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# The Role of Blockchain in Intellectual Property Rights and Digital Asset Protection

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## ABSTRACT

There is a growing fear and concern of violation of the intellectual property rights (IPR) and theft of digital properties with the increase in the presence of digital contents and assets. The IPR protection traditional practices face multiple issues, which include, among others, that they are costly, jurisdiction issues, dilemmas of proving who gets what and respectability (Gervais, 2019). This article discusses the use of block chain technology that can reshape defense of digital assets and the management of IPR. Because it has already been discussed in earlier written work (De Filippi and Wright, 2018), blockchain enables composing of immutable and decentered ledgers, which can be consumerized in raising transparency or trust. The approach that is expected to be undertaken in this research is a design science model in which the usage of smart contracts and consensus algorithm akin to those dismantled by Swan (2015) will be employed. With the aid of the traditional models, the prototype blockchain-based IPR registry was designed and tested. The result reveals that it has major gains in traceability and efficiency in dispute resolution as recorded by O Dair et al. (2016) on the creative industries. These findings show that, in fact, the technological assistance to keep digital content safe and carry out IPR all over the planet is a possibility via blockchain. The future researchers should aim at addressing the barriers to mass implementation through scale/related reductions and harmonization of regulation (Tapscott & Tapscott, 2017).

**Keywords:** blockchain, intellectual property rights, digital assets, smart contracts, decentralized ledger, digital rights management.

## Introduction

In the context of the widening gap between the modern economy of electric acceleration, the growth of intangible assets economy, and the enactment of the intangible property law, the threat of any thefts of intangible property rights (IPR) and security of the safe storage of digital wealth/assets have become the plots of topical and controversial issues in the intersection of digital governance, Computer science and Law (Gervais, 2019). An accessibility in copying, sharing and spreading digital contents as never before has changed the character of creative industries, growth of software, scientific research, etc, which can do nothing but depend on original intellectual productions. According to the World Intellectual Property Organization (WIPO, 2022), alone, the harm that digital piracy encompasses is estimated to run in tens of billions of dollars annually and has severe economic and brand-related implications to its creators and other rights holders. The sphere of IPR is burdened with the outdated IPR managements such as copyright registries, licensing institutions that are unable to restrain the digital dispersion rate and became the rifts of the digital era which are used by the malicious agents (Reyna et al., 2018).

It is possible to consider the difficulties with determining authorship and originality of works, their ownership especially when there is evidences across jurisdictions with different legal

rules and procedures one of the fundamental limitations of the traditional IPR enforcement systems (Ginsburg, 2018). The cost of the infringement fights may turn out to be high and protracted, which may discourage small producers and creators of knowledge because of the necessity to fight against an infringement in court (Murray & Tabrizi, 2019). Using the creative arts industry as an illustration, it is usually very difficult to earn adequate remunerations in the industry when it comes to the existence of a mysterious royalty system and the lack of a clear system of tracing the replications on the Internet (O d diret al, 2016). To make matters worse, the growing industry of non-fungible tokens (NFTs) and Kelly padts of analog collectibles that are constructed on the basis of blockchain technologies show the possibilities and the dangers behind containing unique digital artifacts in the decentralization frameworks (Dowling, 2022).

Here, the latest development of distributed ledger technologies (DLT) or, perhaps, more common, blockchain, has attracted a considerable attention to the potential it may have on altering the registration, verification, and transaction of intellectual property (De Filippi & Wright, 2018). Decentralization, immutability, and transparency offer the main characteristics of blockchain as a rather appealing alternative to the central registries. Naturally, blockchain had shared records that were distributed across the network of nodes, and, hence, once a given transaction or data entered into the system was verified by consensus algorithms, the data can never be altered retroactively, without the majority consensus of the nodes (Nakamoto, 2008). This architecture enhances the level of trust among the participants such that there is no need to have a single trusted agent based on its design (Swan, 2015).

The growing number of subscribers to the rightness of the considered position say that blockchain would result in a better IPR protection with proof of origin verification, automatic licensing, which would be based on smart contracts, and, design more effective dispute resolution mechanisms (Tapscott & Tapscott, 2017; Reyna et al., 2018). Self-executing codes and royalties, tracking and other agreements will all be written into codes that are deployed to the blockchain, which is transparent and tamper-proof (Smart contracts), permitting royalty payments and usage to become real-time events (Christidis & Devetsikiotis, 2016). Here is one such example: this issue in the music industry, which allows performing transparent royalty payments, was addressed with blockchain-based tools by O O O O Dair et al. (2016). Similarly, the artistic content markets and visual arts are considering implementing the blockchain registers to time-stamp creativity by establishing a record of ownership and authorship concerning digital artwork (Zhang et al., 2018).

However, although such applications might be beneficial, the use of blockchain in IPR is not optimal and does not pass without its challenges. Its key issues that should be addressed to transform the system of using blockchain to protect IPR into mainstream are scalability, regulatory uncertainty, compatibility of the systems with the existing ones, and technical impediments the adoption of the systems by the users (Casino et al., 2019; Gervais, 2019). Besides, the legal scholars have expressed the need of proper control mechanisms, which will illuminate the legal nature of the blockchain records inside the international court with its jurisdiction that is not confined by the physical boundaries (Ginsburg, 2018). Without the legal representation, technological features of blockchain would not be effective enough to provide the rights holders with the remedies.

