A LONGITUDINAL PATENT ANALYSIS ON THE EMERGING PERSPECTIVES OF NFT IN INTELLECTUAL PROPERTY PROTECTION

R. Anlin Golda,[*] Mahima Khare,[**] Vidhu Prathap C.[***]

Abstract

Distributed ledger technologies (DLTs) such as blockchain are emerging technologies that leverage existing secure business models. Blockchain technology based on non-fungible tokens (NFTs) has started to make an immense impact on the Intellectual Property (IP) ecosystem. World Intellectual Property Organization (WIPO) and various patent office's globally have acknowledged the importance of safeguarding intellectual property in the digital realm by establishing blockchain task forces, regulations, and standards. However, despite the tremendous growth of businesses involving digital assets, there has not been comprehensive research in protecting the IPs of such assets through NFTs. NFTs for intellectual property provide a strong platform for innovators and asset owners to commercialize and monetize their IP with transparency. In this study, an exhaustive patent analysis has been carried out on the development of NFT technology for IP protection, to comprehend existing problems in managing digital assets and to identify research frontiers and business capabilities of this technology. The analysis provides the technical field of innovation in NFT-based IP protection along with other bibliographic analyses. Moreover, the detailed study brings out the technical problems and their solutions and identifies potential technology gaps and white spaces yet to be explored. The research and search methodology presented here uses an intensive query for extracting relevant documents from the PatSeer database and can be used for patent landscape analysis and other search analyses.

Keywords: NFT, Non-Fungible Tokens, Blockchain, IP protection, Intellectual Property.

1. Introduction

Blockchain is an emerging technology that helps in decentralizing various business models requiring trust and value which include finance and its counterparts.

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Ethereum, the next iteration of blockchain technology, empowers developers to construct smart contracts on a decentralized ledger. The development of smart contracts has enabled token generation for financial applications,[1] crowdfunding,[2] data management,[3] energy systems,[4] and unique identifiers.[5] Leveraging blockchain has initiated the creation of tokens for digital assets in the distributed ledger facilitating immutability, transparency, transferability, fraud prevention, and authenticity.[6] Blockchain technology is further divided into fungible and non-fungible tokens. The fungible tokens have equal values that are interchangeable whereas non-fungible tokens (NFT) have unique values and are stored in the blockchain. NFTs are tradable rights of digital assets or digital representations of real-world objects, where ownership becomes traceable through smart contracts.[7] NFTs leverage the potential of blockchain technology to establish non-fungible digital assets, such as patents, copyrights, trademarks, and trade secrets thereby safeguarding and empowering the holders of intellectual property. These distinctive assets can be bought or exchanged, with a digital ledger documenting every transaction.

In a real-world scenario, securing a trademark, copyright, or patent is a time-consuming and costly process. Applying NFT's unique identifier capability can simplify it, reducing the time in securing ownership claims.[8] This will lead to faster opportunities for the business organization to monetize its IP. Also, despite minimal transactions, ownership can be traced as each transaction is logged into the blockchain. Therefore,

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1 Mohd Javaid, Abid Haleem, *et. al.,* "A review of Blockchain Technology applications for financial services" 2(3) *BenchCouncil Transactions on Benchmarks, Standards and Evaluations* 2 (2022).

2 Bernd Teufel, Anton Sentic, *et. al.,* "Blockchain energy: Blockchain in future energy systems" 17(4) *Journal of Electronic Science and Technology* 319 (2019).

3 Hasnan Baber, "Blockchain-based crowdfunding", in Righi Rosa, Alberti R., *et. al.* (eds.), *Blockchain Technology for Industry 4.0*: *Secure, Decentralized, Distributed and Trusted Industry Environment* 117-130 (Springer, Singapore, 2020).

4 Hye-Young Paik, Xiwei Xu, *et. al*., "Analysis of Data Management in Blockchain-Based Systems: From Architecture To Governance" 7 *IEEE Access* 186091-186107 (2019).

5 Manoj, T., Krishnamoorthi Makkithaya, *et. al*., "A Blockchain Based Decentralized Identifiers for Entity Authentication in Electronic Health Records" 9(1) *Cogent Eng*ineering 3 (2022).

6 Shuai Wang, Liwei Ouyang, *et. al*., "Blockchain-Enabled Smart Contracts: Architecture, Applications, And Future Trends 49(11) *IEEE Transactions on Systems, Man, and Cybernetics: Systems*, 2266-2277 (2019).

7 Seyed M. H. Bamakan, Nasim Nezhadsistani, *et. al.,* "A Decentralized Framework for Patents and Intellectual Property as NFT in Blockchain Networks" *Research Square* (2021) *available at:* https://www.researchgate.net/publication/355101127_A_Decentralized_Framework_for_Patents_and_Intellectual_Property_as_NFT_in_Blockchain_Networks#fullTextFileContent (last visited on March 26, 2025).

8 Julia Hugendubel, "Blockchain technology and intellectual property–A basic introduction" (October 08, 2021), a*vailable at:* https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3917801 (last visited on March 26, 2025).

whenever an IP gets minted as an NFT, the inventor automatically starts generating royalty revenue every time it is licensed without having to track it.

The copyright protection of digital assets through NFTs intersects with the copyright law in the following stages, namely:

(i) minting/registering of the asset with NFT;
(ii) storage of the asset linked with NFT;
(iii) offering for sale of the NFT; and
(iv) transferring the NFT.

