are actively exploring blockchain opportunities; the EU Commission is planning to establish a blockchain observatory, and the US Congress recently created the Congressional Blockchain Caucus [43]. Global standards for self-executing contracts are being discussed by various organizations. However, they all agree that a set of internationally agreed and supported standards is needed for blockchain technology to succeed in managing intellectual property rights.

In general, the Metaverse and its technological elements (blockchain, artificial intelligence, digital avatars and personas, big data, identification information, cryptocurrencies, etc.) require the establishment of rules governing their creation, operation, and use. The development of this topic, the general design and regulations for the Metaverse begins with the formulation of relevant concepts and categories based on the results of an in-depth study of technologies, in particular blockchain and its practical application [44].

The actualization of the issue of blockchain use at the international level gave impetus to the creation of the International Association for Trusted Blockchain Applications (INATBA) in April 2019, which brings together suppliers and consumers of distributed ledger technology, as well as representatives of governments around the world to ensure compatibility and legal certainty of use relevant technologies [45]. It was the said organization in cooperation with the International Organization for Standardization within the framework of Technical Committee 307 that developed the technical regulations ISO/TR 23455:2019 (Blockchain and distributed ledger technologies - Overview of interactions between smart contracts in Blockchain and distributed ledger technology systems)[46] ISO/TR 23244: 2020 (Blockchain and distributed ledger technologies - Privacy and personally identifiable information protection considerations),[47] as well as ISO/AWI TS 23259 (Blockchain and distributed ledger technologies - Legally binding smart contracts),[48] which is currently being developed. In addition, the ISO TC68 Financial Services Technical Committee has created a multidisciplinary international standard ISO 20022, which describes the general requirements for all messaging platforms and applications (including those used within the Blockchain network).

Since 2022, Ukraine has joined the Government Advisory Board (GAB) of the International Association for Trusted Blockchain Applications (INATBA), which aims to implement technologies at the national and international levels. The association includes representatives of

38 countries and organizations such as the European Commission, the World Bank, the World Trade Organization (WTO), and others [49;50]. Ukraine is represented in this international blockchain association by the Blockchain4Ukraine IFI, which will work to change our global technological leadership.

It should be noted that in 2023, the Chinese government published the first national standard for the blockchain technology industry, which sets the criteria for the application of this innovation and the conditions for development in China. Also The document standardizes the requirements for the architecture and key elements of the system.

Currently, there are a number of technical challenges that hinder the widespread adoption of blockchain technologies for intellectual property registration. One of the main problems is the scalability and accessibility of such systems. Blockchain networks often require significant resources, which can be prohibitive for small businesses or independent authors. The costs of implementing and maintaining such solutions sometimes become a serious obstacle, especially for those who could benefit from them the most. In addition, the technology requires specialized technical knowledge, which is not always available to creators or small companies.

Another challenge is the risk of fragmentation. As more and more industries and companies create their own blockchain solutions for managing intellectual property, there is a risk of a large number of incompatible platforms. The lack of common standards and interoperability between them can lead to chaos, complicate the verification of property rights, and reduce the effectiveness of the technology itself as a global tool.

Blockchain has all the prerequisites to transform the field of intellectual property protection. However, its full potential can only be realized if these barriers are overcome - through coordinated cooperation between technical experts, lawyers, regulators and platform developers.

Today, many modern startups are focused on developing digital platforms for integrated intellectual property management. Among them:

- Trademark Now is a platform for automated trademark management;
- Cognition IP (a startup within the YCombinator business incubator) - offers tools for searching for patents, creating application templates, and supporting their filing and registration;
- Copytrack - specializes in monitoring copyrighted works, detecting infringements and recording unauthorized use of content without a license;
- UDIAR (Unified Depository of Intellectual Activity Results) - creates a unified digital depository of intellectual activity results, which allows depositing copyrighted works in digital format with the possibility of further sale or licensing.

Innovations in the legal sector, in particular in the field of intellectual property, are gaining new value due to their ability to provide a full cycle of rights protection - from registration to commercialization.