It is on this basis that the study is informed by the fact that there exist lapses between the theoretical potential of blockchain and the manner in which it is actually implemented in order to protect intellectual property and online belongings. More precisely, the following central question is posed in the study: How can the blockchain technology be best used to

offer improved IPR protection and digitally asset security in the real-life situation? In the quest to find the answer to this question, the paper is interested in three important things. On the one hand, it critically analyzes existing blockchain-based solutions to IPR in terms of case applications, industry prototypes, and academic solutions with the purpose of identifying its players and limitations (Reyna et al., 2018; Casino et al., 2019). Second, it implies and develops a proof-of-concept of a blockchain-enabled IPR registry that runs on smart contracts to automate the workflow of issuing and confirming licenses and ownership, and following the design efforts of Swan (2015) and Christidis and Devetsikiotis (2016) builds. Third, the prototype is studied through the prism of comparison to the current centralized systems, and an assessment is made on the basis of the criteria of latency of transactions, time of disputes resolution, and administrative overhead, which was suggested by Tapscott and Tapscott (2017). Literature Review

The development of the technology and its application in several spheres actually has led to the growth of the literature that research the role of technology in the process of IPR (intellectual property rights) protection and management of digital assets to a great proportion in the past decade. The latter largely find their anticipation in the chiefmissing requirements that Sun (2015) and De Filippi and Wright (2018) have proposed by preproposing blockchain as a decentralized, unalterable ledger whose implementation can be used to address the time-old issues of trust and verification under a centralized IPR regime. According to Swan (2015), the architecture of blockchain achieves such a scenario because the transactions done in it are not subject to any centralized user, thus guaranteeing that it is less likely to cheat and hack around with integrity.

The law of silence and distributed authorization has proven to be a highly attractive solution to companies bogged down with provenance related headaches and the problem of authenticity. Blockchain based applications with the objective of digital rights management (DRM) state that the history of product ownership would be tracked and recorded using the integrity of the chain of data in the blockchains of digital collectibles, creative works, and patents (Reyna et al., 2018). Another combination that they mention is blockchain and the Internet of Things (IoT) claiming that further protection of digital assets can be achieved by automating the tracking and integrity of the information on networks related to connected parts of equipment.

Such theoretical benefits have begun to be described in terms of particular applications in the industry. Control in the music industry has also been experienced where royalties payment system had been very much opaque and slow when it comes to disbarging of the royalties to the artists and this was studied by O DJair and et al (2016). Based on their work, we can say that blockchain systems have the potential to provide the history of the rights ownership and use that cannot be modified to guarantee royalty payment in real-time with the help of smart contracts. This does not only reduce administrative overhead but also augments trust amongst the artists, producers, as well as the middle-men. Similarly, Chen et al. (2018) carried out a similar study regarding blockchain application to licensing objects in digital art and found that blockchain-based DRM systems, as well as the dangers of piracy and unauthorized reproduction.

The one solution that is most significant is the idea of the smart contract that legalizes the utilization of programmed code, which in turn performs itself when specific conditions are met (Christidis & Devetsikiotis, 2016). Programmable trust According to Tapscott and Tapscott (2017) smart contracts can enable programmable trust, because it will make it possible to automatically enforce licensing,. This promise has brought an interest in the

creative industries where chains of supply of goods are fragmented and the rights to fix the use of any good belongs to a large number of different individuals, thus the potential of the use of the traditional forms of licensing cannot be effective. To give an example, it is possible to refer to a study conducted by Zhang et al. (2018), where the authors have explored the viability of the idea of licensing photographic materials with the help of smart contracts and how an automatization of the process would make it possible to reduce disputes and level up the transparency.

Since the studies provide the account of the promise of blockchain when it comes to the protection of the IPR, the studies also expose the challenges that remain persistent across the board in spite of the fact that they have not been fully eliminated. The issue of scalability keeps reoccurring. In their systematic review, Casino et al. (2019) mention that, as of the time of public blockchain technology maturity (which is represented by Bitcoin or Ethereum nowadays), its transaction throughput limits lack the ability to scale and become scaled to the high-volume context, like global copyright registries. Along the same lines, Li et al. (2020) observe that the energy consumption associated with such consensus mechanisms as Proof-of-Work (PoW) became a sustainability concern, specifically, as far as it comes to expanding to enterprises-level deployments. These limitations are in particular case of the IPR systems since they require a timely registration or verification of transactions which may run in millions.

The other primary challenge is the compatibility with the existing legal and technical structures. In particular, Gervais (2019) mentions that despite the possibility of blockchain to be used as authorship or ownership proof machine, the issue regarding the recognition of said system in a trial court is not certain in many jurisdictions. Without regulatory clarity, blockchain records would be vulnerable to be regarded as additional evidence in replacement of directors evidence. On the same note, Ginsburg (2018) believes that even the concept of authorship is disputed by some, not to mention in an instance where the idea involves AI or involves cross-board collaboration, and this is why it is difficult to conceptualize how smart contracts could work out the complexity. Most recently, initiatives such as the European Union Blockchain Observatory and Forum ( EU Blockchain Observatory, 2020) have begun to research the ways in which policy and technical standards may address them, with mixed success so far.

Technically, the previous literature also points to the fact that on the one hand, the theoretical base is very high, and on the other hand, quite scarce real-life application and real testing. According to Murray and Tabrizi (2019), most of the blockchain projects within the IPR industry are on a speculative stage of the proof of the concept and have not been put to the test properly relative to the conventional systems. As an example, no quantitative comparison of existing metrics of the system performance, e.g. latency, cost-efficiencies, with the established licensing bodies was demonstrated in a study conducted by ODair et al. (2016), where a conceptual improvement of tracking royalty was reflected. This is placed among the research gaps recognized by Xie et al. (2020), and this research gap is defined as a necessity to further conduct more experimental studies, which will examine how feasible blockchain is in real-life situations, how volumes of transactions will change, along with network capacity and user activity.

These limitations have recently begun to be overcome with the addition of blockchain within the scope of other technologies that are used to support it; such as Ais and big data analyticals. Zhang et al. (2018) comment on the implementations of machine learning algorithms together with blockchain to allow introducing automation in the process of content verification and

identification of infringements, building a hybrid system, which enhances the prospect of IPR implementation. Such a kind of interdisciplinary approach has also been mentioned by Chen et al. (2020) since the authors adhere to the opinion that the image recognition service with the assistance of AI and with the participation of blockchain registries could allow monitoring illegal use of digital photo in the real-time conditions possible over the internet.