Any creative expression is protected under copyright through smart contracts while outputs from GenAI that are associated with the NFTs are not copyright-protected as specified by the (USPTO) copyright office.[9] NFT marketplace provides the brand owners the same opportunity in the identification of their goods and services as in the real physical world. The trademark rights and the licensing agreements are enabled through smart contracts, while the transactions associated with the trademark are recorded in the blockchain networks. NFT presents opportunities for patent holders to manage a portfolio of patents at a low transaction cost, keep track of the right transfers, commercialize, and monetize their patents. Also, new patentable ventures on NFT-related inventions are gaining importance to enhance the technical accessibility.

In the era of technology empowerment which has also led to a rise in cybercrimes, national laws and business legislations have been evolving to tackle this multifaceted problem. In March 2023, the Virtual Asset User Protection Act was approved by the South Korean National Assembly, serving as a crucial foundation for the regulation and oversight of Crypto Assets within the country.[10] The Indian government unveiled a National Strategy on Blockchain in December 2021, aiming to establish a platform that provides blockchain as a service. Moreover, the amendment in the Income Tax Act, 1960 imposed taxation on the transfer of Virtual Digital Assets through NFT.[11]

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[9] Non-Fungible Tokens and Intellectual Property: A Report to Congress (uspto.gov)

[10] Eddie Wrenn, "Anndy Lian: South Korea's New Crypto Rules Bring Market Stability" *Techopedia* (February 26, 2024), *available at:* https://www.techopedia.com/anndy-lian-south-koreas-new-crypto-rules-bring-market-stability (last visited on March 26, 2025).

[11] Megan-Hylton, "*Blockchain & Cryptocurrency Laws And Regulations 2025 – India, Global Legal Insights, available at*: https://www.globallegalinsights.com/practice-areas/blockchain-cryptocurrency-laws-and-regulations/india/ (last visited on March 26, 2025).

The implementation of multiple additional legislations illustrates the government's awareness of advancements in technology. The world of metaverse introduced avatars in the technology, entertainment, and gaming sector. This could lead to a rise in the mimicking of humans and their intellectual works in the virtual world, which raises IP consequences. The case of *Digital Collectibles Pte Ltd*. v. *Galactus Funware Technology Pvt. Ltd*.[12] shows the possibilities of infringement. The defendants were charged for using the artistic drawings of plaintiffs and famous cricketers along with their names as digital player cards in an online gaming platform. They were using the players' signatures and other attributes without their authorization and license.[13] Though the plaintiff claimed the protection of their gaming cards with famous cricketers through NFT, the decision to prevent the defendant from using their concept failed, as information in the public domain cannot be owned by anyone because of the right to freedom of speech and expression under Article 19(1)(a) of the Constitution of India. The online gaming industry provides for a high degree of infringement of intellectual property, particularly copyright.

The *MDY Indus., LLC* v. *Blizzard Entertainment, Inc*.[14] case is another such instance where MDY faced a copyright infringement claim for an automated gameplay bot that it made available on Blizzard's gaming platform. MDY was charged with breaking the End User License Agreement and Terms of Use agreed by players while playing the online version of the game.[15] Game developers also face IP issues when YouTubers live-stream video games with commentary. Distributed ledger technology can help overcome these problems by identifying the unregistered IPs, unlicensed gaming factors, and the source of operations.

Furthermore, trademark infringement has been observed in the metaverse market through the sale of virtual goods bearing the trademarks of physical brands. This has raised the need for the physical brands to protect their trademarks under Metaverse goods

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12 CS (COMM) 108/2023.

13 Arunima, "Delhi High Court Refuses Injunction Sought Against Mobile Premiere League and its App Striker" *SCC Times Online*, April 29, 2023, *available at:* https://www.scconline.com/blog/post/2023/04/29/delhi-high-court-refuses-to-grant-injunction-against-mobile-premier-league-and-its-app-striker-online-fantasy-sports-legal-updates-research-news-awareness-law/ (last visited on March 25, 2025).

14 629 F.3d 928 (9th Cir. 2010).

15 Gayathri Prajit, "Protecting intellectual property in the metaverse: Challenges, opportunities, and recent case laws" *The Times of India*, May 6, 2023.

and services classification (class 009, class 016, and class 035 NICE classification system as per the USPTO's Trademark Next Generation ID Manual), and NFTs to be on the safer side. Tanishq is the first Indian jewelry brand to enter the metaverse environment through its IP-protected 3D jewelry designs, Rivaah, along with a 3D virtual jewelry try-on through a Metaverse press conference.[16] Mahindra & Mahindra has issued NFTs for its Thar vehicle in the metaverse environment. Similarly, MakeMyTrip has taken up the sale of NFTs for their virtual vacation trips.[17]

Metaverse systems are enabled through Augmented reality (AR), Virtual Reality (VR), and Mixed Reality (MR).[18] Interaction with 3D digital objects is made possible through brain-computer interfaces, VR headsets, gloves, and several other sensors. All the inventions developed for metaverse, and digital environments are protected through patents. Moreover, the inventions developed in the metaverse are design protected. However, based on the technical effect and public order of the inventions, the product remains patentable or non-patentable. And NFTs play an important role in protecting virtual objects where patentability remains a question.[19]

Despite the challenges of IP in the digital environment, there have been ample opportunities for business and heavy market through NFT creation. The development of NFT tokens for the protection of digital assets has created better transparency. Though the issue of NFT does not mean the transfer of rights, it identifies the change in ownership, shared licenses, and royalties.

This paper aims to investigate the evolving nature of NFT with intellectual property along with its technology trend through a longitudinal analysis of the patents. Also, a detailed analysis of the problems solved and the adaptability of the technology in real-world scenarios has been addressed through the patent analysis.

