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TECHNOLOGICAL PROSPECTING OF NFTS FOR INTELLECTUAL PROPERTY: A PATENT-BASED ANALYSIS

PROSPECÇÃO TECNOLÓGICA DE NFTS PARA PROPRIEDADE INTELECTUAL: UMA ANÁLISE BASEADA EM PATENTES

PROSPECCIÓN TECNOLÓGICA DE NFTS PARA LA PROPIEDAD INTELECTUAL: UN ANÁLISIS BASADO EN PATENTES

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ABSTRACT

The increasing digitization of creative assets poses significant challenges to the protection of intellectual property. In this context, blockchain and Non-Fungible Token (NFT) technologies emerge as promising solutions to ensure the authenticity, traceability, and monetization of digital assets. This study aims to explore the landscape of technological innovation at this intersection through a systematic search in patent databases. The methodology consisted of a search on the Orbit Intelligence database, followed by a rigorous dual validation process that combined manual screening and analysis by Artificial Intelligence (DeepSeek), resulting in a final portfolio of 119 patent families. The results reveal a sharp increase in the number of filings from 2018 onwards, with a peak in 2022, and a strong geographical concentration in China. The analysis of technological domains indicates that innovations are focused on "IT methods for management" and "Digital communication," highlighting the use of the technology as a governance infrastructure. The qualitative analysis of selected patents demonstrates the sophistication of the solutions, which address issues ranging from registration efficiency to rights management for AI-generated content. It is concluded that the field is rapidly maturing, moving beyond proof-of-concept to develop specialized solutions that address complex challenges in the intellectual property ecosystem, thereby redefining protection paradigms in the digital economy.

Keywords: Technological Prospecting. Intellectual Property. Non-Fungible Tokens. Blockchain. Patents.

RESUMO

A crescente digitalização de ativos criativos impõe desafios significativos à proteção da propriedade intelectual. Neste contexto, as tecnologias de blockchain e Tokens Não

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Fungíveis (NFTs) emergem como soluções promissoras para garantir autenticidade, rastreabilidade e monetização de ativos digitais. O presente estudo tem como objetivo explorar o panorama da inovação tecnológica nesta interseção, por meio de uma prospecção sistemática em bases de dados de patentes. A metodologia consistiu em uma busca na base Orbit Intelligence, seguida de um rigoroso processo de validação dupla que combinou triagem manual e análise por Inteligência Artificial (DeepSeek), resultando em um portfólio final de 119 famílias de patentes. Os resultados revelam um crescimento acentuado no número de depósitos a partir de 2018, com um pico em 2022, e uma forte concentração geográfica na China. A análise dos domínios tecnológicos indica que as inovações se concentram em "Métodos de TI para gestão" e "Comunicação digital", evidenciando o uso da tecnologia como uma infraestrutura de governança. A análise qualitativa de patentes selecionadas demonstra a sofisticação das soluções, que abordam desde a eficiência do registro até a gestão de direitos para conteúdo gerado por IA. Conclui-se que o campo está em rápido amadurecimento, transcendendo a prova de conceito para desenvolver soluções especializadas que endereçam desafios complexos do ecossistema da propriedade intelectual, redefinindo os paradigmas de proteção na economia digital.

Palavras-chave: Propriedade Intelectual. Tokens Não Fungíveis. Blockchain. Patentes.

