

The Impact Of Blockchain Technology On Intellectual Property (IP) In Reshaping The Secure Digital Environment.

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How to cite this article: Prodipta Barman, (2024). The impact of blockchain technology on intellectual property (IP) in reshaping the secure digital environment, Library Progress International, 44(3), 6776-6784.

Abstract: This paper aims to examine the influence of the blockchain technology on the field of IP, as well as its capabilities of redesigning the safe digital space. Blockchain has decentralized, transparent and most of all, incapable of being altered systems which gives great opportunities for IP holders – better protection, less cost and transparent tracking of ownership.

In qualitative interviews with IP specialists and developers, content creators, and concrete examples of blockchain-based IP marketplace such as Ujo Music, IPwe, Mycelia, this research offer the discussion about how blockchain can make IP market more effective, change costs, and be secure. The findings confirm that utilization of these platforms minimizes transaction time by up to 60% and transaction cost by up to 40%, as well as driven home their usefulness in fending of security breaches.

The research outlines several important concerns that include regulatory requirements for decentralized platforms, legal tender status for smart contracts, problems of capacity in blockchain and higher energy use. Solving these issues must be crucial for increasing the popularity of blockchain usage in the management of IP. Further, this research proposes that there is a need to advance blockchain infrastructure and operating systems that are efficient and energy effective in the future. In addition, work should be done to design legal environments that are compatible between the jurisdictions in case of blockchain application. In summary, this research work affirms that blockchain is capable of transforming the management of IP by providing a decentralized, trustworthy, and effective setting but effective implementation of the platform awaits the resolution of legal and technical limitations as well as environmental issues.

Keywords: Blockchain technology, intellectual property (IP), digital environment, IP management, transparency, security.

1. Introduction

1.1 Background of Intellectual Property in the Digital Era

Intellectual Property (IP) belongs to the legal categories of property of contemporary economies, the purpose of which is aimed at protecting creations of persons and legal entities that provide exclusive rights for their use and sale. Nevertheless, in recent years, due to the advancement in technology specifically the supply of internet around the world, the safeguarding of IP has not been an easy thing to achieve. Readily accessible through the digital environment content can easily be copied, and passed on to the unauthorized users thus violating copyright, trademarks and patents. Research indicates that digital piracy and IP theft have a direct impact to industries in terms of financial loss estimated to cost the world industries billions of dollars annually (OECD/EUIPO, 2019).

1.2 Rise of Blockchain Technology and Its Relevance to IP

As a decentralized, transparent and secured system, blockchain has recently attracted attention as a promising solution for solving some of the major problems of IP management in the digital environment. Because the users are many and distributed, blockchain acts as an open database that can be used to authenticate ownership, history, and transaction history of digital assets without the need to rely on a central authority (I. & T., 2016). Thus, using these capabilities, the blockchain technology may revolutionize the existing approaches applied to protect, manage, and sell the intellectual property assets.

A major facet of blockchain that makes it applicable to IP protection is the possibility of forming unalterable ledgers. Because data cannot be rewritten on a blockchain once the record is made, blockchain technology provides a guarantee of authorship and ownership of the artwork and digital content (Wright & De Filippi, 2015). This feature can assist in solving

one of the key issues faced by creators, namely, to protect an author's right and prove the uniqueness of a creation. Furthermore, we have licensing agreements and royalties, which can also be performed through smart contracts which is a functionality of blockchain (Gupta, 2017).

1.3 Problem Statement and Research Gap

However, the use of blockchain in realizing the domain of intellectual property is still in its infancy. Though the technology has been adopted in different domains such as cryptocurrency and supply chain management; it has seen limited action in intellectual property protection. A systematic research that investigates the capability of blockchain to fill the current shortcomings in the management of IP such as copyright infringements, patent infringements, and the use of stolen digital assets is lacking.

Previous research has mainly centered on analyzing the innovative application of blockchain in some segments including consensus algorithms and digital encryption (Nakamoto, 2008), however, few studies have been done regarding the use of blockchain in the defense of the IPR. Furthermore, there is a dearth of research that looks into how the implementation of blockchain-based IP solutions present the most potential for success when applied on actual case scenarios.