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[16] Queppelin, *Tanishq Metaverse on Queppelin's Platform*, 2022, *available at:* https://www.youtube.com/watch?v=oWAJp8kCyv4.

[17] Meghna Sherman, "Trademarks and the Metaverse", IP & Legal Filings, February 08, 2023, *available* at: https://www.ipandlegalfilings.com/trademarks-and-the-metaverse/ (last visited on March 24, 2025).

[18] Efe Ahmet, "Taking Virtual Reality and Augmented Reality to The Next Level: Artificial Intelligence with Mixed Reality" 4(2) *Journal of Public Administration and Technology* 141-165 (2022).

[19] Iony Randrianirina, "Patent Law and Metaverse" *Metaverse and the Law* (Lyon, France, 2023) *available at:* https://hal.science/hal-04314534/document (last visited on March 24, 2025).

2. Methodology

In the present article, patent data is utilized for analysis primarily due to its ability to offer a unique perspective on the evolution of technology over time, enabling researchers to track innovation trends, and technological advancements, and identify emerging areas of interest within various industries. Additionally, patent data contains detailed technical information that may not be readily available through other sources, making it a valuable resource for understanding the underlying mechanisms behind technological advancements.

The longitudinal patent analysis on the emerging perspectives of NFT in IP protection comprises mainly of five steps. The first step involves the discussion among the authors on the solution for IP protection, finalizing the technology area for analysis, and the overall planning for the analysis. Then, the concepts and synonyms relating to the technology domain are identified through literature reading. The concepts and synonyms related to NFTs and IPRs are collected from relevant documents and a matrix is created based on the concepts and synonyms. A query is created based on the concepts and synonyms, and a search has been conducted in the PatSeer database. After several iterations and filtering, a result set with 236 relevant unique patents is finalized for the analysis. Analysis of the relevant set of patents aided in extracting pertinent graphs. Finally, by examining these graphs, the authors formulated the insights for the analysis.

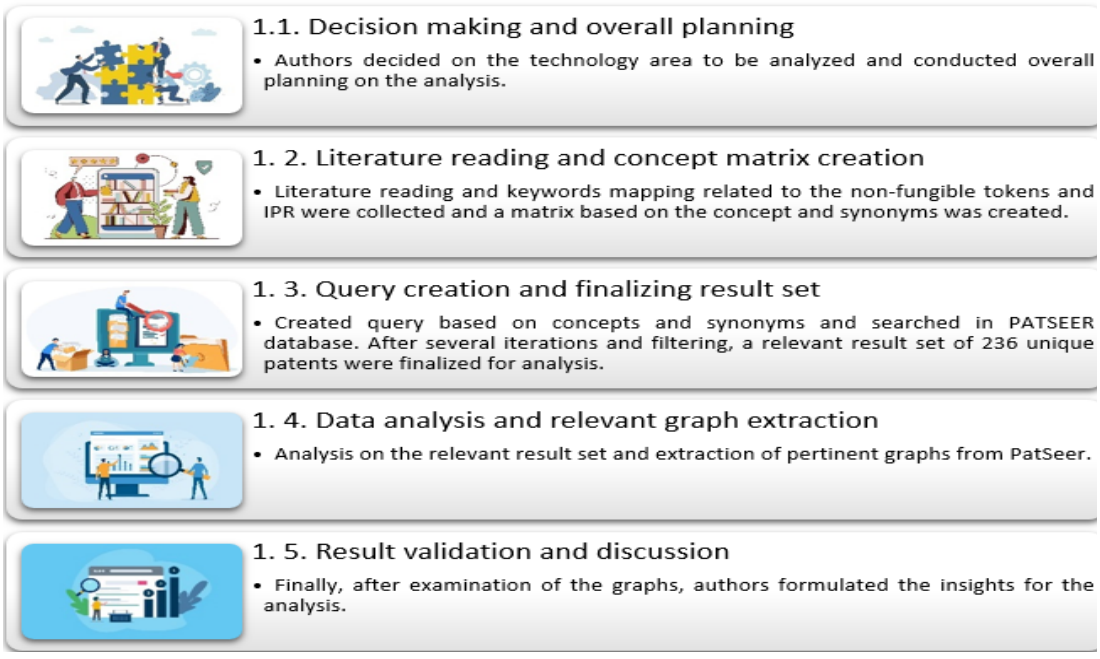

Figure 1: Schematic view of research methodology

2.1. Search Strategy

The authors obtained patents about NFT in IP protection from the PatSeer database and Espacenet. As the first-ever NFT "Quantum" was minted in 2014, therefore, the analysis focuses on emerging perspectives of NFTs in IP protection globally from 2014.[20] The search was made within patents till January 2024 and an in-depth filtration was carried out with manual reviewing. The analysis extracted 236 relevant unique patents. Keywords related to NFTs such as cryptographic tokens, authorization tokens, non-fungible tokenization, smart contract, immutable ledgers, and minting, *etc*. and keywords related to IP such as patents, copyright, design patents, and trademarks *etc*. were used. It is important to note that search results may be subject to limitations due to the 18-month lag period. On analyzing the relevant result set, insights on the patenting trend in the field of study, key players, major technical areas of research, top citations, high competition areas, and whitespace opportunities were uncovered. Table 1 illustrates the search strategy used for the analysis.