At the same time, it is important to realize that technology itself does not replace legal responsibility: it rather performs a preventive function in the digital environment, where legal relations are constantly transforming. In addition, the peculiarity of the digital age is that any user can become a creator. As a result, creativity becomes massive, and thus partially loses its uniqueness.

These changes are taking place against the backdrop of significant technological shifts. As noted in the introduction to the European Parliament's resolution on civil law and robotics (2015/2103(INL), point P), it cannot be ruled out that in the long run artificial intelligence may surpass human intellectual potential.

Therefore, modern legal science should play a prognostic role, which is critical in the context of rapid digitalization, which is already shaping the contours of the legal practice of the future.

4. Blockchain and the Law: Regulatory Perspectives

On April 10, 2018, 30 European countries signed the Declaration on the establishment of the International Blockchain Partnership, which aims to create the European Blockchain Services Infrastructure (EBSI) to ensure the provision of digital services in compliance with cybersecurity and personal data protection standards. European states have agreed to jointly study the use of Blockchain in various areas of business, where it will be most efficient [51]. As a result, on October 3, 2018, the European Parliament adopted a Resolution on distributed ledger technology and blockchain aimed at building trust without limits. The Resolution defines the basic concepts of distributed ledger technology, smart contracts, as well as their application in various sectors, such as energy, finance, healthcare, education, supply, intellectual property protection, transport, and requirements for the development of this technology, including standardization, scalability, consistency of distributed ledgers and legal support for their operation [52].

In 2019, the United Nations Economic Commission for Europe (UNECE) held a discussion and prepared a report on the need to introduce blockchain in trade finance, the so-called "White Paper. White Paper. Blockchain in Trade Facilitation"

In the same year, the European Blockchain Observatory and Forum was created, a platform that promotes the integration of blockchain technologies into the business environment. The platform researches the legal and technical aspects of blockchain, as well as supports training and implementation of the findings. At the EU level, the analysis of the application of various directives and regulations to blockchain is ongoing, in particular: 1) the Electronic Identification Directive (eIDAS), which, as of September 29, 2018, ensures mutual recognition of electronic identifiers in the EU after hardware and software are brought to a single standard; 2) the Rome I Regulation, which defines conflict-of-laws rules for binding relations in Europe [53]; 3) the Anti-Money Laundering Directive, which increases transparency and limits anonymity associated with virtual currencies; 4) the E-Commerce Directive and the consumers, requiring suppliers to provide consumers with all necessary product information [55;56]; 5) the General Data Protection Regulation, defining the "right to be forgotten" and guaranteeing data security [57].

Building on the EBP and the work already done for the EBSI, EUROPEUM-EDIC was established in May 2024 as a new legal entity formed by a consortium of nine member states to strengthen cooperation in the field of blockchain and Web3 technologies. This initiative aims to use the EBSI infrastructure to deliver cross-border public services across the EU, building trust and cyber resilience in line with EU regulations, including the European Digital Identity System [58].

Thus, Europe is currently developing a common legal framework for the implementation of Blockchain technologies in various areas of business.

In the United States, the processes of in-depth implementation of Blockchain technology are also underway, which is reflected in national legislation, which, in turn, “brings to a common denominator” the legal novels of Arizona (Arizona Electronic Transactions Act), Delaware (Delaware General Corporation Law), Wyoming (Wyoming Money Transmitter Act), Tennessee (Tennessee Uniform Electronic Transactions Act), etc [59]. The legal regulation of Blockchain use at the federal level began with the adoption of the E-SIGN Act in 2000, which recognizes the legal significance of electronic digital signatures, including cryptographic signatures, to certify entry into certain categories of transactions. In 2014, the Fiduciary Access to Digital Assets Act was

passed, which sets out the procedure for managing digital trust assets (computer files, virtual currency, but not email or social media accounts) [60]. At present, legislative work in this area is in full swing.

One of the main problems of using blockchain is law enforcement in different jurisdictions. For example, copyright and related rights are regulated by different laws in different countries, and the integration of blockchain and AI into these different legal systems is difficult. While blockchain can create a single global registry, enforcing intellectual property rights across borders remains challenging. National and international laws will need to be adapted to recognize intellectual property rights registered on the blockchain as legally valid in multiple jurisdictions, which may take years to develop and standardize.