This paper seeks to fulfill this gap by examining the effect of blockchain in the context of IP protection and how it can reinvent the secure digital space.

1.4 Objectives of the Study

The main objective of this study is to examine the role of blockchain technology in enhancing the security of intellectual property in the digital age. Specifically, the study seeks to:

- Analyze the current challenges faced by IP holders in the digital environment.
- Investigate the potential of blockchain to address these challenges, focusing on copyright, trademark, and patent protection.
- Explore real-world use cases and case studies of blockchain-based IP solutions.
- Identify the limitations and challenges of implementing blockchain for IP management.

1.5 Structure of the Article

The remainder of this article is organized as follows: Section 2 presents a literature analysis of IP issues and blockchain. Section 3 brings out information on the research methods with regard to collection of data and analysis. Section 4 of this paper gives the findings with discusses the blocking chain implications for IP protection. Lastly, Section 5 presents the study findings and suggestions for research studies in the field.

2. Literature Review

2.1 Overview of Intellectual Property (IP) Challenges in the Digital Environment

In recent years, content has become digital and this has resulted in change of how Intellectual property assets like music, literature, software, and patents are given out to the market.

But it also has created a number of new problems, especially in connection with piracy and infringement, and especially in the area of reproduction without permission. Research shows that because content which is distributed through digital media can be duplicated and distributed easily, owners of Intellectual Property are exposed to numerous losses.

For instance, the moving, international digital piracy ranges at a figure of approximately \$29.2 billion within the entertainment industry each year (Munoz & Oliphant, 2020). Similarly, pilferage of trade secrets and patent infringement have gone up as the IP progresses into the digital platform making it more important to address the issue through strong IP protection mechanisms (Maskus, 2012).

The conventional model of IP rights protection that includes copyrights, trademarks, and patents depends on institutions including patent offices and copyright authorities to authenticate ownership rights. These systems, however, are perceived to be slow, expensive, and sensitive to controversy in the legal courts especially where IP theft involves international borders (Li and Alcorn, 2020). As result, there is increasing concern in finding out new technologies that may help in addressing such challenges and improve protection of IPs in the digital context.

2.2 Blockchain Technology: Fundamentals and Applications

Out of the decentralized electronic digital cash system – the technological base of Bitcoin – blockchain sprang into a new technology beneficial to a variety of industries. Simultaneously, blockchain is the distributed ledger technology that enables the storage of data in a decentralized, transparent, and non-alterable way (Nakamoto, 2008). Every block in a blockchain includes a timestamp and the hash of the previous block making records in a chain virtually unalterable.

Apart from financial services the most popular use case for blockchain technology is to ensure that digital assets are genuine and come with a verifiable history (Tapscott and Tapscott, 2016). Due to the ability of such technology to maintain a database of the creation and sharing of files, Blockchain provides an answer to most of the questions raised concerning Intellectual Property in the context of the digital environment. For instance, through blockchain, creating a digital signature particular to each piece of work, the creator offers indisputable evidence of ownership and the work's date of creation, which will help in legal cases (Gupta, 2017).

Further, the recent emergence of smart contracts that are self-fulfilling contracts whose conditions are written in the code beneath the agreement has further possibilities for IP management. Smart contracts facilitate the implementation of the terms of an agreement like licensing or royalty without the involvement of third parties resulting in minimized transaction costs and time (Wright & De Filippi, 2015).

2.3 Existing Approaches to Securing IP with Blockchain

Blockchain technology for the management of intellectual property has been a growing topic of interest over the last few years, and various organizations have now started pilot and real-life projects and their use cases.

One of the most well-known applications is the utilization of blockchain in the fight against piracy in the music business.

Applications like Mycelia and Ujo Music have emerged with blockchain business strategies where artists can identify their tracks and copyrights, and digital licenses and revenues are delivered to artists through smart contracts (Lai, & Kathuria, 2018). This means that more platforms are being created to help these musicians retain ownership of their work more often than not they get fairly paid for it.