Table 1: Search strategy for the analysis

Database Used	PatSeer, Espacenet (Patents) Google Scholar (NPL)
Keywords Used in NFTs	NFT, cryptographic tokens, authorization token, non-Fungible tokenization, smart contract, immutable ledger, minting
Keywords Used in IPR	IPR, patent, copyright, design patents, trademarks
Geographical area	Worldwide
Areas covered	Patenting trend, key players, top classification, technology hotspot, highly competitive technology areas, potential gaps in technology areas, patent citation analysis

[20] MK Manoylov, "A brief history of NFTs: From CryptoPunks to Bored Apes" *The Block*, October 18, 2023, *available at:* https://www.theblock.co/learn/251477/a-brief-history-of-nfts (last visited on March 20, 2025).

3. Analysis Description

3.1. Patent Trend Analysis

The chart (Figure 2) below shows a patenting trend analysis on number of application filings and published grants for NFT technology. The chart was generated on overall records (236 Records)[21] and the trend analysis is for the last 10 years.

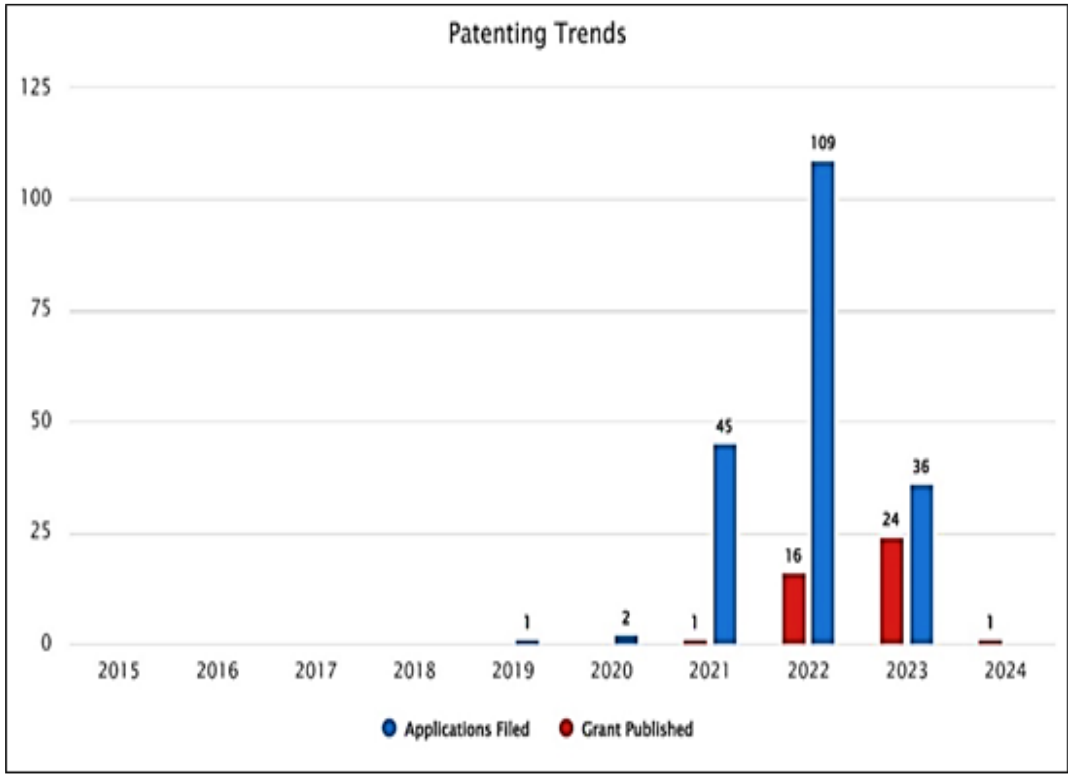

Figure 2: Trend analysis in years

Patenting trend analysis provides an important statistical analysis of the rate of publication of patents concerning NFT and its technology strategies. The analysis is performed by counting the number of patents based on the years as generated by the database.

As shown in Figure 2, among the 236 unique patents, 193 were classified as filed patent applications and 42 patents were categorized as granted published patent applications.[22]

Patents are being filed consistently in this domain. Interaction with the filed patent application increased sharply in 2021 with 45 patents, followed by a steady

[21] Out of total 236 unique patents, 01 patent is utility patent.
[22] 01 utility patent out of 236 is excluded from the patenting trend analysis.

increase in 2022 where the number of filed applications reached to 109. In 2023, it was 36. The Patent application is published after 18 months period from the filling/priority date of the application, so there are many applications in the upcoming year.

As for the granted patents, the number reached its maximum in the year 2023 with 24 patent records which was more than the 16 granted patents in the year 2022.In 2024, there is one granted patent application. This is because patent grant takes time due to procedural delays that include searching, drafting, filing, publication, examination, and office actions and their replies. So, many applications may appear on the list this year.