RESUMEN

La creciente digitalización de activos creativos impone desafíos significativos a la protección de la propiedad intelectual. En este contexto, las tecnologías de blockchain y Tokens No Fungibles (NFTs) emergen como soluciones prometedoras para garantizar la autenticidad, trazabilidad y monetización de activos digitales. El presente estudio tiene como objetivo explorar el panorama de la innovación tecnológica en esta intersección, a través de una prospección sistemática en bases de datos de patentes. La metodología consistió en una búsqueda en la base de datos Orbit Intelligence, seguida de un riguroso proceso de validación doble que combinó una selección manual y un análisis por Inteligencia Artificial (DeepSeek), resultando en un portafolio final de 119 familias de patentes. Los resultados revelan un crecimiento acentuado en el número de solicitudes a partir de 2018, con un pico en 2022, y una fuerte concentración geográfica en China. El análisis de los dominios tecnológicos indica que las innovaciones se concentran en "Métodos de TI para la gestión" y "Comunicación digital", evidenciando el uso de la tecnología como una infraestructura de gobernanza. El análisis cualitativo de patentes seleccionadas demuestra la sofisticación de las soluciones, que abordan desde la eficiencia del registro hasta la gestión de derechos para contenido generado por IA. Se concluye que el campo está en rápida maduración, trascendiendo la prueba de concepto para desarrollar soluciones especializadas que abordan desafíos complejos del ecosistema de la propiedad intelectual, redefiniendo los paradigmas de protección en la economía digital.

Palabras clave: Propiedad Intelectual. Tokens No Fungibles. Blockchain. Patentes.

1 INTRODUCTION

Intellectual property rights (IPR) management faces unprecedented challenges in a digital landscape characterized by the massive production and dissemination of content by a diverse range of creators, ranging from large corporations to independent artists (Ferro et al., 2023). Traditional protection systems, designed for an analog world, often prove inadequate to keep up with the speed and complexity of digital transactions, resulting in vulnerabilities that facilitate piracy and make it difficult for rights holders to be fairly remunerated. This lag creates a demand for technological solutions that can offer more agile, secure, and transparent mechanisms for the management of intellectual assets in the digital environment.

In this context, blockchain technology emerges as a promising infrastructure, with the potential to revolutionize the protection of intellectual property (Qizi; Kamalovich, 2025). Through its distributed, transparent, and immutable ledger, blockchain offers a secure platform for tracking asset ownership and transaction history, combating fraud and strengthening proof of anteriority and authenticity. Specifically, Non-Fungible Tokens (NFTs), which are unique digital representations of assets registered on the blockchain, together with smart contracts, enable the automation of IPR enforcement, dynamic licensing, and royalty distribution in a programmatic and efficient way (Ferro et al., 2023). The combination of smart legal contracts with the operability of smart contracts on the blockchain represents an innovative approach to formalize legally binding contractual aspects while also taking care of notarization and transfer of rights.

Despite the transformative potential widely discussed in the literature, there is still no established consensus on the ability of these technologies to properly manage and transfer intellectual property rights on a large scale (Ferro et al., 2023). Most existing studies tend to focus on conceptual analyses or specific case studies, leaving a gap in terms of an empirical and comprehensive analysis of the real technological development scenario. Understanding the direction, intensity, and focus of innovation is key to anticipating trends and assessing the maturity of this field. This is where technological prospecting, as a competitive intelligence tool, plays a fundamental role.

Patent analysis is a consolidated and effective methodology for technological prospecting, allowing mapping the state of the art, identifying promising technologies, and analyzing the strategic positioning of the main actors in a given sector (Altuntas; Dereli; Kusiak, 2015). Patent documents are a direct indicator of research and development (R&D) efforts and market protection strategies of organizations, offering insight into developing

innovations. Therefore, the application of a quantitative analysis of patents is a methodological approach to empirically investigate the evolution of the intersection between NFTs and intellectual property.

In view of the above, the objective of this article is to map the global panorama of technological development at the intersection between NFTs and the protection of intellectual property, through quantitative technological prospecting based on patent data. To this end, it seeks to answer the following research question: What is the state of the art and emerging trends in the use of NFTs for the management and protection of intellectual property, as reflected in the filing of patents on a global scale? The main contribution of this study lies in offering an empirical analysis of the patenting scenario, identifying the main technological domains, the most active actors, and the geographic and temporal distribution of innovation, filling a gap in the literature on the real technological trajectory behind the discourse on NFTs and IPR.

To achieve this objective, the article is structured as follows: Section 2 details the methodology of technological prospecting used in the collection and processing of patent data. Section 3 presents the quantitative results of the analysis, including the temporal and geographical evolution of the deposits, the main technological domains and the most relevant actors. Section 4 discusses the implications of the results, contextualizing them in the broader innovation and market landscape. Finally, Section 5 presents the conclusions of the study, its limitations, and points out directions for future research.