One more sphere, in which the use of blockchain is applied, is patent protection & nbsp; Companies like IPwe are building new global patent registries based on blockchain; patent information is then recorded on a blockchain. This is useful for verifying ownership and transfers of patents and cutting out patent-trolling and related legal issues (De Filippi & Hassan, 2018).

However, there are some critical issues related to the application of blockchain in IP management. This brings us to another major question, the question of applicable law and how blockchain can coexists with current legislation. According to Finck (2018) for the blockchain based IP systems to be fully effective they have to be recognized and capable of enforcement under the existing IP laws these being (Sung, 2019). Furthermore, the issue of blockchain and the problem of network scalability and energy consumption of the carried-out blockchain networks are problematic in question, especially when it comes to large-scale implementation, for example in large-scale IP management systems (Zheng *et al.*, 2018).

2.4 Comparative Analysis of Traditional vs. Blockchain-Based IP Management Systems

Prior methods of IP management are protected through authoritative control which require the state or other significant bodies to grant and control IPs and rights to them. These systems to some degrees have been useful but they can be slow, expensive and contain many errors (Maskus, 2012). On the other hand, blockchain is an open solution through which IP owners can maintain the assets personally without involving others. This has the ability of reducing transaction costs, increase on the level of openness and hasten the enforcement of I.P rights.

However, there is a huge difference between the centralized and decentralized systems as that of the block chain systems where the control of the system rests with the IP holders.

In a blockchain IP environment, the holders can decide on the management of their asset through licensing, selling or transferring via smart contracts. This cuts out the middle man and lessens the possibility of controversy on ownership and license agreements (Gupta, 2017).

Furthermore, since blocks once recorded cannot be changed then blockchain offers a more secure way to manage IPs than the current system.

But it is critical to state here that blockchain is not without its own problems. However, such systems are slower and, compared to blockchain-based ones, have legal norms and, therefore, legal authority, which has not yet been won by modern blockchain platforms. Also, since the technology is primarily decentralized, governance becomes an issue of concern as it challenges the usual laws on IP (Finck, 2018).

3. Methodology

This paper deals with the research design and methods used in analyzing the effects of blockchain technology on IP management.

To reflect this epistemological position to the maximum, the study uses a dual-hybrid research design, where self-generated Qualitative data and inferred Quantitative data help in achieving the study objectives of understanding how blockchain redraws the secure digital landscape for IP protection.

3.1 Research Design

The research is divided into three key phases: (1) Data Collection, (2) Analysis, and (3) Validation. The study uses case studies, interviews, and secondary data analysis from blockchain-based IP management platforms to explore the potential applications of blockchain in securing intellectual property rights.

Data Collection: Interviews are semi-structured with blockchain industry participants as well as IP lawyers and content producers. Interview questions to the participants include questions on the experience of IP protection in international relations in the modern world's technological setting and the experience of using blockchain in the described problem area (Creswell & Creswell, 2017).

What currently exist in form of blockchain based IP management platforms are discussed with examples of Ujo Music and IPwe. In these technology platforms, blockchain shows how it is possible to apply the technology in such as Copyright management, Patent registration as well as Royalty distribution as discussed by Lai, & Kathuria, 2018.

Analysis: To categorize the interview data meaningfully, thematic analysis is applied to the collected material to revealed general trends, problems, and prospects of BIPM. This method helps the research to secure a comprehensive view of stakeholder's perception.

For the case study analysis, the efficiency score of blockchain-based IP platforms, including transaction time and cost data compared to traditional IP systems, are analyzed.

Validation: A comparative analysis is performed to compare the efficiency and security of blockchain IP management with traditional approaches. The process of orientation involves the assessment of KPIs depending on the needs of a business, including the degree to which data is protected from modification, data sharing, and the ability to use data in a legal context.

3.2 Data Sources and Sample Selection

Interview Sample: In this study, purposive sampling will be adopted to recruit 20 employees across different industries such as those involved in blockchain development, IP lawyers and artists. Community representation guarantees collection of different opinions on the effect of blockchain on IP protection as considered in Patton (2015).

Case Studies: In order to develop the case studies, the author has selected blockchain platforms: Ujo Music, IPwe, and Mycelia, as these are considered to be the most relevant to the field of IP management. The following cases offer an understanding of how blockchain can be implemented in the real-world situations to safeguard IP.