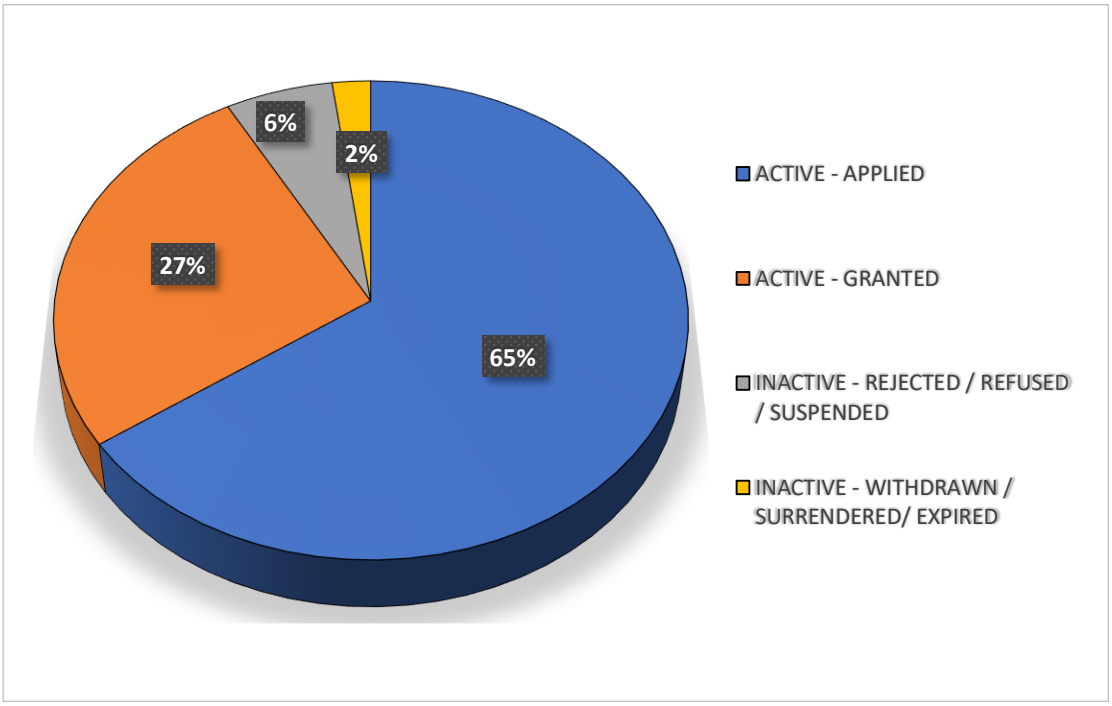

Figure 3: Current legal status

Figure 3 shows the legal status of the patent records. To check whether the patents are in force or not, it is essential to analyze the legal status of patents that are active and inactive. Out of 236, only 65% are currently active in applied status, and 27% are active in granted status. 8% of the inactive patents have expired due to non-payment, rejection, withdrawn, or other reasons.

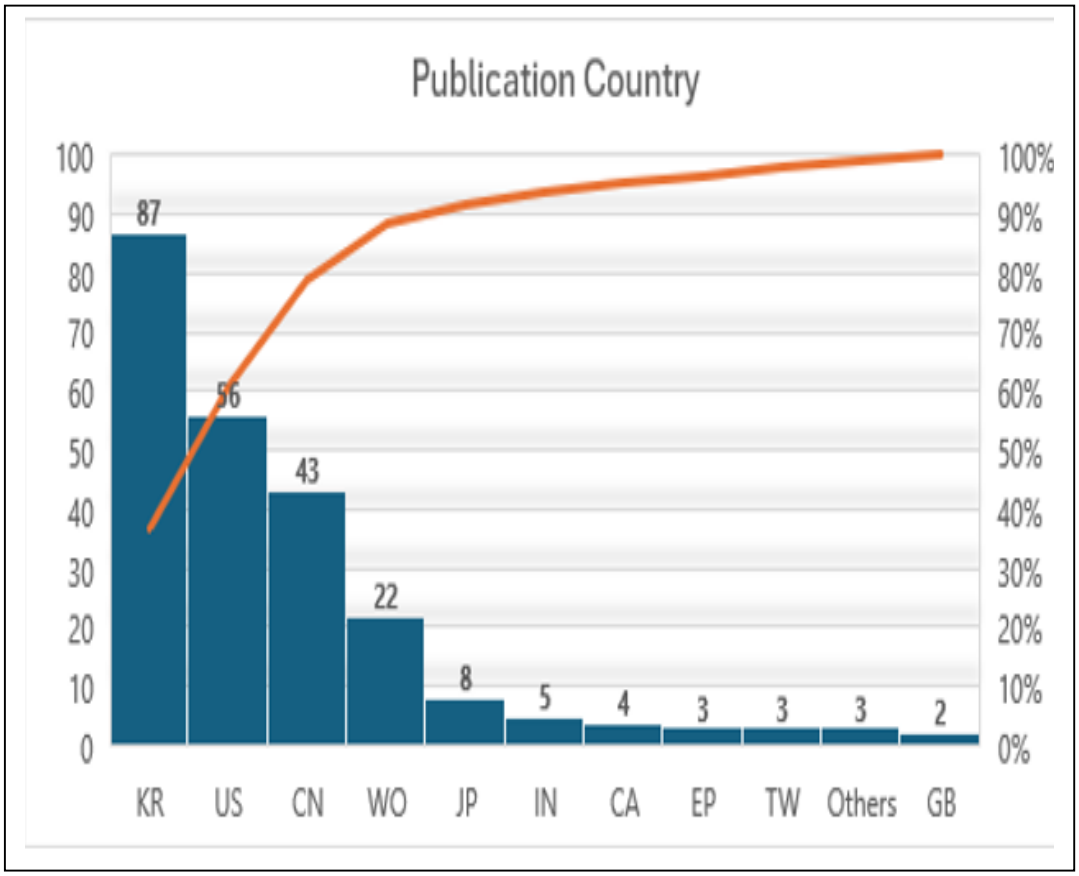

Figure 4: Geographical distribution of patents

The geographic distribution of patents therefore indicates the level of diffusion of technology and knowledge across regions. The chart shows the number of records published across the different areas/jurisdictions. When grouping by family, all the publication countries present in the family are factored and the count represents the number of unique families present in the country.