2 METHODOLOGY

This section describes the methodological procedures adopted to carry out technological prospecting, which constitutes the core of this study. The methodology was structured to ensure the systematicity and replicability of the research, following the best practices for patent analysis as a source of technological information.

2.1 CHARACTERIZATION OF THE RESEARCH

This study is characterized as an exploratory and descriptive research, with a quantitative approach. It is exploratory because it investigates an emerging technological field that is still poorly consolidated in the empirical academic literature. It is descriptive, as it aims to describe the characteristics of the patenting scenario related to the use of NFTs for the protection of intellectual property. The quantitative approach is manifested in the collection

and analysis of patent indicators, such as number of filings, geographic distribution, and technological classification, allowing the identification of patterns and trends (Zhang; Liu, 2020).

2.2 DATA SOURCE

For the technological prospection, Questel's Orbit Intelligence patent database was used as a data source. The choice of this database is justified by its global scope, which consolidates information from more than 100 patent offices around the world, including the main ones such as the United States Patent and Trademark Office (USPTO), the European Patent Office (EPO), the Japan Patent Office (JPO) and the World Intellectual Property Organization (WIPO). In addition, the platform offers robust analytical tools for data treatment and visualization, which are essential for the proposed analysis (QUESTEL, 2023).

2.3 DATA COLLECTION PROCEDURES

The collection procedures followed a systematic protocol, divided into the definition of the search strategy and its execution and refinement, as detailed below.

a) Definition of the Search Sequence: The construction of the search equation is a critical step to ensure the relevance and accuracy of the results. The process was iterative, involving the identification of keywords and their synonyms, as well as the use of Boolean operators and patent classification codes. The scope of the search was defined around two core concepts:

a. **Base Technology:** Covers terms related to blockchain technology and Non-Fungible Tokens (NFTs).

b. **Application:** Encompasses terms related to the protection and management of Intellectual Property (IP).

Table 1

Patent search strategy

Concept	Keywords and Operators
Base Technology	("non-fungible token" OR nft OR) AND (blockchain)
Application	("intellectual property" OR copyright OR patent OR trademark OR "trade secret" OR "industrial design" OR "geographical indication" OR author* OR royalty OR licensing OR piracy OR counterfeit*)

Final Operator	(Base Technology) AND (Application)

Source: Prepared by the authors, 2025.

b) Search Execution and Refinement: The search equation was entered into the Orbit Intelligence platform on September 10, 2025, resulting in an initial portfolio of patent documents. On this portfolio, the following refinement filters were applied:

a. Duplicate Removal: The platform was configured to group documents by patent family, considering only one registration per invention to avoid duplicate counting of technologies.

b. Time Period: The period from 2014 (the year the first NFT prototype appeared) to 2025 was considered, to ensure the coverage of the entire history of the technology's development.

After applying the filters, a final portfolio of patent families was obtained, which constituted the basis for the data analysis.

Validation and Refinement by Artificial Intelligence: to ensure the robustness and accuracy of patent selection, a double validation process has been implemented that combines manual screening and validation by Artificial Intelligence. This procedure aims to mitigate human biases and increase the scope of the analysis, following the best practices in technological prospecting studies involving large volumes of documents (CHEN et al.,).

The validation process was structured in two stages:

a) Manual Screening: Each document in the initial portfolio was analyzed individually by the researchers, considering the established relevance criteria: (i) explicit presence of blockchain technologies or NFTs; (ii) direct or indirect application to the protection of intellectual property; (iii) technical feasibility of the proposed solution; and (iv) clarity in the description of the innovation.

b) AI validation: The same set of documents was subjected to analysis by the DeepSeek language model, configured with specific prompts to identify relevant patents based on the same criteria used in manual screening. The model was instructed to evaluate each document considering the presence of key concepts and relevance to the scope of the research.

The use of AI as a counterproof tool offers three fundamental methodological advantages: (I) bias reduction: AI processes documents consistently, without the influence of subjective factors; (II) increased comprehensiveness: the model can identify connections and

patterns that can be overlooked in manual analysis; and (III) cross-validation: the convergence between the results of the two approaches strengthens confidence in the final data set.