Many legal systems are still unfamiliar with blockchain and may not yet trust it or recognize it as a legitimate tool for registering intellectual property. Governments and regulators will need to create a framework to allow for the recognition of copyrights and trademarks registered on blockchain. This process may involve new laws or amendments to existing ones, which will likely require extensive legal reform.

Countries with market economies have long realized that the level of efficiency of intellectual property rights protection directly affects the level of development of the state economy, and also emphasize that today's digital technologies are inextricably linked to the protection of intellectual property rights. That is why Ukraine, which seeks to effectively develop its market economy, is increasingly paying attention to innovative security technologies, among which blockchain plays an important role.

Blockchain technology is essentially a computer code that defines the rules for the functioning of a particular program. Like any software, it is not immune to errors and vulnerabilities, the so-called “bugs.” This means that transactions or agreements embedded in the form of smart contracts in the blockchain program code may not be executed properly or at all due to a technical error. The consequences of such failures, including disputes between the parties whose interests have been violated, should be regulated by legal rules or predefined contractual provisions that are already being integrated into smart contracts at the stage of their creation.

Experts emphasize that blockchain is not a universal solution to all legal and technical problems. For example, the issue of the transfer of works to the public domain cannot be resolved by technical means alone - it requires not only an appropriate legal framework but also effective state mechanisms for its implementation.

At the same time, the world is gradually recognizing the legal force of blockchain technologies. For example, the state of California legalized the use of blockchain and smart contracts, the state of Arizona recognized the legal force of blockchain back in 2017, and the United Kingdom initiated a project aimed at exploring the possibilities of legislative recognition of smart contracts. In China, the Supreme People's Court has officially recognized blockchain as a valid tool for authenticating evidence in litigation.

In Ukraine, Blockchain technologies have been used in public authorities since 2017. Thus, the Cabinet of Ministers of Ukraine approved the implementation of measures to introduce a Blockchain data storage and protection system in the work of the real estate property rights registry and the electronic trading system SETAM of the Ministry of Justice of Ukraine. Subsequently, the Ministry of Justice of Ukraine, the Ministry of Agrarian Policy and Food of Ukraine, the State Agency for E-Governance of Ukraine, the NGO Transparency International Ukraine and Bitfuri Holding BV signed a Memorandum of Understanding and Cooperation (hereinafter - the

Memorandum) to create and maintain the land cadastre and other state registers based on Blockchain technology, as well as to develop a methodology for the use of Blockchain in the public sector. Thus, the updated State Land Cadastre has already been formed on Blockchain technology.

On October 6, 2017, the Draft Law "On the Circulation of Cryptocurrency in Ukraine" No. 7183 [61] was submitted to the Verkhovna Rada of Ukraine, which contained the terms 'cryptocurrency', "cryptocurrency exchange", "Blockchain system", "Blockchain system user", "cryptocurrency owner", "miner", 'mining', "Blockchain system reward", "transaction block", etc., which also touched upon the issues of state guarantees, mining and use of cryptocurrency and the operation of a cryptocurrency exchange. However, the draft law was withdrawn.

An important event in Ukraine was the adoption of the Law No. 2074-IX "On Virtual Assets" dated February 17, 2022 [62]. According to the Law, virtual assets will not compete with the hryvnia and will not be a means of payment. At the same time, Ukraine will be able to legally operate on international exchanges where virtual assets are traded [63].

As of today, Ukraine has no special legal regulation on the use of blockchain technology in the field of intellectual property protection. In this regard, blockchain technologies are considered as a type of computer programs or databases, and accordingly fall under the general provisions of copyright law, in particular [64].

1. the use of blockchain technology must be carried out in compliance with the basic principles of copyright;

2. blockchain programs are protected as literary works;

3. an object created and recorded using blockchain is recognized as an object of copyright from the moment of its creation;

4. copyright in information systems built on the basis of blockchain does not depend on the fact of their state registration or any other formalization;

5. copyright protection applies to all works that can be recorded and protected using blockchain technologies.