As shown in Figure 4, South Korea is the leading country in this NFT field with 87 patent counts followed by United States with 56 patent counts, China with 43 patent counts, and India with 5 patent counts.

3.2. Key player analysis

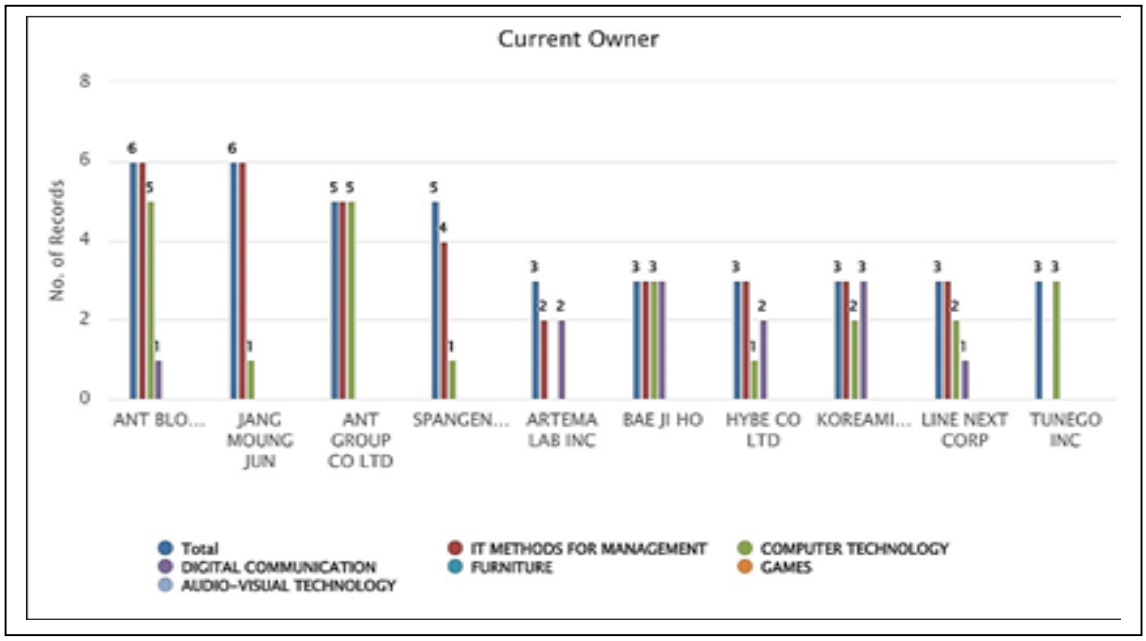

Figure 5: Top assignees

The graph in Figure 5 shows the top 10 active contributors in this field collectively covering nearly 17% of the patents filed. The major contributors of patents in the field of NFT for IP protection majorly belong to South Korea, China and the US. This demonstrates the awareness of risks and challenges in the crypto space and the countries' initiatives to protect their virtual assets.

A legal framework called the Virtual Asset User Protection Act has been passed in South Korea for the protection of its crypto assets. The most significant contributors are Ant Blockchain Technology (Shanghai) Co., Ltd. from China with five patents related to computer technology and one on digital communication. Four patents of the Ant Group are presently owned by Alipay (Hangzhou) Information Technology Co., Ltd. Jang Moung Jun owns the highest number of patents relating to digital asset management, followed by Erich Lawson Spangenberg and Bae Ji Ho. Artema Labs holds 34 patents in blockchain and cryptocurrencies and three patents in IP protection. Hybe Co. is a leading South Korean entertainment company that has enabled its sound source copyright fee generation through tokenization patents. It is followed by Line Next Corp. and Tunego who run online platforms to protect their music and other digital assets. It can be concluded from the patent holders that the entertainment industry and online e-commerce

sites for digital assets strongly believe in NFT and want to protect their assets through tokenization.