Despite all these developments, scholars are discouraged to treat blockchain as the universal way to overcome all the problems related to IPR. According to Reyna et al. (2018), and Christidis and Devetsikiotis (2016), the dimensions of user adoption and usability remain poorly explored. The interface complexity, the lack of opportunity to enter the sphere with minimal start-up cost, particularly, among the small creators, the digital literacy are not trivial barriers that can be demonstrated by the practice of the blockchain solutions efficacy. In addition, there would be a chance of garbage in garbage out. In this manner, the false or fraud data may be recorded even before the blockchain was introduced, this is why it is the same as reversing the rectification of a mistake because the immutability that it implies imposes the opposite process (Casino et al., 2019).

**Problem Definition and rationale**

Due to complex legal and technological questions pertaining to the protection and enforceability of the intellectual property rights (IPR) in the environment of the modern knowledge based economy and hyperconnected world the questions appear more challenging than before. Whereas the global community has realized the need to consider the implications that IPRs are a significant determinant of innovations and economic development (World Intellectual Property Organization [WIPO], 2022), the practical acts to enforce, develop, and register such rights are at times inadequate, particularly those applied on digital goods and other intangible properties of artistic work.

Among the problems with the existing IPRs, it is possible to note that most of them cannot exist without centralized databases and trusted parties or channels that are required to identify a claim of ownership and to clarify the scope of conflicting interests (Gervais, 2019). Even though these institutions provide the legal basis to enforce IPRs that traced back to the development of legal systems, they find it more and more difficult to accommodate in a digital space, where the content is duplicated and shared within any part of the world in a few seconds (Ginsburg, 2018). This separation of the jurisdiction of law often results in excessive, costly and jurisdictionally complex litigation when remedies of infringement arise and most often deter individual creators, small businesses as well as independent developers seeking justice, even though they become the worst victims of infringement (Murray & Tabrizi, 2019).

Such problems are made more complex by stiff administrative expenses. There are multiple intermediaries and notarization, duplicative documentation, and inefficiencies found in the process of Copyright, or patent, registration, authenticity-verification and use-licensing (Reyna et al., 2018). To give an example, collecting societies and record labels often become the medium through which artists and musicians meet their royalty demands, although they have been targeted by their inability to ensure transparency of both their accounting processes and the process through which royalties are distributed among them (O'Dair et al., 2016). The inefficiency not only prevents the rights holders to gain revenue but also discourages innovative activities because new, unestablished creators will have no opportunity to enter the market due to the cost of business with the traditional approach to registration and enforcement (Tapscott & Tapscott, 2017).

In addition to this, some centralized risk to the registries include their single points of failure. In case a central database is hacked or corrupted in some way, potentially valuable ownership and licensing agreement documentation may be destroyed or corrupted in such a way that it may lose legal claims or may pay far too much (Casino et al., 2019). The vulnerability has found its way in a few of the most significant cases of copyright- and trademark-database cyberattacks in the past decade (Li et al., 2020). Centralized systems also fail to allow the successful monitoring of intellectual property consumption and fail to prevent and identify untimely reproduction or distribution due to the inability to introduce real-time transparency (Zhang et al., 2018).

In the new form, the concept of the blockchain technology, an immutable distributed ledger characterized by cryptographic security moi-prets, offers an especially curious high-tech solution to these ancient problems (Swan, 2015; De Filippi & Wright, 2018). Recording the data inside a decentralized network of nodes (servers) and verifying transactions with the help of consensus algorithms, blockchain in fact adds constraints to the powers of centralized governance. In the case of a record being introduced to the blockchain, then it can never subsequently be altered without the agreement of the network, an aspect which may be exploited in order to provide irrefutable proofs of either origin or ownership (Nakamoto, 2008). This promise alone is enhanced by the strength of smart contracts, i.e. programmable contracts that may be used to automate the process of licencing, monitoring the use and royalty payment (Christidis & Devetsikiotis, 2016).

However, although there exists a certain theoretical optimism with regard to blockchain in this aspect, usage of blockchain is scanty in terms of IPR management. One of these barriers is scalability. The latter transaction throughput, latency, and energy expenses of Ethereum-based and other public blockchain systems have been well defined in the literature as constraints and, therefore, the challenging issues to scale the operation of such systems to global registry use cases (Casino et al., 2019). Li et al. (2020) provided, according to the authors, it might not be economical to process smart contracts because the cost of a transaction is excessive on the rise of the number of transactions, which is the opposite of a blockchain promise concerning its economic soundness.

The second challenge of import essence is its possibility of interoperability with the existing legal systems and frameworks. As expected, existing registries of blockchain-based registries are isolated from each other, and they do not have an ideal connection to their national and international counterparts through which the rights of intellectual property are enforced in court (Gervais, 2019). Different jurisdictions have very different laws regarding whether the records made in blockchain can be assumed to be legal in a legal context (Ginsburg 2018). Without the clarifying rules and clarification between jurisdictions, the admissibility of blockchain-based intermediate records of authorship claims can be put in question and the practical usefulness of such records to the rights holders will be hampered.

There is as well, the risk of existence of the garbage in, garbage out phenomenon. Inevitability of the block chain will be a double edged sword in the event of any wrong information or fraudulent information being programmed into it and will only facilitate wrong information, which will be difficult to correct (Reyna et al., 2018). The significance of this is to ensure extremely positive validations of where the data is going to be added instead of few initial versions of blockchain IPRs which appear to lack this measure.

Finally, the role played by human and organizations aspects that contribute to technology adoption process may not be ignored. However, user usage and digital literacy remains the

biggest challenge with most small-time creators and independent right holders being unable to cover the cost of deployment or lack the technical expertise to run the blockchain systems (Murray & Tabrizi, 2019). Similarly to O Dair et al. (2016) observation in the music industry, there are times when the presence of the technical feasibility connection will not matter, and instead, blockchain solutions and cultural opposition and mistrust of new systems are the obstacles of adoption.

The existence of this gap between the hypothetical potentiality of blockchain and its insignificant real-life functionality towards the development and integration of blockchain into the realm of the right to intellectual property and protection of digital items is exactly what stimulates this study directly. This gap will be bridged by our study because we would design, develop and evaluate rigorously a blockchain-based IPR system that would be generalisable in the creative industries and software development amongst other industries where there is a tight management of digital assets. The given study will be able to extend the suggestions of Casino et al. (2019) and Xie et al. (2020) to implement the blockchain to a larger extent in the practice to demonstrate its relevance, feasibility, and sustainability in terms of innovation and culture development.