The results of both analyses were compared and consolidated, prioritizing the inclusion of documents identified as relevant by either of the two approaches. This procedure resulted in the final portfolio of patents that formed the basis for all subsequent analyses

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2.4 DATA ANALYSIS AND PROCESSING

The data analysis was carried out with the support of the analytical tools of the Orbit Intelligence platform itself. The following indicators were extracted and analyzed:

a) Temporal Evolution of Filings: Analysis of the distribution of the number of patent filings over the years, to identify the technological maturity curve.
b) Geographical Distribution: Mapping of the main priority countries of deposits, indicating innovation centers and key markets.
c) Top Applicants: Identification of the most active companies, research institutions, and inventors, revealing the key players in the development of the technology.
d) Technological Classification: Analysis of the main codes of the International Patent Classification (IPC) and the Cooperative Patent Classification (CPC) assigned to the documents, to map the predominant technological domains.
e) The results were exported in the form of graphs and tables for the elaboration of the results and discussion section, allowing a clear visualization of the technological panorama.

3 RESULTS AND DISCUSSIONS

This section presents and discusses the results obtained from the technological prospecting carried out in the Orbit Intelligence patent database. The analysis was structured to reveal the innovation landscape at the intersection between Non-Fungible Tokens (NFTs), blockchain, and intellectual property protection, addressing the characterization of the patent portfolio, temporal and geographic dynamics, the predominant technological domains, key actors, and a qualitative analysis of representative technologies.

3.1 CHARACTERIZATION AND VALIDATION OF THE PATENT PORTFOLIO

The prospecting process began with the application of three distinct search strategies, which generated a gross volume of documents. To ensure the robustness and accuracy of the analysis, this dataset was subjected to the double validation process described in the methodology section (section 2.3). Table 2 presents the consolidated result of this process, comparing the manual screening performed by the researchers with the validation performed by the DeepSeek Artificial Intelligence model.

Table 2

Comparison of relevant patents after manual filtering and AI validation

Search Keys	Manual Analysis	DeepSeek Review	Consolidated Total
(((REGISTRATION) AND (INTELLECTUAL PROPERTY) AND (NFT OR BLOCKCHAIN OR SMART CONTRACTS))	65	72	72
(REGISTRATION AND PLATFORM) AND (INTELLECTUAL PROPERTY) AND (NFT OR BLOCKCHAIN OR SMART CONTRACTS)	32	34	34
(REGISTRATION AND INTERFACE) AND (INTELLECTUAL PROPERTY) AND (NFT OR BLOCKCHAIN OR SMART CONTRACTS)	13	13	13
Total	**110**	**119**	**119**

Source: Prepared by the authors, 2025.

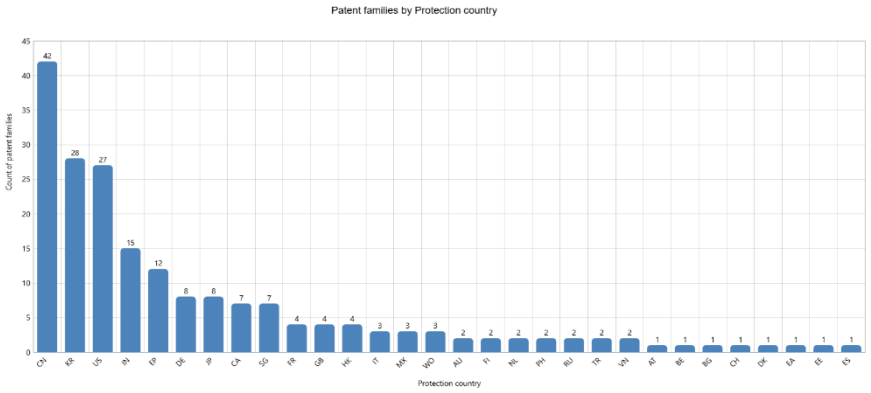
The results demonstrate a satisfactory convergence between the two validation approaches. The AI model identified 9 additional patents that proved pertinent, slightly broadening the dataset and confirming the effectiveness of the double validation process. This convergence strengthens confidence in the final portfolio of 119 patent families, which forms the basis for all subsequent analyses.