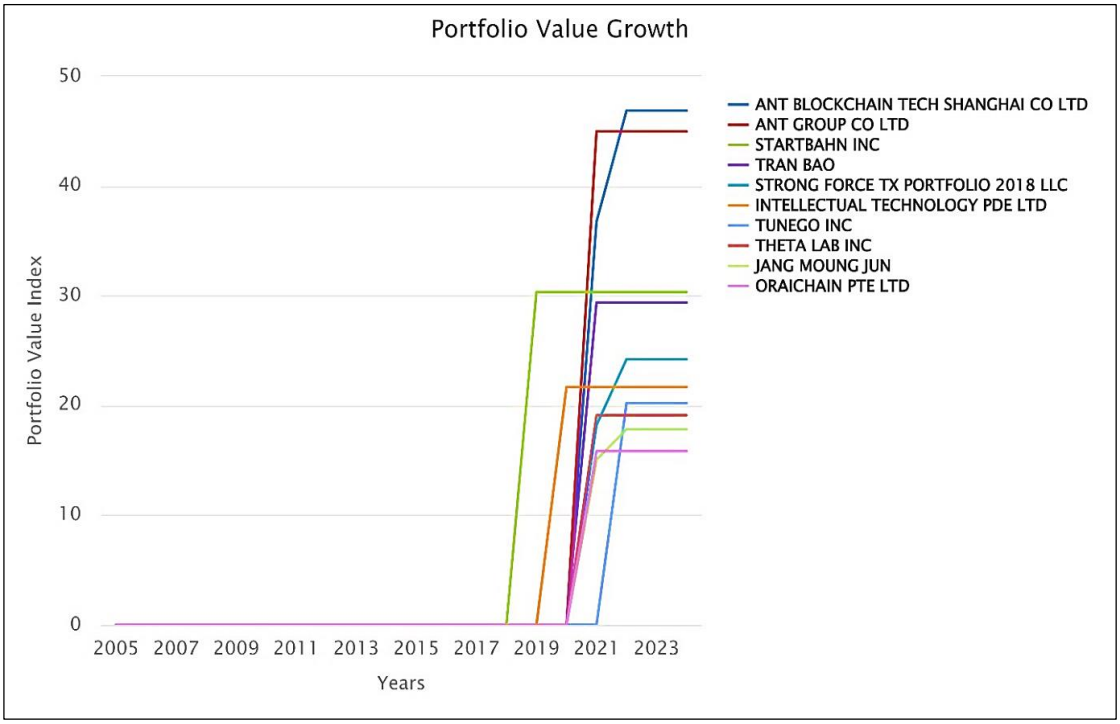

Figure 6: Top patent portfolio holders

The patent portfolio value index has been derived over the years based on forward citations, International Patent Classification (IPC) and Cooperative Patent Classification (CPC) diversity, forward assignee spread, patent lifetime, and patent family coverage. It can be observed from Figure 6 that the portfolio value index of the highest patent holder, Ant Group, gains the highest value indicating the market need and applicability of the patents. Ant Group stepped into patent creation of IP protection through NFT in 2020 but has a portfolio of patents in methods for digital asset registration in NFT, payment for the assets through NFT, and circulation of the digital assets. Startbahn, Inc. has a high index value for their patent in transaction management of digital assets through NFT. Tran Bao has patented technology for recording the ownership of any digital property and involves authentication techniques, key generation, and smart contract creation. The other top-profile index holders have patents in IP asset management platform, media content IP management, and digital rights management systems. Oraichain Pte. Ltd. holds an invention on copyright issuance technique for AI-generated

multimedia content. The portfolio index analysis confirms the enablement of IP protection through NFTs by their patented technologies.

3.3. Top classifications

The chart in Figure 7 illustrates the top CPC full classes for the patent document records. When grouping by family patent documents, all the classes belonging to all the family members of the patent documents are factored and the count shows the patent number of unique families against the class.

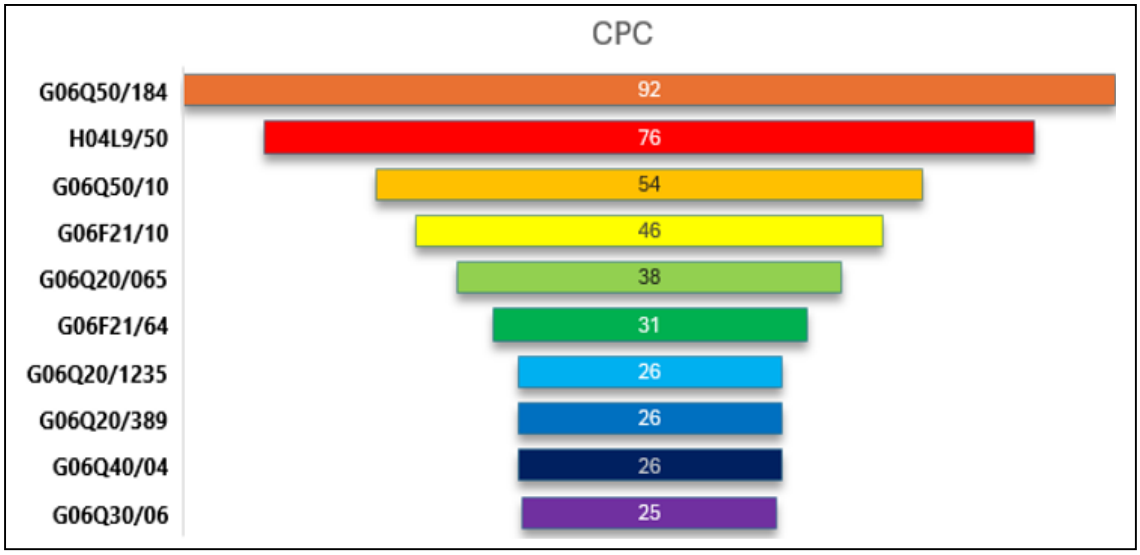

Figure 7: Top CPC classifications

This analysis shows that the highest number of patent applications are filed under the CPC classification of G06Q50/184 with 92 patent applications. The maximum patents are filed under the G06Q classification. In this classification, G refers to physics, and G06Q refers to the Information and Communication Technology (ICT) specially adapted for administrative, commercial, financial, managerial, or supervisory purposes; systems or methods specially adapted for administrative, commercial; G06Q50 refers to ICT specially adapted for implementation of business processes of specific business sectors such as utilities or tourism; and G06Q50/184 refers to IP management. It is followed by HO4L9/50 with 76 patent applications, where H refers to electricity and its subgroup H04L refers to the transmission of digital information such as telegraphic communication, specifically using hash chains that include blockchains or hash trees; G06Q50/10 with 54

patent applications; G06F21/10 with 46 patent applications; and G06Q20/065 with 38 patent applications.[23]

The results show that the development of NFT technology is mainly concentrated in G06Q and G06F, which refers to Information and Communication Technology and Electric Digital Data Processing. This classification data plays a crucial role in the research of NFT technology for companies as well as researchers. Based on their contents, needs, and objectives, they can understand the key technologies and features of the patent document using the classification system.