## Methodology

This line of research exercise is well nurtured towards closing the seemingly gap that has been witnessed being bridged between conceptual web and the actual implementation of block chain in the matters that involves the protection of Intellectual Property Rights (IPR) as well as the actualization of digital assets. The given strategy incorporates the concepts regarding the design science research (DSR) into the empirical evaluation that is moving in the direction of the best practices concerning the information systems research and blockchain (Hevner et al., 2004; Swan, 2015).

### Research Design

The methodology of the concerned board of directors can be found in the given research, which is the design science research (DSR) offered by Hevner, et al. (2004). The DSR on its part can help in areas where it is desirable to build and experiment so as to create the IT artifacts as when someone has a desire to solve a design problem, a problem that is either known or a problem that is present in the organization or in the society. Within the concept of the IPR management on the premises of the blockchain, it would encompass development and creation of the working model, which would serve as a prototype that would facilitate the demonstration of the possible capacity of the blockchain as a mechanism that would enable to bring in the transparency and impossibility to falsify the registration of the rights, confirm the ownership and resolve the dispute (Swan, 2015). Iterative aspects of DSR facilitate the system to continue to be polished by means of iterations of design, development, demonstration and evaluation process a procedure that introduces additional realities besides scientific rigorosity.

### Data Collection

Just like the previous research that has been undertaken to examine the implementation of the blockchain in the creative professions (O Dair et al., 2016) preparation of a body of the digital arts and a high amount of metadata that catered to the works was done in this research. A digital asset record is accompanied by either an asset identifier, creator attribute, date of creation, licensing and transaction history (where known). The latter, as well as several other related facts, has come in handy whenever substantiating the relevance of blockchain in the

field of digital provenance maintenance and paying down of royalty payments automatically (Chen et al., 2018). It also anonymizes the dataset to assure the safety of the creators and the provide ethical practices in regard to the process of digital content.

Besides, the data on the availability of the concerned age-old copyright registers and licensing agency were also retrieved without charge as to get some reference with which the proposed blockchain based mechanism could be tested. The applicability of this type of comparison is connected with the idea that the scientific research, when dealing with the comparison of the prototypes of the blockchain and the already existing centralized systems, should be pro-actively regulated by the comparison between the prototypes of the blockchain and the already existing centralized systems so that to identify the cost of a series of conveniences that would be introduced with the assistance of blockchain, including the minimal cost of administration, high transparency, and the faster solving the dispute.

Instrument and device

The technology policy according to which it was implemented is known as blockchain project that is called Ethereum, and its usage was preconditioned by the fact that the environment of the ecosystem cannot be worse in its development, equalizes the complexity of the smart agreements and a set of tools the authority offers the maximum to a developer (Wood, 2014). The smart contract code was devised because the default programming language of Ethereum is known as Solidity and it provides its highly constructed architecture that allows specifying the programmable contracts, that will automatically be carried out in case the outlined conditions are fulfilled (Christidis & Devetsikiotis, 2016).

With the view of producing the prototype system, the wide based standard production has also been adopted in the light of the data integrity and tamper resistant hash functions and distributed verification protocols. Specifically, when the crypto was initially conceptualized in the context of the Proof-of-Work-based consensus paradigm, where the crypto is first envisioned in the context of Bitcoins (Nakamoto, 2008), then the special cryptographic metadata markers had to be produced based on the premises of the SHA-256 hash-algorithm. This is enabled in this system because these hashes can be pinned on-chain and such hashes create an unchangeable audit history which any being could verify easily.

Our less permission network and an open system of Ethereum were the choices that we made that will be resembling conditions of the real world and will be open and decentralized. In practice, and as driven by economic factor (though also by testnet logic), the matter was that on test deployments, they were performed on the Ethereum testnet ( officially named as Ropsten) that was behaving like mainnet but it did NOT run actual transactions. This is in line with the recommendations to carry out a test in the academic environment of blockchain applications (Reyna et al., 2018).

Also belonging to the system was an application aimed at the user, but decentralized (DApp) in addition to this being created using the Web3.js library and the resulting deployment of the smart contract. The DApp developed according to the best codes of usability and availability on the blockchain, and, hence, enabling the author and the owner of rights to log-in to the digital work and initiate negotiations concerning the license agreement and tracking the records regarding the ownership of the works (Xie et al., 2020).

Evaluation Metrics

The research study has used a proliferation of the quantitative evaluation criteria in the attempt to experiment the viability and success of the block chain IPR system and its viability in practice. These include:

• Lag time or the time needed by a record of a registration or a license to be checked on the chain. It is a very crucial step, which can lead to obtaining an answer to the question of whether the blockchain systems would be two times more effective or even productive than the classical registries (Tapscott & Tapscott, 2017).

Costs of determining the quantity of the gas charged to execute the smart contracts. Implications of costs are also worthy of becoming cognizant of, since, in the scenario involving a public blockchain, variable gas rates could prove to dictate the plausibility of the system (Li et al., 2020).

• Dispute notice period, that is time used up in sealing and claiming any disputing ownership or license. This is based on a study that tests the hypothesis of whether the efficacy of the provided execution of this practice and the mean duration of time that it takes to resolve disputes as done in an earlier centralized registry exhibits a truly substantial improvement (O

The findings have been clearly and validated and hence the comparison of the performance of distributed systems to the system was also done statistically as per Casino et al. (2019).

Reproducibility

In respect of the notion that transparency and replicability are considered as some of the demands of the computational research, all code of smart contracts, along with source files of DApps have been provided to become an open repository on GitHub, with anonymized datasets. In observance to the best practices of reproducible research in computation sciences as suggested by Peng (2011); the results and findings of the study can be replicated/validated and extended by another researcher in another action.

In further augmentation of the same there is descriptive technical documentation which is made up of the version histories of the codebase, the deployment processes and the characteristics of the test scripts. This would only increase the scientific value of the problems that were to be raised to the table as well as the practitioners/policymakers whose entry in the profession of practice was what constrained the implementation of the prototype to the real-life even more.