3.2 INNOVATION OVERVIEW: TEMPORAL AND GEOGRAPHICAL ANALYSIS

The analysis of the evolution of patent filings over time, presented in Figure 1, reveals a trajectory of sharp growth, characteristic of an emerging technology.

Figure 1

Annual evolution of patent families (2014-2025)



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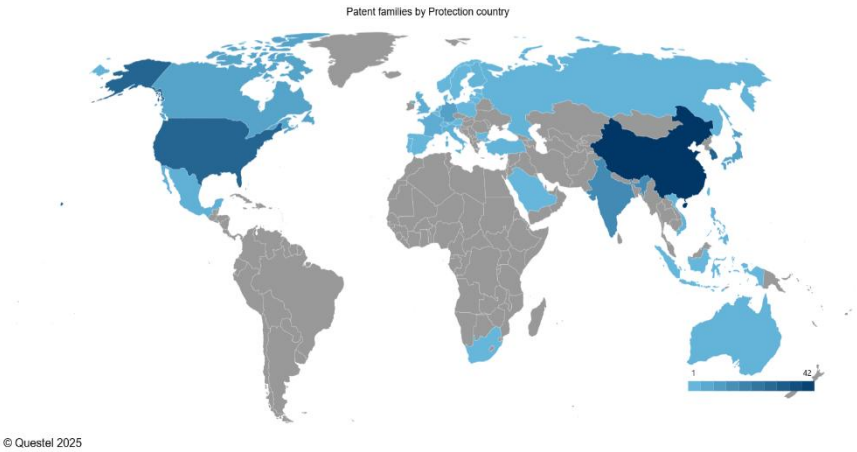
Source: Orbit, 2025

It is observed that, although the first records appear sparsely from 2014 onwards, interest in the technology gains significant traction from 2018 onwards. Growth intensifies, reaching a notable peak in 2022. This time pattern is strongly correlated with the global market's attention and investment cycle in crypto assets and NFTs, which experienced a boom between 2021 and 2022. This suggests that patented innovation in this field is largely reactive to market trends and the perception of new business opportunities, rather than being purely driven by a long-term fundamental research agenda.

Geographically, the patenting scenario is marked by a strong concentration, as illustrated in Figure 2.

Figure 2

Distribution of patent families by priority country



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Source: Orbit, 2025

China emerges as the undisputed leader, accounting for a majority share of deposits. Next, with considerably smaller volumes, are the United States, South Korea and India. This distribution reflects the national strategies to encourage innovation and patenting, especially the Chinese policy of encouraging the registration of intellectual property in strategic technologies. The Chinese leadership indicates a deliberate effort to establish technological sovereignty in a field considered promising, while the presence of other technological hubs confirms the global relevance of the topic.

3.3 STRATEGIC TECHNOLOGY DOMAINS

The analysis of the technological domains, carried out from the classification of patents, allows mapping the priority application areas. Figure 3 shows the distribution of patent families by technological domain.

Figure 3

Distribution of patent families by technological domain

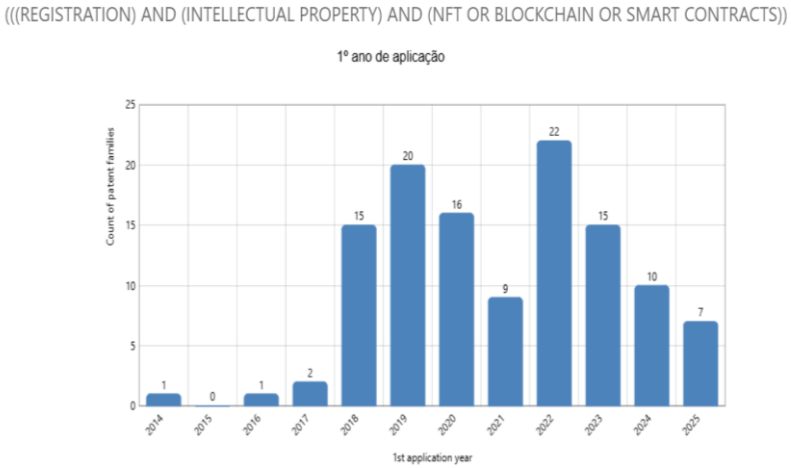
Source: Orbit (2025)