In the context of the rapid development of digital technologies and general digitalization, the issues of inheritance of digital assets and intellectual property have become particularly important. In particular, the transfer of copyrights to digital works and products requires clearly defined legal regulation that would guarantee the proper transfer of property rights along with access to the relevant digital resources. At the same time, it is necessary to take into account the specifics of storage and administration of such assets in the digital environment [65]. According to M. I. Pypiak and Y. A. Kokarch, one of the key factors in creating a legal framework for digital inheritance is the ability to record a person's will in the online space. Amendments to the current legislation should integrate the concept of digital inheritance as an integral part of the inheritance process, as well as provide for effective legal mechanisms for implementing the testator's will in relation to digital assets. This includes, in particular, the regulation of court procedures in disputes related to digital inheritance and the determination of the legal status of the relevant assets. Thus, the formation of a clear and coherent legal framework in this area is a prerequisite for the proper regulation and management of inheritance rights in the digital age [66].

In Ukraine, the use of blockchain for the protection of intellectual property rights is still in its infancy. Both Ukrainian and foreign researchers have repeatedly emphasized the importance of integrating this technology into the legal system of intellectual property protection. Among the key advantages of blockchain in this area are: decentralization; distribution; transparency; cryptographic protection; anonymity; publicity; speed; efficiency.

Despite the fact that blockchain technology is at the stage of active development, it is increasingly being used in the field of intellectual property in Ukraine. The main areas of its use include: smart contracts in the field of intellectual property; identification of authorship and confirmation of property rights; creation of an intellectual property market platform; unification of the global patent system; version control of digital assets; creation of a register of unregistered rights.

One of the serious threats is the centralized approach to the development of blockchain projects and the focus on creating closed distributed systems. Another problem is the insufficient level of the legal framework for conducting transactions in the digital environment and recognizing digital circulation. Other challenges include imperfect legal regulation of the use and processing of data, the procedure for accessing them and liability for unauthorized use, as well as the difficulty of legitimately registering the results of intellectual activity in digital form.

In order to fully realize the potential of blockchain technology in the field of copyright management, the blockchain must be used by a wide range of rights holders and cover a sufficient number of copyrighted works. As the number of users increases, the system will become even more valuable and attractive to a wider audience. The unique potential of the blockchain also lies in the possibility of creating secure decentralized platforms for interjurisdictional data exchange, which will facilitate cooperation, in particular in the protection and management of intellectual property rights.

The ownership of an intellectual product is determined by law, and its value and efficiency depend on the methods of distribution and the social costs that arise from this process.

Blockchain technology can significantly reduce transaction costs, increase commercialization and ensure reliable protection of intellectual property. The task of state regulation is to clearly define the digital circulation of intellectual property and ensure a balance between the private interests of right holders, users and the public good in the form of the possibility of free circulation of intellectual property of universal value.

In order to fully utilize the potential of this technology, close cooperation and interaction between all stakeholders within the framework of distributed registries is required.

Blockchain is a unique platform with unified processes to support such a structure. It is important that the information shared between stakeholders helps to achieve goals without violating existing laws and regulations.

In the future, artificial intelligence will open up new opportunities, as blockchains will automatically optimize prices and profits using the data stored in the registry and automatically initiating decisions and actions.

Therefore, from the point of view of state legislation, it is very difficult to implement rules for a system that does not fall under its jurisdiction. An autonomous system maintained and controlled by users themselves, without the influence of government organizations, can create a supranational economy where the traditional concept of a legal entity will be completely inapplicable. The high level of anonymity of blockchain is a problem for legislation.

Thus, legislation should adapt to new technologies. Given the cross-border nature of blockchain, it is also necessary to harmonize legislation at the international level, in particular with regard to the establishment of applicable law. It is important to direct the efforts of state and international bodies to regulate the protection of the rights of users of such technologies, in particular to include provisions on copyright and related rights to objects in digital form.

5. Artificial Intelligence and Blockchain

Artificial intelligence is a branch of computer science that aims to create systems that can mimic or surpass human cognitive functions, including learning, understanding, decision-making, and language interaction. The nature of AI is a combination of algorithms, models, and data structures that allow machines to recognize patterns, adapt to changes, and perform tasks without direct human intervention [67;68].