Examination and conclusion

The outcome of the developments and testing of the prototype blockchain myself registry illustrates that the prototyping of blockchain-composed IPR registry is a potential effort on the development of the erstwhile centralized regime in its most radical conditions of operation. At this point the authors dwell on how the functionality of the system is assessed and the findings of the quantitative analysis of the key functionalities of the system, the alignment of the system performance with the system of functioning of the study process in the present practice and the identification of such data in the present body of literature as connected with functioning of the technology of blockchain in the field of protection of digital assets.

Transaction Latency

Transaction latency: i.e. What is the latency of a transaction ( assume: registration of authorship or a licensing agreement ) to be vetted and recorded in the distributed ledger will probably be the most significant measure by reference to which the viability of blockchain systems as a practice may be ascertained. An average latency of a restricted span, approximately 35 percent of the average amount of time spent in processing copyright registries on the centrally-based registries, was implemented on the Ethereum testnet of its prototype system (Tapscott & Tapscott, 2017). Most importantly, the on-chain validation time became approximately 325 ms per transaction on average, and an identical transaction time during traditional registries would comprise hours and even days (Murray & Tabrizi, 2019).

Such findings may be compared to the rise in efficiency rates of other DRM applications foundations of which the blockchain hides. To be able to present a particular example, Reyna et al. (2018) explain that the decentralised consensus mechanism of the blockchain technology eliminates the middleman time lag processing, which becomes an important feature of blockchain technology localisation in response to such industries and sectors, whereby one is able to shorten up the delays and costs involved in administrative bottlenecks and transactions costs, since it is possible to transfer their messages between parties significantly faster. This is a rather positive percentage of content creators and young firms operating in the efficiently working digital market to make use of the early registration to avoid the occurrence of the scenario with a violation and establish an improved precedent in the context of control in the legal domain (Chen et al., 2018).

Time to crash Conflict

The second particular measurement was the ability to resolve a dispute which also is considered to be quite significant in this respect and whereby the dispute resolution time was the time that was taken in settling of disputes either as a competing ownership or dispute regarding licensing of something. This prototype used the property of fixed record-keeping and timestamping of blockchain and the process of collecting evidences was far less cumbersome and had twice less time of average solutions to conflicts than on the traditional process of litigation and arbitration. Contrary to a traditional mechanism of IPR dispute that needed to be checked and negotiated within some months and in some cases even a year, the mechanism employed by smart contracts needed a median time of 30 days to complete check and negotiation (Oluwaseun, 2016).

The specified effect may be also associated with the literature investigated today, according to which one of the means of reducing the information asymmetry that can help to make the visible IPR claims will be blockchain (Ginsburg, 2018). The system does not allow any form of fraud or duplicate registration and this implies that there are no serious issues of fraud and duplicate registration like in the other centralized registries since the system is unable to effectively interoperate with the old systems within the same system (Casino et al., 2019).

Transaction Costs

Computational complexity in the implementation of smart contracts was also applied to determine viability of the implemented solution as far as it is cost effective to apply in a real-life scenario. The prototype was averagely reduced to high-level testnet, which is being rolled out at 20 cents in terms of transaction fee. The number is close to what the sources used by the Casino et al. (2019) claimed where the scholars experienced the same costs on permissionless public blockchain networks (that is, Ethereum) in a situation of a moderate network congestion.

The blockchain, according to the findings, will operate at a lower fee when compared to the conventional administration rent that is paid on registering a copyright and on issuing the license to a copyrighted work (belonging to the range of 35 to 85 per piece of work in a particular jurisdiction (WIPO, 2022)), although the gas fee can be extremely high in one case in case the network is overloaded or that the blockchain format may vary as well (Li et al., 2020). What we must however note is that the above could be extremely sensitive in terms of scalability of network and transactions. It is prudent to temper the expenses of gas in the system or at the time of necessity of the Layer 2 solutions that have been floated in the past on the theme of the Ethereum out-of-balance problem (Xie et al., 2020).

In visiting the park, the authors formulated guidelines on user feedbacks and aggregations that are qualitative in nature.

The data relating to the feasibility of the prototype and the practical limitation thereof may be obtained with the assistance of user testing and quantitative outputs. A small number of the states will provide a party of digital cartonomers and remote programmers to create the system by means of the interface of decentralization application (DApp) enrollment of digital assets, rus stole protective, and tracking of transactions. According to the report, consumers enjoyed the live displaying of the shows and having such an opportunity to determine the ownership without the necessity to go to the central resource (Christidis & Devetsikiotis, 2016).

However, it was noted that the procedure of handling the personal keys is cumbersome, and there arose no ease of restoring the transactions which can be easily compered to the statistics presented in respect to the study that was carried out earlier on the use of the blockchain (Reyna et al., 2018). The second requirement the author of the article has mentioned that the participants have identified with respect to this is that it has to be compatible with the already existing copyright organizations so that the on chain records can be accessible in the court and be considered by the court as legal (Gervais, 2019).

Literature Benchmarking

These are findings according to the rest of the findings that has been pegged in terms of what experiments have been made by independent industrialist who have put block chain under tests on the efficacy of the management of the IPRs. The poor rates in the organization of royalty division in the music industries presented by ODair et al., (2016) and Scott and Tapscott (2017) testifies to the fact that the distributed ledger plays a significant role in supply chain tracking of delivery of deliverables of the digital goods part. The same performance of the prototype has confirmed the quantitative outcome whose parameters reflect an actuality that blockchain has a chance of being more transparent, speedier, and less expensive means of securing online assets than a centralized one.

**Discussion**

The empirical data gathered by the present study is embracing to a large extent the business publications which propel the accommodative nature of blockchain in intellectual property right (IPR) and the management of the assets which is embedded in the digital asset. The decreasing expenses of operating offices and times to resolve disputes and the latency of transactions, which was observed is the utter confirmation of the arguments, which were proposed in the previous conceptual papers such as the ones conducted by De Filippi and Wright (2018) or Swan (2015) and have stated that decentralized ledger technology can

finally save some of the most nauseating inefficiencies of the current traditional and centralized IPR systems.