The results indicate a massive concentration of innovations in "IT methods for management" and "Digital communication". This predominance confirms that the main focus of the patented solutions is not on blockchain technology per se, but on its application as a tool for governance, administration, authentication and traceability of digital assets. The technology is seen as an infrastructure to optimize processes and ensure the security and provenance of intellectual property in the digital environment, which is in line with literature discussions about the potential of blockchain for IPR management (Ferro et al., 2023).

The temporal evolution of these domains (Figures 4, 5 and 6) corroborates this analysis, showing that the growth in the number of deposits from 2018 onwards was mainly driven by innovations in these areas of management and communication.

Figure 4

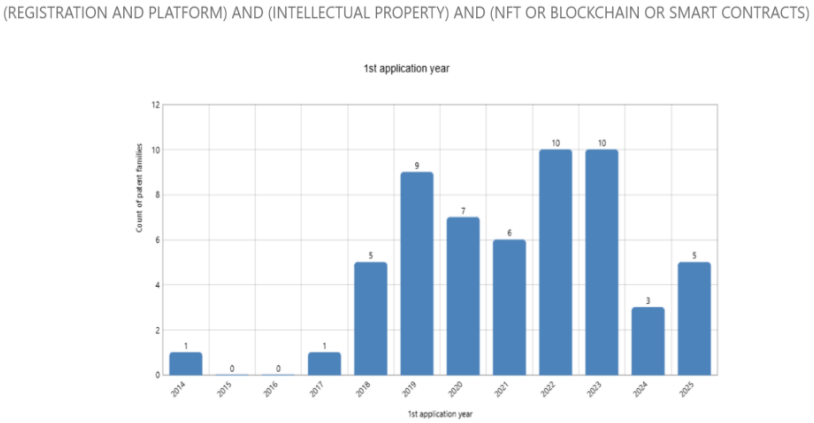
Temporal evolution of the technological areas of the patent families related to the first search key.



Source: Orbit (2025)

Figure 5

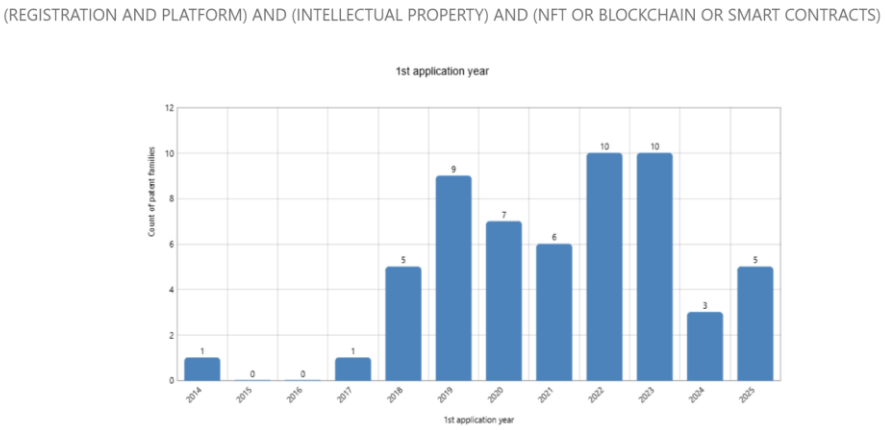
Temporal evolution of the technological areas of the patent families related to the second search key.



Source: Orbit (2025)

Figure 6

Temporal evolution of the technological areas of the patent families related to the third search key.