Philosophically and functionally, AI is an attempt to model human intelligence, although most modern implementations have a narrow specialization (e.g., image recognition, risk prediction, text analysis) rather than a universal mind.

Artificial intelligence is a system of algorithms capable of self-learning, data analysis, automated decision-making, and pattern recognition. "Artificial intelligence is a computer program based on algorithms for analyzing relevant data and algorithms for making autonomous decisions based on them, in the course of which it can learn from experience and improve its own efficiency through data analysis in order to achieve its goals [69]." In the field of IP, AI is used to detect copyright infringement, predict market risks, automate the registration of objects, and create new forms of creative content [70].

Currently, there is a competition in the field of artificial intelligence between two main approaches: symbolic and connectionist. They can be described as follows:

Top-Down AI (top-down approach) is also known as semiotic or symbolic. It is based on the creation of expert systems, knowledge bases, and logic mechanisms that simulate high-level cognitive processes: thinking, reasoning, speech, emotions, creativity, etc.

Bottom-Up AI (bottom-up approach) - or biological, connectionist. This area focuses on the study of neural networks and evolutionary algorithms that model intelligent behavior by imitating the principles of biological systems. Technologies such as neurocomputers are created on the basis of this approach.

Today, more and more attention is paid to the connectionist approach, especially after the breakthrough in deep learning.

The variety of approaches to the definition of artificial intelligence (AI) has led to the emergence of several classifications that allow for a better understanding of the complexity and capabilities of these technologies. Scientists usually divide AI into three main categories:

1.Weak Artificial Intelligence (ANI) - these are systems focused on solving specific tasks that can also be performed by humans. Examples: voice assistants, chatbots, recommendation systems. They do not have their own consciousness and are not capable of independent thinking.

2. Strong artificial intelligence (Artificial General Intelligence (AGI)) is a hypothetical system capable of performing any intellectual tasks available to humans, regardless of the context. Such AI implies the presence of understanding, learning, intuition, and adaptation at a level comparable to that of humans.

3. Artificial Superintelligence is a hypothetical level of AI development that exceeds human intelligence in all areas: creativity, decision-making, scientific research, and emotional perception. Such a system may have consciousness and subjective perception of reality.

Scientists also classify robotic systems according to the level of their anthropomorphism and functionality:

- Simple robots perform mechanical or programmable actions.
- Android robots have a human appearance and limited autonomy.

- Androids are high-tech systems capable of imitating gestures, emotions, and social interaction.

There are already examples of such systems in practice: ASIMO is a humanoid robot capable of movement and gestures; Kismet is a robot that expresses emotions; Siri is a voice assistant with natural language processing functions.

With the increasing complexity of intellectual property (IP) management, artificial intelligence (AI) and machine learning (ML) are coming into play to optimize processes and improve accuracy. These technologies are being actively integrated into various aspects of intellectual property law, from analyzing large amounts of data to detecting infringements.

One of the main functions of AI and ML is to help identify and enforce intellectual property rights. Traditional methods of detecting copyright or trademark infringement are often time-consuming and labor-intensive. Instead, AI-powered tools can quickly scan the Internet, databases, and digital platforms to identify unauthorized use of protected material or potential infringement. Such automated monitoring saves time and allows for more comprehensive searches, covering a larger amount of data than is possible with manual methods.

In the field of patent law, AI and ML contribute to the improvement of patent analytics. AI-powered systems can analyze existing patents, prior art, and technical documentation to help companies determine whether their inventions are truly new. This speeds up the filing of patent applications and reduces the likelihood of rejection due to similar patents. AI tools can also identify trends and predict the likelihood of patent application success by analyzing previous court decisions and cases.

For trademark registration, AI helps automate the search process. AI-powered platforms can quickly scan global trademark databases to check whether a new trademark infringes on existing ones. This significantly speeds up the approval process and reduces the likelihood of legal conflicts after registration.