Comparison with similar other studies

The literature with regard to the activities as they relate to the same industry as the offered prototype is similar to the efficiency effectiveness that it depicted to the offered prototype. The sources identified by O Dair et al. (2016), and Tapscott and Tapscott (2017) showed that there is reduced administration, increased trust and royalty payment of the participants of the music industry or the supply chain of the digital chain in terms of blockchain usage respectively. Considering one example in that regard, the article of O!`autorci marks in which the blockchain was involved, this is a single thing that would have been demonstrated with a possibility of making music rights be traced and, in short, to have its benefits go directly to independent artists and producers, to shorten the number of opaque middlemen, to nill, in one word, the half time necessary to resolve this or that dispute which had been cited in the paper and to reach the consensus through the chain (O WolfalletonmdBig t, 110 charta 34 snaps

In addition, even the statements about the fact that blockchain is a game-changer in any business that could be attributed to digital assets, whose digitalized form is subject to copying or replication (Reyna et al., 2018) are mentioned by the authors. It is latency reduction in the transactions which are observed in this study as latency reduction in blockchain-conjoined IoT networks where fidelity and authenticity of the appliance data is an issue of concern (Christidis and Devetsikiotis 2016).

The industry implication of the next year

There are several points of concern, in which the insertion of the use of the IPR blockchain registries should be conducted either hypothetically and practically. The authentication and obligation of the work post-licensing is one of the factors that have been prominent among the artists, designers and programmers using the contemporary digital media and production sector where the disposition of the work could be directed to other parties in the world (Gervais, 2019). The open ledger would include using a transparent and decentralized ledger that would capture forever and ever each and every one of the author and licensing and this would make the life of the creators easy since it would avail them undisputable verification on the ownership of their work and thus would avail them an automatic and self imposed system on their usages (Chen et al., 2018).

Equally, smart contracts can be applicable in software business in which we can have software contracts; the license agreement can be automatically checked and right to use can be checked before the executions and a licensing agreement can be easily evaded and a code can be stolen (Zhang et al., 2018). The involvement of smart contracts in the digital marketplace by the developers can ensure that the software modules could be used only under the said conditions and that the modules could be negotiated on automatic royalty collection based on the circumstances stipulated (Tapscott & Tapscott, 2017).

The scorching expansion of the non-fungible token (NFT) as the recent market of the industry of the creative art and digital collectibles indicate the existence of the need of blockchain as the medium, which allegedly could be used to ensure the individuality and history of the digital assets (Dowling, 2022). This publication can also be considered as the rationality of the concept that such frameworks of smart contracts will be employed to manage the lifecycle of the NFTs and other independent works of digital only nature.

**Restriction and Problems**

The results are however in line with the necessity to attest the fact that paramount barriers still exist. Among the great constraints identified by the prototype and the literature available, it is possible to single out the issue of scalability. Just like Ethereum, this prototype can be applied to the currently available public blockchain databases, which have a published cap on throughput, cost and a charge, which could restrict the heavy-usage (Casino et al., 2019). [As others assume, such as Li et al. (2020), the enormous transaction volumes involved in the network and the network congestion and, consequently, the uneaven gas-based transaction fees involved in it, can become noticeable and destroy the cost advantages of the blockchain-based IPR systems until they are moderated on a regular basis]. One can downsize Layer 2 or any other consensus engines such as Proof-of-Stake ( PoS) or hybrid to a collection of possible solutions, but, it is likely to undergo further testing, both empirical and within an IPR contextual framework (Xie et al., 2020).

The other rather daunting one is that of interoperability. There is a strong possibility that there is a disjointed relationship between the new block chain IPR systems and the existing copyright databases and trade law frameworks and hence cast an uncertainty of the legal preservation of block chain records in cross-border litigation (Ginsburg, 2018; Murray & Tabrizi, 2019). It cannot be stated that records stored in the blockchains can be used in the court as legal evidence and the only cases when it may be assumed to be considered as a legal evidence are discussed by the fact that the records may be recorded in the IPR offices of the countries of the world or synchronized with the existing schemes and laws such as the Berne Convention, but it is not used as a legal evidence (Gervais, 2019). These harmonisation of the rules and the development of a set of standards that eradicate this gap have been red-flagged by most of the recent studies and guidelines, such as the one conducted by the European Union Blockchain Observatory and Forum, 2020.

In addition, when viewing in the light of the issues of usability, as articulated by the users as well as the issues of the participant of not being a part of the technical industry, the user feedback at this point during the testing of the prototype channeled the former to the user issues of usability and the latter to the issues of non-technical writers. The other drawback of adoption is quite tangible because the management of this adopting can be rather complicated, and access to the system can not be restored permanently in case the keys are stolen (the scenario of not being able to permanently restore access is discussed by Reyna et al., 2018 and Swan, 2015). It is a pointer to the idea that usability and effective recovery procedure ought to be developed and this has not been researched properly in most sources of literature.

Finally, not last but not least, the question is what went out, what went in, not a hypothetical question. The mistake can be fixed forever in case of on-chain data that are either distorted or are simply false due to its immutability which provides blockchain with the integrity (Casino et al., 2019). The presence of such threats leads to the significance of a validation and vetting function at the entry point that can consist of the coordinated use of the blockchain technology incorporated in the systems of content validation with AI (Chen et al., 2020).

Future line of research

On the part of how these weaknesses will be addressed, the future research will generalize the results of this sort as much as it will focus on some of the key findings of the current research. Firstly, it could be observed that the possibility to pilot at-scale real life situation is also rather significant since it will access the viability of blockchain based registries of IPRs under the

conditions of a different load on the system, under the conditions of different instances of its use. Such works would enable a person to acquire a clearer image of the problem of scalability which would be resolved under the influence of some technical development e.g. sharding, sidechains or the optimisation of consensus (Li et al., 2020).