Source: Orbit (2025)

The annual evolution of patent families, illustrated by Figures 04, 05 and 06, demonstrates significant growth from 2018 onwards for the broader combination of terms (registration, intellectual property and (NFT, blockchain or smart contracts)), with notable peaks in 2019 (20 filings), 2020 (16) and, especially, in 2022 (22), evidencing the peak of interest in this technological convergence. When the term "platform" is included, the deposit curve shows a similar behavior, but on a smaller scale, with emphasis on 2019, 2022 and 2023, revealing a progressive consolidation movement.

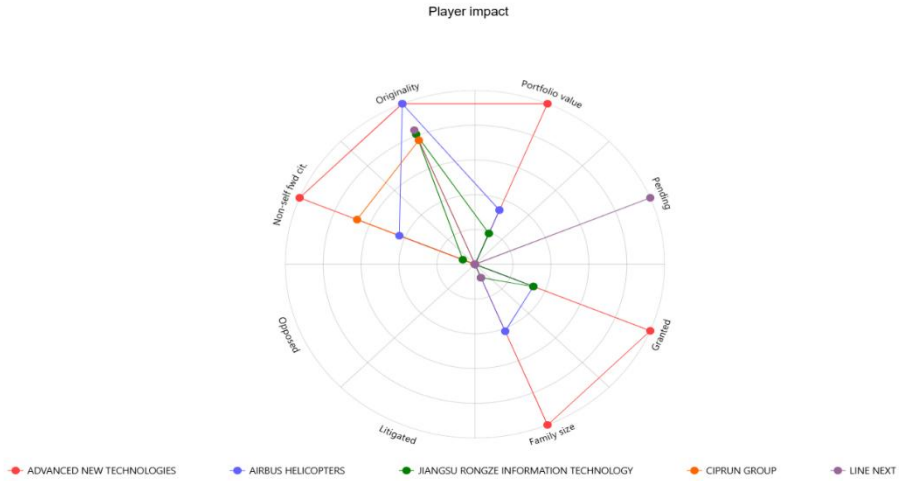
On the other hand, the inclusion of the term "interface" results in a very small number of deposits, concentrated from 2019 onwards, intermittently and with significantly lower volumes. These results suggest that the general theme of NFTs and blockchain applied to intellectual property is already in a phase of greater maturity, while more specific applications, related to platforms and, mainly, interfaces, are still in early and dispersed development. This relationship between territory and temporality reinforces the need to understand how the geography of deposits influences the evolution of applications over time.

3.4 MAPPING OF THE MAIN ACTORS

The analysis of depositors reveals a diverse innovation ecosystem. Figure 6 presents a comparison of the main actors.

Figure 7

Comparative impact of the main players



Source: Orbit (2025)

It is observed that leadership varies according to the technological niche. While more general searches are dominated by a diverse set of companies, specific searches reveal niche leaders such as Ant Group (Ant Blockchain) in "platform" solutions and the CASC Institute in "interfaces." This indicates a maturation of the sector, with specialization and market segmentation.

Two clear innovation strategies emerge: one focused on patent volume and market coverage, and the other on innovation with high scientific impact and high citation factor, as observed in players such as Airbus and Cable Television Labs. This segmentation into technological layers, from infrastructure to application, shows the maturity of the sector. A player's impact is therefore defined by its leadership in specific niches rather than a monolithic dominance of the field.

In summary, the analysis of Figures 01, 02 and 03 reveals that the scenario of patents in blockchain, NFTs and smart contracts applied to intellectual property is characterized by significant time growth and a geographical concentration in advanced technological hubs, notably China. The predominance of innovations in "IT methods for management" and "digital communication" underlines the centrality of these technologies in the management and security of digital assets, while the comparative analysis of players in Figure 04 demonstrates diversified innovation strategies, whether in volume of deposits or in originality and scientific impact. This panorama suggests a maturation of the sector, with the consolidation of specific niches and the redefinition of competitive positioning strategies.

3.5 QUALITATIVE ANALYSIS OF KEY TECHNOLOGIES

To complement the quantitative analysis, an in-depth analysis of four patents representative of different jurisdictions was performed, whose characteristics are compared in Table 3.