Predictive legal analytics is another important area where AI and ML are transforming intellectual property law. The process of analyzing large amounts of legal data allows AI to predict the outcome of intellectual property disputes, helping companies assess their chances of success in litigation. This allows for businesses can make more informed decisions about whether to go to court or settle a dispute out of court [71].

Overall, the role of AI and ML in IP law is to reduce errors, increase efficiency, and provide businesses with useful insights that would be difficult to access through traditional methods. As these technologies continue to evolve, their impact on intellectual property management will only increase [72].

With the development of AI and ML, new tools have emerged to automate and simplify the protection of intellectual property. These tools help businesses and lawyers to work more efficiently with various aspects of IP law, from searching for prior art to monitoring brands and detecting copyright infringement.

Currently, PatSnap and Innography are widely used for patent search, analysis, and trend detection: they use AI algorithms to process large amounts of data and provide useful information to businesses. AI significantly improves search efficiency, allowing you to find relevant prior art faster and assess the novelty of inventions.

TrademarkNow and CompuMark are popular tools for searching and registering trademarks. They use AI to scan global databases and identify potential conflicts, which helps businesses avoid legal issues. AI greatly simplifies the trademark search process, making it faster and more accurate.

Currently, Pixsy and Copytrack are actively used for copyright protection. They effectively detect copyright infringement. AI helps to monitor unauthorized use of content and helps creators to protect their rights.

In general, AI-powered IP management tools have become an important resource for businesses and lawyers. They help increase efficiency, accuracy, and strategic insight. With the development of AI, these tools will become even more powerful and advanced, which will bring intellectual property management to a new level.

The advantages of both blockchain and AI are speed, accuracy, cost reduction, and minimization of the human factor. Blockchain eliminates the possibility of data fraud or disappearance, while AI allows you to work with large amounts of information in real time.

As artificial intelligence (AI) continues to evolve, it creates unprecedented opportunities along with critical challenges. Ensuring that AI complies with ethical principles, human rights and legal standards requires a robust regulatory framework.

In its latest report, the INATBA Working Group on the Convergence of Artificial Intelligence and Blockchain, AI Regulation and Blockchain: Bridging Ethics and Governance, highlights this timely topic. By analyzing regulatory frameworks in different regions, including the EU, the US, Brazil and China, the report explores similarities and differences in approaches to AI governance [73].

In the future, these technologies will form the basis of a new intellectual property infrastructure - automated, transparent, and focused on the global digital economy. Their integration creates the potential to create smart rights management systems that operate without intermediaries and adapt to changes in the legal environment.

The integration of blockchain and artificial intelligence technologies opens up a wide range of opportunities for improving information systems in various industries [74]. In particular, it makes it possible to

- Increase the level of data security and transparency. Blockchain technology ensures the integrity and reliability of stored data by fixing it in an unchanging sequence of blocks. This is especially relevant for processing confidential information in areas such as healthcare, financial services, and public administration. At the same time, artificial intelligence algorithms help analyze large amounts of data, identify statistical patterns, and perform predictive modeling to support management decisions.

- Optimize complex management processes.

In the field of logistics and supply chain management, artificial intelligence can be used to predict consumer demand, manage inventory, and optimize deliveries. Blockchain technology, in turn, provides the ability to track the movement of goods in real time and confirm their authenticity.

- Develop adaptive systems with a self-learning function.

The use of machine learning methods allows creating systems capable of self-improvement based on the analysis of accumulated data. Combining such algorithms with blockchain technologies can provide decentralized management that adapts to changes in the environment without the need for centralized control.

- Provide protection against unauthorized interference and abuse. The use of blockchain to verify the authenticity of data and artificial intelligence models reduces the risk of their falsification or modification. This approach helps to increase the level of trust in the functioning of intelligent systems.

- Improve the functioning of smart contracts.

Smart contracts are automated algorithms that perform certain actions under predefined conditions. In combination with blockchain platforms, they allow creating reliable and secure mechanisms for fulfilling obligations without the participation of intermediaries.

- Promote the formation of decentralized management systems.

Blockchain makes it possible to implement management models that do not involve centralized control. Such systems can be effectively applied in the processes of electronic voting, digital rights management, resource allocation, and data access control. - Develop adaptive systems with a self-learning function.