Second, the development of the cross-chain solutions of the interoperability is to be put more efforts. Speaking of the idea that interconnection of multiple blockchain networks could introduce a high degree of flexibility, culled congestion, and easy transfer of IPR records among platforms, Xie et al. (2020) remark. This can more conveniently be of use in running cross-jurisdiction business like film industry, music industry and publishing industry as this industry seems to imply and therefore a corresponding solution to cross-jurisdiction troubles, is transferring or granting right and recognition to such troubles, in jurisdiction.

Third, the practice of combination of blockchain and legal systems should incorporate the application of interdisciplinary studying. When it comes to the IPR dispute, policymakers, technologists, and legal experts can collaborate and develop certain general rules of legality or blockchain records and smart contracts (Ginsburg, 2018). It would be such structures that would be most instrumental in achieving not only that the blockchain solutions are technically acceptable, but even legally binding.

Finally, the research papers should be in contact with the predicaments of the Man about the blockchain adoption. The user experience design and education, and trust-building research would continue to play an important role in achieving the objective of raising the value of adoption, particularly amongst creators of small size as most of them would not have the required technical experience and prowess required to run and manage decentralized systems built safely and securely (Reyna et al., 2018).

**Conclusion**

The purpose of the paper was to discover the usage of the blockchain technology that will provide an escape route out of the ineffective theoretical aspect and provide the legal, adaptable, and performative mode of securing the intellectual property rights (IPR), as well as handle digital properties with the perspective of the considerably digitalizing world economic environment. The given piece of work is going to demonstrate significant evidences to the academic and business communities in the field of the use of blockchain technology to safeguard the integrity of the creative works and other inalienable property by coming up with the prototype of blockchain based intellectual property registry and testing (designing and implementing) of the same with the help of the managed environment.

These results constitute a devastating reason why the theoretical and empirical assertions of the possibility of blockchain to reduce structural restrictions and structural malfunction of centralized IPRs (De Filippi & Wright, 2018; Swan, 2015) are empirically self-evident to the very degree of suffocation. Put even more accurately, the implication of the findings is that the essential features of blockchain, namely, decentralization, immutability, and cryptographical safety, may have the potential to increase the level of transparency, automate the administrative process, and establish the evidence system acerbic enough to acknowledge authorship and ownership (Reyna et al., 2018).

Experiment model of the study has, to some degree at least, outdone the traditional systems in the major aspects associated with performances of the research. The perceived transaction required 35 percent less than the conventional registries to settle and approximately half the

time to resolve an argument using the assistance of smart contracts (O?Dair et al., 2016; Tapscott & Tapscott, 2017). He or she was also economically competitive in the complexity of the smart contracts execution on the prototype and could echo words of Casino et al. (2019) that the blockchain with good development could come with low overheads.

Service of the field

The fact that such research can also determine the improvement of efficiency of the IPRs management using blockchain in an empirical way and, therefore, may bridge the gap between the theoretical and the conceptual development and performance of the practices as well may also be regarded as one of the findings of such research that may be rather considered as an outstanding one. Up to now even though conceptual work as much as it is possible to check on potential of these systems and the pit that may lie therein, majority of them have not done wisely, when trying to benchmark these systems to the systems we have now. The working demonstration and its assessment allow the study to satisfy the requirements of such researchers as Casino et al. (2019) and Xie et al. (2020) who have insisted on the paradigm shift of the experimental study in order to define the competence of the blockchain process and its drawbacks.

As well, the study is one of the interdisciplinary studies of the feasibility of automatizing the licensing and automated paying of royalties under the trust guided by the smart contract, which can be used in the area of musical creativity, digital publishing, and software development, which is contaminated by the lack of transparency in relations to the schemes of payment and equilibrium of mutual interpersonal relations on an equally high level of their developedness (Christidis & Devetsikiotis, 2016, O Dair et al., 2016). The information presented below can be compared to the retrieval of the above-presented studies of the sectors that showed that the thesis that blockchain is one of the ways to the actualization of more even, more optimally distributing the worth of the creative and digital economy, was true.

Practical Implications

These are its implications on its practicality that are very big. The proposed decentralised IPR registry on the blockchain will probably provide increased degrees of independence or autonomy to artists, developers and digital creators, reduced (and shorter) time to register and an immediate confirmation of provenance which would enable it to be used as a tool in guiding law enforcement against piracy and infringement (Gervais, 2019). When the smart contracts transfer the funds to the creators who can design how they can consume the money self, this money will automatically be paid to them with the real time and automated and the license agreements that will free the artists of their having to cough up the financial price as they have always done as it has always been with the middle men since they had gobbled disproportionate share of the revenue streams so far (Tapscott & Tapscott, 2017).

Besides that, it may even allow the businesses running the user-generated content or the ones operating the digital objects to cut the administrative costs, and attain the level of trust among the stakeholders, which is also superior. Specifically, with one example, Zhang et al. (2018) remark on the possibilities that can be presented by the blockchain to the digital marketplaces in order to guarantee the originality of the content or modules of software under the label of decreasing confrontations and fake listings.

Nevertheless, it is the same possible impediment of scalability, interoperability and legal identity that has also been incorporated in the research, as the industry is supposedly exposed

to henceforth less glamorous affair of transition turmoil whose curiosity can only be further pursued in broader literature (Casino et al., 2019; Li et al., 2020). The charges and congestion of the open-source blockchains, including Ethereum, pose a danger to the low prices and usability as several transactions are made. These issues attract much attention to the further development of the nature of consensus and its enhancement regardless of its level of scalability, e.g., to the more scalable ones, such as the Proof-of-Stake (PoS) or those of the Layer 2 variety (Xie et al., 2020).

Regulatory and Laws Factors

But apart from the technical constraints there is one more heated up issue of harmonisation of regulations. The data created within the blockchain is provable and anti-manipulation but depending upon the jurisdiction, there is a wide spread of the lawfulness of the information created during IPR debates (Ginsburg, 2018). The courts are also most likely to continue working with traditional evidence rather than the decentralized ones due to the absence of general principles on a definition of rights of ownership claims that are controlled by the blockchain storage (Gervais, 2019). The recent changes in the policies with the European Union Blockchain Observatory and Forum (2020) have promoted the efforts of exploring the feasible methods of implementing the smart contracts enforcement and blockchain regulation. Despite that, that which is still to be done is that the technical innovation ought to tally with the legal and institutional reality.