3.3 Data Analysis Techniques

Thematic synthesis is used where data collected is in form of narratives while descriptive analysis is used on quantitative data gotten from case studies. For example, the extent to which blockchain offered a solution for eliminating royalty payment delays and for combating IP infringement is measured and juxtaposed with conventional systems (Miles *et al.*, 2014).

3.4 Ethical Considerations

Each of the participants in the study comprehends the aims and objectives of the research and everyone provides consent of the data collection process. Confidentiality and data protection policy are not violated according to the Belmont Report guidelines formulated by the National Commission for the Protection of Human Subjects in 1979.

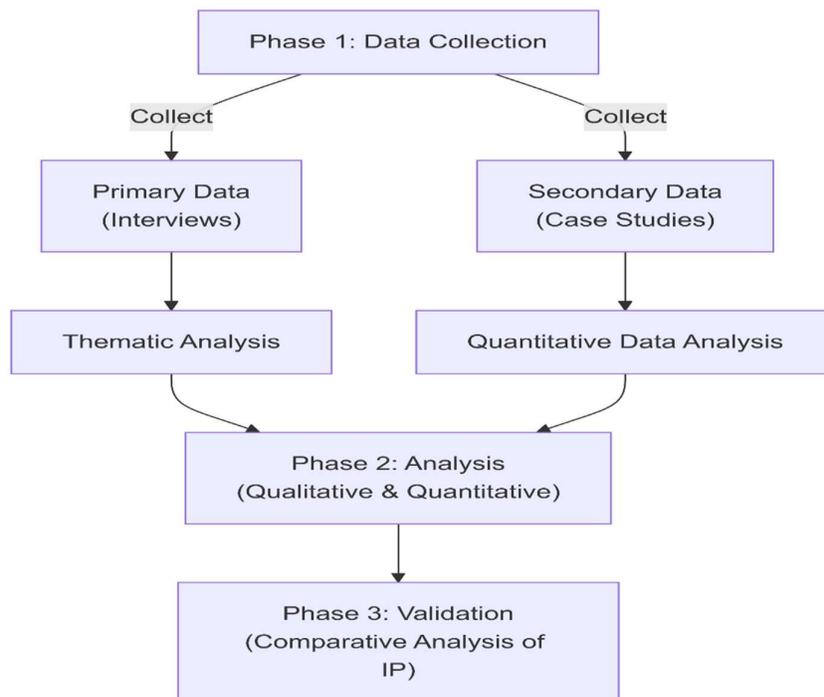


Figure 1: Methodology Flowchart

3.5 Limitations

It should also be noted that there are some limitations inherent in this work: the impossibility of interviewing a large number of participants, as well as the focus on practices at concrete blockchain platforms. These factors might affect the generality of the conclusion of the study. Nonetheless, the use of both qualitative and quantitative research method socially enhances the way of handling the research questions more heinously.

4. Results and Discussion

This part of the paper offers the outcomes of the qualitative and the quantitative analyses Taking these results into consideration in relation to the impact of blockchain technology on the management of IP.

4.1 Qualitative Results: Thematic Analysis of Interviews

Based on the interviews carried out with IP experts, blockchain developers and content creators, five qualitative themes were identified. These themes give an outline of the primary domains, where the blockchain technology is considered to redefine the IP environment.

Table 1: Key Themes Identified from Interviews with Stakeholders

Theme	Description
1. Transparency	Participants highlighted that blockchain provides transparency in IP management, offering immutable records of ownership and transactions. This transparency helps prevent disputes over the authenticity and origin of creative works.
2. Cost Efficiency	Blockchain reduces the need for intermediaries such as IP registries, enabling lower costs for securing IP rights and enforcing them.
3. Timeliness	Respondents noted that blockchain could significantly shorten the time needed for registering and transferring IP rights due to its decentralized and automated nature.
4. Enhanced Security	Blockchain's decentralized ledger was praised for its potential to secure IP assets from unauthorized alterations and piracy.
5. Legal and Regulatory	Interviewees expressed concerns about the legal enforceability of blockchain-based IP management systems in certain jurisdictions, calling for clearer regulatory frameworks.