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The number of publications discussing possible industries and applications of blockchain and artificial intelligence, especially in the field of intellectual property, is growing every year.

Today, it is only natural that more and more companies are seeking to combine the benefits of blockchain and artificial intelligence in practice. There are dozens of examples, and the range of applications of this tandem is very wide: energy, finance, agriculture, medicine, logistics, retail, art, law enforcement, etc [75;76;77;78].

The advantages of combining blockchain and AI are obvious: these technologies are universal, efficient, and complementary. As innovations develop, their application areas will grow, making many processes in everyday life more reliable, efficient, and secure. According to Emergen Research, in 2020, the blockchain solutions market will grow from in 2017 was estimated at $226.9 billion, and by 2028 it is expected to grow to $1,414.1 billion with an average annual growth rate of 25.6%.

These technologies do not compete, but rather reinforce each other. And this tandem will facilitate their massive adoption and positive impact on various spheres of life.

The integration of blockchain with generative AI opens up new opportunities for copyright protection, transparency, and legal regulation in the digital age. More and more companies and developers are choosing this path for the efficient, ethical, and controlled use of future technologies.

Recently, there has been a growing interest in the concept of intellectual management or intelligent control in academic circles, which is gradually shaping a new paradigm in public

administration. This necessitates a deeper analysis of the state of its scientific development and understanding of the content of this concept.

Historically, the concept of intelligent management dates back to 1971, when American scientists J. Saridis and K. Valavanis presented it to the Technical Committee of the Society for Control Systems of the United States. These were the first steps towards the formation of the theory of cognitive control systems capable of adaptation and interaction with the environment. The main idea was to make autonomous decisions in structured and unstructured environments by combining artificial intelligence, human thinking, and automated control systems and the use of powerful computer technologies.

The peculiarity of intelligent control is that it does not have a rigid boundary between the controlling element and the object of control - control mechanisms can not only influence the object but also change its structure or functions.

Such control is able to operate under conditions of an insufficiently clearly defined goal, allowing it to be refined in the course of the system's operation. To be effective, intelligent control systems need to adapt to dynamic external changes, which requires flexibility, hierarchy, and the ability to evaluate alternatives.

In today's digital environment, where artificial intelligence technologies are intensively developing, the formation of the concept of intelligent management is increasingly associated with the need to effectively use and protect the results of intellectual activity. Intelligent governance is based on the synergy of artificial intelligence, knowledge, cognitive technologies and intellectual capital, which necessitates the use of modern mechanisms for protecting rights, including through blockchain technologies.

Blockchain, as a decentralized system for registering and verifying data, ensures transparency, immutability and reliability of information, which is especially important in the context of intellectual property management, for example, for recording copyrights, tracking license agreements or managing digital assets.

Combined with artificial intelligence technologies, blockchain allows for the implementation of autonomous management systems that independently assess situations, make decisions, and verify them through smart contracts.

Intelligent management, complemented by blockchain solutions, creates the preconditions for a new model of digital governance - one that involves the integration of knowledge, technology, management algorithms, and trust mechanisms. This is especially important in an increasingly complex and dynamic environment, where the effectiveness of management systems depends not only on the accuracy of calculations or the speed of response, but also on the ability of systems to self-adapt, self-verify, and ensure the legal force of decisions.

Conclusions

Thus, blockchain technologies, in conjunction with artificial intelligence, are becoming the foundation for a new intellectual paradigm of public administration, which increases the level of digital security, responsibility, accountability, and trust between all participants in the management process.

The combination of blockchain technology, artificial intelligence (AI), and machine learning (ML) is significantly changing approaches to the registration, protection, and enforcement of intellectual property (IP). These technologies not only simplify and speed up IP management, but also provide new levels of transparency and security that were previously impossible to achieve.

Blockchain has the potential to revolutionize copyright and trademark registration by providing immutable records and simplified cross-border protection. At the same time, artificial intelligence and machine learning are opening up unprecedented opportunities for IP analytics, from automating patent searches to detecting infringement in real time. Together, these technologies are making IP law more accessible to businesses of all sizes, enabling them to better protect intellectual assets in the face of rapid digitalization.