Table 3

Comparative analysis of selected patents

Characteristic	**CN117527836 (China)**	**IN202541026604 (India)**	**US20240185191 (USA)**	**GB2611072 (United Kingdom)**
Main Focus	Web3 Framework for Intellectual Property (IP) Registration and Transaction with Enhanced Security and Efficiency.	Copyright management for AI-generated content.	Tokenization of intellectual assets (e.g., patents, academic research).	Copyright protection for digital content using NFTs.
Problem Solved	Slow and high cost in IP registration; plagiarism detection.	Assigning rights between human creators and AI systems.	Difficulty in protecting and monetizing "illiquid" assets such as patents.	Lack of robust mechanisms to prove authorship and history.
Technological Solution	Use of the D-PBFT (Delegated Practical Byzantine Fault Tolerance) algorithm for consensus in blockchain. Detection of plagiarism during registration. Block generation for owners.	Attribution mechanism that quantifies human vs. AI contributions; unique identifiers.	Tokenization via NFTs; use of Ricardian Contracts to bind the asset to the legal contract	Distributed File System (IPFS) Registration; creation of NFTs linked to content.

Source: Prepared by the authors (2025)

The qualitative analysis reveals the sophistication and diversity of technological approaches. The Chinese patent focuses on the efficiency and security of the registry infrastructure, using an advanced consensus algorithm (D-PBFT), which aligns with the

technological domain of "IT management". The Indian patent addresses a frontier issue: the intellectual property of works created by AI, a growing debate in the field.

The U.S. patent introduces the concept of Ricardian Contracts, which seek to create a bridge between the smart contract code and the human-readable legal text, addressing one of the major criticisms of the legal validity of smart contracts. Finally, the British patent details the classic architecture of a content protection system via NFT, using IPFS for decentralized storage.

In sum, the results indicate that the field is evolving from exploring basic blockchain technology to creating complex and specialized solutions that solve specific problems of the intellectual property ecosystem. The combination of quantitative and qualitative analyses provides a robust overview of the state of the art, revealing a dynamic, geographically concentrated and rapidly maturing technological sector.

4 CONCLUSION

The main objective of this study was to explore the panorama of technological innovation at the intersection between Non-Fungible Tokens (NFTs), blockchain and the protection of intellectual property, through a systematic prospection in patent databases. The quantitative and qualitative analysis of the portfolio of 119 patent families allowed to answer the research question and achieve the proposed objectives, revealing a dynamic and rapidly maturing scenario.

The results confirm that the application of NFTs and blockchain for intellectual property management is an emerging technological field, with a significant growth in patent filings from 2018 and a peak in 2022, in line with the global market's attention cycle. Geographically, innovation is led prominently by China, followed by the United States, South Korea, and India, indicating that the technological race in this sector is concentrated in hubs with robust innovation ecosystems and policies to encourage patenting.

The analysis of the technological domains showed that the main focus of the innovations lies in "IT methods for management" and "Digital communication". This is evidence that blockchain technology is primarily being developed as a governance infrastructure to ensure the authenticity, traceability, and security of digital assets, rather than being an end in itself. The diversity of actors, with the coexistence of large corporations and niche players, suggests a growing specialization and the formation of different competitive strategies in the market.

The qualitative analysis of selected patents deepened these findings, illustrating the sophistication of the proposed solutions, ranging from the creation of efficient registration frameworks (D-PBFT) and rights management for AI-generated content, to the linking of smart contracts to traditional legal instruments (Ricardian Contracts). It is clear that the field is transcending proof-of-concept to address complex and specific challenges in the intellectual property ecosystem.

The main contribution of this work lies in the empirical mapping and detailed characterization of a technological field of high relevance and in full evolution. By providing a clear picture of trends, key players, and technology routes, this study offers valuable insights for researchers, businesses, and policymakers. As a limitation, it is recognized that the analysis is based exclusively on patent data, not covering other forms of knowledge production, such as scientific publications or open source software, which also play a role in technological development.

In short, the research demonstrates that the convergence between NFTs, blockchain, and intellectual property is not just a speculative trend, but a fertile field of technological innovation, with the potential to redefine the paradigms of asset protection and monetization in the digital economy.

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