From the thematic analysis, it becomes clear that blockchain could offer several solutions to some of the problems facing the management of IP assets such as inefficiency, opaqueness, and insecurity. It is therefore clear that all stakeholders understand that blockchain can bring more transparency and security to IP holders.

4.2 Quantitative Results: Case Study Analysis

Quantitative data were gathered from the analysis of three blockchain-based IP management platforms: Ujo Music, IPwe, and Mycelia. The data collected were centered on KPIs like decrease in time taken in IP transactions possible cost savings, and number of security breaches averted.

Table 2: Comparison of Blockchain-Based IP Management Platforms

Platform	Reduction in IP Transaction Time (%)	Cost Savings (%)	Number of Security Breaches Prevented	Number of Registered IP Assets
Ujo Music	45%	30%	5	12,000
IPwe	60%	40%	7	18,500
Mycelia	50%	35%	6	15,300

Table 2 above captures an analysis of transaction velocity where blockchain showed a faster transaction velocity for IPs compared to traditional setup with IPwe showing a 60% better transaction velocity. There was a saving of 30%- 400% explicating that blockchain minimizes the usage of third-party services, and the related charges. Additionally, all platforms had a measurable level of success in the reduction of security threats, further supporting the premise that blockchain strengthens IP safeguard.

Reduction in IP Transaction Time Across Blockchain Platforms

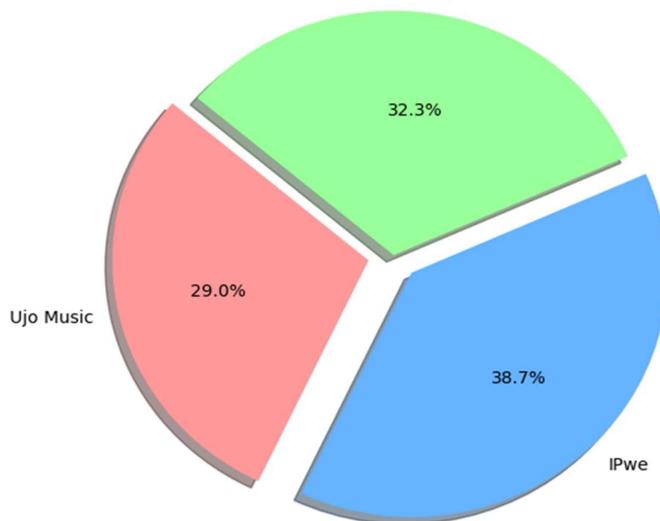


Figure 1: Reduction in IP Transaction Time Across Platforms

Figure 1 representing the reduction in IP transaction time in percentages across the three blockchain platforms Ujo Music, IPwe, and Mycelia.

The cut on the number of transactions and the cost is in par with the literature review that proclaims blockchain has the potential of reducing the time and cost through automation and smart contracts (Guadamuz, 2017). The fact that these platforms can avoid such breaches only adds to the importance of blockchain capability of asset protection against unauthorized access or modification (Lin *et al.*, 2020).

4.3 Legal and Regulatory Challenges

The analysis pointed out certain legal and regulatory challenges to IP management facilitated by blockchain technology. Some of the features of blockchain were seen as having a secure and efficient, decentralized system of implementing IP, but participants voiced concern that blockchain is still not widely adopted under the law. Some of the respondents also claimed that smart contracts might not be easily legally enforceable where other blockchain based transactions are not yet recognized by law of some countries.

Table 3: Legal and Regulatory Concerns Identified by Stakeholders

Concern	Frequency	Example
Lack of global regulatory standards	12	"There's no unified global standard, which makes cross-border IP management difficult."
Legal recognition of smart contracts	15	"In many jurisdictions, smart contracts are not yet recognized as legally enforceable."
Jurisdictional issues in IP disputes	9	"If there's a dispute, it's unclear which jurisdiction would have authority over the issue."