However, the introduction of these technologies also raises important ethical and legal issues. As artificial intelligence begins to create its own content and make decisions about intellectual property management, regulators need to develop clear rules on ownership and liability. It is also necessary to ensure the fairness and transparency of AI algorithms to avoid bias and unfair results.

The future of intellectual property law directly depends on the ability of legal systems to adapt to these technological changes. As blockchain, artificial intelligence, and machine learning continue to evolve, businesses, creators, and lawyers must utilize these tools to remain competitive in a world where intellectual property is becoming one of the most valuable assets. It is important for companies and individuals to be aware of and prepared for these innovations, as this will allow them to better navigate the development of IP law. The challenge is not only to understand the potential of blockchain and AI, but also to shape legal systems that support their integration.

However, the main problem with the implementation of distributed ledger technology for managing IP rights is the complexity of the technology itself. Despite its great potential, blockchain faces a number of legal challenges in the IP context.

For example, it is difficult to determine which laws apply to blockchain transactions due to its decentralized nature. In addition, the immutability of blockchain records may conflict with data protection rules, such as the EU General Data Protection Regulation (GDPR), which includes the "right to be forgotten." Therefore, the legal status of blockchain records and smart contracts varies from jurisdiction to jurisdiction, making it difficult to use them for intellectual property rights management.

Blockchain technology can greatly improve the process of documenting and verifying ownership of intellectual property, especially in patent law, where proof of ownership is key in infringement disputes. Blockchain can provide an immutable record of patent transfers, solving the problems associated with insufficient documentation in international transactions. Blockchain records of ownership can also be useful in corporate transactions, due diligence processes, and bankruptcy cases.

In the context of Ukraine's gradual approximation to the EU legal area and its commitments to harmonize national legislation with EU law, the analysis of the prospects for legal regulation of artificial intelligence in the European legal field deserves special attention. With this in mind, on December 2, 2020, the Cabinet of Ministers of Ukraine approved the Concept of Artificial Intelligence Development in Ukraine. The document defines artificial intelligence as an organized set of information technologies that allows solving complex problems using a system of scientific methods and algorithms for processing both received and self-generated information. These systems are also capable of creating and applying own knowledge bases, decision-making models, data analysis algorithms, and ways to achieve certain goals. Accordingly, the field of artificial intelligence is defined as a branch of information technology aimed at developing, implementing and using such technologies.

At the same time, despite the obvious advantages that artificial intelligence (AI) and machine learning (ML) bring to the field of intellectual property (IP) rights management, their active implementation is accompanied by numerous legal and ethical challenges. As these technologies become more widespread, there is a need to critically reflect on their interaction with issues of ownership, authorship, and fairness.

Another important ethical challenge is the risk of algorithmic bias. Since machine learning systems depend on the quality and representativeness of training data, any distortions in this data can be reproduced in the AI's work. This is particularly relevant for tools that automate trademark search or management of other IP. For example, the algorithm may unconsciously ignore certain marks due to a preference in training data for certain regions, languages, or economic sectors, potentially leading to discriminatory results.

Another concern is the role of AI in enforcing IP rights. Platforms that automatically detect possible copyright or trademark infringement may mistakenly identify legitimate uses as illegal. Such "false positives" can lead to legal disputes, financial costs, and reputational risks for rights holders and users. In addition, the use of AI in legal practice, in particular in predicting the outcome of legal proceedings, raises questions about the transparency of decision-making and the identification of responsible parties in case of errors.

The broader ethical question is how much reliance on automated systems is appropriate in a field where individualized approach and legal context are critical. Excessive automation risks simplifying the analysis of legal situations to the detriment of fairness and accuracy.

To respond to these challenges, new regulatory frameworks need to be developed to ensure both effective regulation of the use of AI in the IP field and compliance with ethical standards. Key measures may include: establishing clear rules for the protection of works created with the help of AI, increasing the transparency of algorithmic processes, and introducing mechanisms for liability for the consequences of errors or bias in the operation of AI systems.

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