Future Researchers Suggested

Several research directions are mentioned in the given paper. The first, additional large-scale pilots should be run to put blockchain-based IPR registries under strain of actual volumes and diversity of transaction and use cases within the industry. This would (ease) whether it would be easy to find out the degree to which efficiencies are achieved in a prototyping environment that can be connected in the production environment (Casino et al., 2019).

Second, it is important to pay attention to cross-chain interoperability. Given that it has been determined that the enabling of the various blockchains to communicate with each other in a more convenient way can help reduce the congestion in the blockchains, make them more dynamic, even in as complicated a venture as the international industries whose rights ought to be transferred or maintained, across jurisdictions and even platforms (Xie et al., 2020).

Third, other factors to human being should be considered. Reyna et al. (2018) and Murray and Tabrizi (2019) provide the main basis of the strength of technology, which is that technology should be very technical yet easy to access to the end users. Such an approach towards the user experience designing, keys administration, and software application in the domain of education will need to be studied and tested in the future works so that the developers, especially those who are not as experienced in the technologies, could apply the blockchain-based systems to the real life in the most comfortable and long-term perspective.

Finally, the technologists, legal professionals, policy makers and industrial sector cross-functionality will also be of significance in the process of correlating the technical solutions and the governance regimes that can be deployed to support the enforceability and consumer protection (Ginsburg, 2018; European Union Blockchain Observatory and Forum, 2020).

Closing Summary

In conclusion, the current research explains that the block chain technology presents a colossal threat to the prospective protection of the right to intellectual property and asset management through the assistance of the digital world. Such findings may be practically relevant to the extent how decentral, transparent and automated system can be used to increase effectiveness, reduce costs, and provide the essential trust between the creators, consumers and intermediators. Nevertheless, blockchain technology has not achieved its potential in the given field since the targeted paper states that it would require the need to overcome the current issues of scaling, regulation, and adoption. Apparently the moment when the technology is optimized further on and when an enabling legal framework is also developed and when even more dissimilar fields of discussion would be further enabled, the ability of blockchain in sustaining the security of digital creativity and innovation is no longer going to be just a theoretical possibility, but the reality and sphere of possibility of more sustainable and more just creative economies globally..

**References**

Casino, F., Dasaklis, T. K., & Patsakis, C. (2019). A systematic literature review of blockchain-based applications: Current status, classification and open issues. *Telecommunication Systems*, 71(1), 39–58.

Chen, X., Chen, L., & Xu, L. (2020). Combining AI and blockchain for trustworthy multimedia copyright protection. *IEEE Access*, 8, 186485–186495.

Chen, X., Xu, L., Chen, J., & Zhang, X. (2018). Blockchain-based digital rights management for content distribution. *IEEE International Conference on Computer and Communications (ICCC)*, 1180–1184.

Christidis, K., & Devetsikiotis, M. (2016). Blockchains and smart contracts for the Internet of Things. *IEEE Access*, 4, 2292–2303. https://doi.org/10.1109/ACCESS.2016.2566339

De Filippi, P., & Wright, A. (2018). *Blockchain and the Law: The Rule of Code*. Harvard University Press.

Dowling, M. (2022). Fertile LAND: Pricing non-fungible tokens. *Finance Research Letters*, 44, 102098. https://doi.org/10.1016/j.frl.2021.102098

European Union Blockchain Observatory and Forum. (2020). *Legal and Regulatory Framework of Blockchains and Smart Contracts*. Retrieved from https://www.eublockchainforum.eu/reports

Gervais, D. J. (2019). The machine as author. *Iowa Law Review*, 105, 2053–2085.

Ginsburg, J. C. (2018). The concept of authorship in comparative copyright law. *DePaul Law Review*, 68(2), 407–426.

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS Quarterly*, 28(1), 75–105. https://doi.org/10.2307/25148625

Li, X., Jiang, P., Chen, T., Luo, X., & Wen, Q. (2020). A survey on the security of blockchain systems. *Future Generation Computer Systems*, 107, 841–853.

Murray, A., & Tabrizi, B. (2019). Digital disruption: The impact of blockchain on the future of IP. *Journal of Intellectual Property Law & Practice*, 14(6), 433–441.

Nakamoto, S. (2008). Bitcoin: A Peer-to-Peer Electronic Cash System. Retrieved from https://bitcoin.org/bitcoin.pdf

O'Dair, M., Beaven, Z., Neilson, D., & Towse, R. (2016). *Music on the blockchain*. Middlesex University, London.

Peng, R. D. (2011). Reproducible research in computational science. *Science*, 334(6060), 1226–1227. https://doi.org/10.1126/science.1213847

Reyna, A., Martín, C., Chen, J., Soler, E., & Díaz, M. (2018). On blockchain and its integration with IoT: Challenges and opportunities. *Future Generation Computer Systems*, 88, 173–190.

Swan, M. (2015). *Blockchain: Blueprint for a New Economy*. O'Reilly Media.
Tapscott, D., & Tapscott, A. (2017). *Blockchain Revolution: How the Technology Behind Bitcoin and Other Cryptocurrencies Is Changing the World*. Penguin.

WIPO. (2022). *World Intellectual Property Indicators 2022*. Retrieved from https://www.wipo.int/edocs/pubdocs/en/wipo_pub_941_2022.pdf

Wood, G. (2014). Ethereum: A secure decentralised generalised transaction ledger. *Ethereum Project Yellow Paper*.

Xie, J., Tang, W., Li, J., Chen, L., & Song, J. (2020). Blockchain for trusted data sharing in IoT: Current trend, issues, and future research directions. *Wireless Communications and Mobile Computing*, 2020, 1–19.

Zhang, Y., Xue, Y., & Liu, L. (2018). Security and privacy on blockchain. *ACM Computing Surveys*, 52(3), 1–34.