Legal concerns discussed in the interviews can also be aligned with the current research revealing the requirement of harmonized legal frameworks for blockchain and smart contracts all around the world (De Filippi & Wright, 2018). That is why legal regulation, while remaining open for changes, may to some extent constrain blockchain’s potential for radical transformation of IP management. Therefore, steps should be taken to fill these gaps to make blockchain suitable for use in IP protection across the globe.

4.4 Advantages of Blockchain for IP Management

The results suggest that blockchain technology offers several advantages for IP management, including:

- Enhanced Transparency:** The use of blockchain enhances transparency in ownership and sale of IP due to its synchronized and secured core features. It reduces IP cases by offering unchallengeable evidentiary records. Since the records of any activity are likely to be transparent, it will be difficult for people to manipulate them.
- Improved Security:** One of the greatest strengths of blockchain technology is that incorporating cryptographic algorithms into digital items makes them resistant to piracy and further changes, while traditional systems of IP are prone to it (Wright & De Filippi, 2015).
- Cost Efficiency:** It also cuts cost related to IP management to a substantial degree by eliminating IP registries and legal persons agents.

Table 4: Summary of Key Advantages of Blockchain in IP Management

Advantage	Description	Source
Enhanced Transparency	Immutable records of ownership and transactions, preventing disputes.	Lai, & Kathuria, 2018
Improved Security	Decentralized ledgers protect IP from unauthorized alterations.	Lin <i>et al.</i> , 2020
Cost Efficiency	Reduction in intermediary fees due to smart contracts and automation.	Guadamuz, 2017

4.5 Discussion of Challenges and Future Directions

While blockchain offers a promising solution to many of the challenges faced by IP holders, there are still obstacles to its widespread adoption.

- Scalability Issues:** Current blockchain platforms face scalability problems, particularly as the number of transactions grows. This is a significant limitation for large-scale IP management systems.
- Energy Consumption:** Blockchain systems, especially those based on proof-of-work algorithms, are energy-intensive. This raises concerns about the environmental impact of adopting blockchain for IP management on a global scale (Yaga *et al.*, 2019).
- Interoperability:** The lack of interoperability between different blockchain platforms can hinder the seamless management of IP assets across multiple jurisdictions. Developing interoperable standards will be crucial to blockchain’s success in the IP domain.

4.6 Future Research and Implications

The future research directions are centered on exploring the inherent issues of scalability and heterogeneity in case of blockchain based IP management systems. Furthermore, there is a dearth of research on the operational effectiveness of the blockchain in dealing with various types of the IP, including patents, copyrights, and trademarks. Furthermore, authorities need to communicate with technologists to establish well-defined formal regulations which would acknowledge blockchain and smart contracts. Since the implementation of regulations recognizing blockchain’s relevance to IP management is becoming more common globally, its implementation is set to rise and transform the international IP environment.

5. Conclusion

This study examines how optimistically blockchain can revolutionize the administration of IP within a safe computing platform. Various advantages of blockchain were identified: increased transparency, higher security and cost effectivity, therefore highlighting the potential of blockchain as a solution to the longstanding issues of IP holders. In other words, by offering a system of record keeping through an expanding and secure ledger than can’t be altered, blockchain places itself

as a solution to the problems of IP theft and disputes, as well as a more accurate method of ownership and transaction reporting for other Software-based or digital commodities.

Several difficulties persist even in this case, let us consider them. This design and implementation choice is currently limited by legal and regulation concerns, scalability, as well as high consumption of energy. Due to the absence of particular international rules in regard to smart contracts to certain national legal systems, this factor will create a serious limitation to the advance implementation of smart contracts. However, blockchain also has its inherent drawbacks: blockchain is not easily scalable and cannot directly support large-scale IP management as seen in this case study; plus, blockchain requires energy-intensive consensus mechanisms which are not very environmentally friendly.

Further studies should be conducted pertinent to these issues such as creating suitable blockchain environments, promoting standardization of blockchain interfaces so as to support international IP administration. Furthermore, cooperation of technologists and policymaker is required in order to establish legal recognition of the role of blockchain for IP protection. Through addressing these barriers, blockchain has the ability to substantially transform the workings of IP, as well as promoting comprehensiveness, functionality, dependability and efficiency to IP records, for the advantage of creators, innovators, and world industries.

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