3.4. Technology hotspot analysis

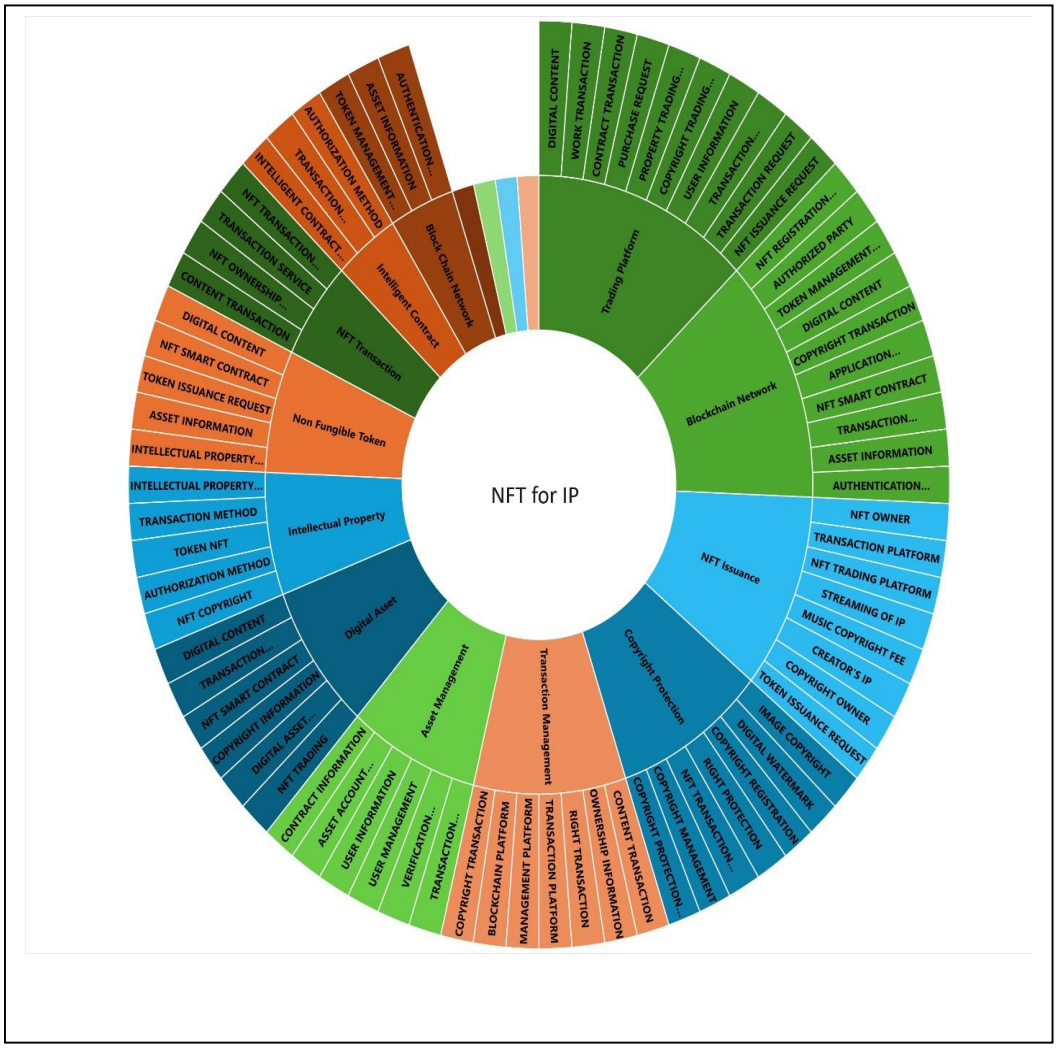

Figure 8: Technical fields of analyzed patents

[23] European Patent Office, "Cooperative Patent Classification", *Escapenet*, *available at*: https://worldwide.espacenet.com/classification?locale=en_EP (last visited on March 20, 2025).

The technical fields of the analyzed patents shown in Figure 8 show the categorization of technology topics in this field. The inner circle highlights the major topics while the outer circle highlights subtopics. The technology topics for the patents were extracted and were found to belong to the following categories: NFT (181 patents), blockchain network (152 patents), digital asset (147 patents), NFT transaction (84 patents), smart contract (147 patents), transaction management (18 patents), NFT issuance (34 patents), asset management (152 patents), intelligent contract (31 patents), copyright protection (46 patents), and right confirmation (20 patents). It is evident from the patenting trend that technologies and methodologies are evolving for smart contracts and intelligent contracts by crafting NFTs, valuing and regulating data assets, farming an NFT marketplace, IP generation and authorization method, transaction platforms and reward systems, monetizing IP, transfer pricing, and copyright protection.

The other upcoming technology area is asset management which involves asset registry, protocol development, asset inheritance, asset registration, maintenance, virtual asset management and operating system, and content identification. The technology areas in the next highly patentable areas include NFT transactions, particularly mining systems, NFT issuance, NFT trading, pirate detection, trading IP rights, revenue information, and electronic wallets. The analysis also showed that NFT-based IP protection futuristically covered 13% patents, 9% trademarks, and 71% copyright.

The patents in NFT-based copyright protection included technologies such as copyright infringement, game asset platforms, valuation of creative rights, media content verification, copyright creation for AI-generated content through NFT, literary work management system, artist licensing system, securing a virtual space, copyright authentication method, live streaming content protection, trading copyright, music copyright, sound source authentication, video-based copyright transaction, art data protection through cryptography, digital artwork, choreography plagiarism in video content, right confirmation, metaverse data, identification information, and copyright trading platforms.

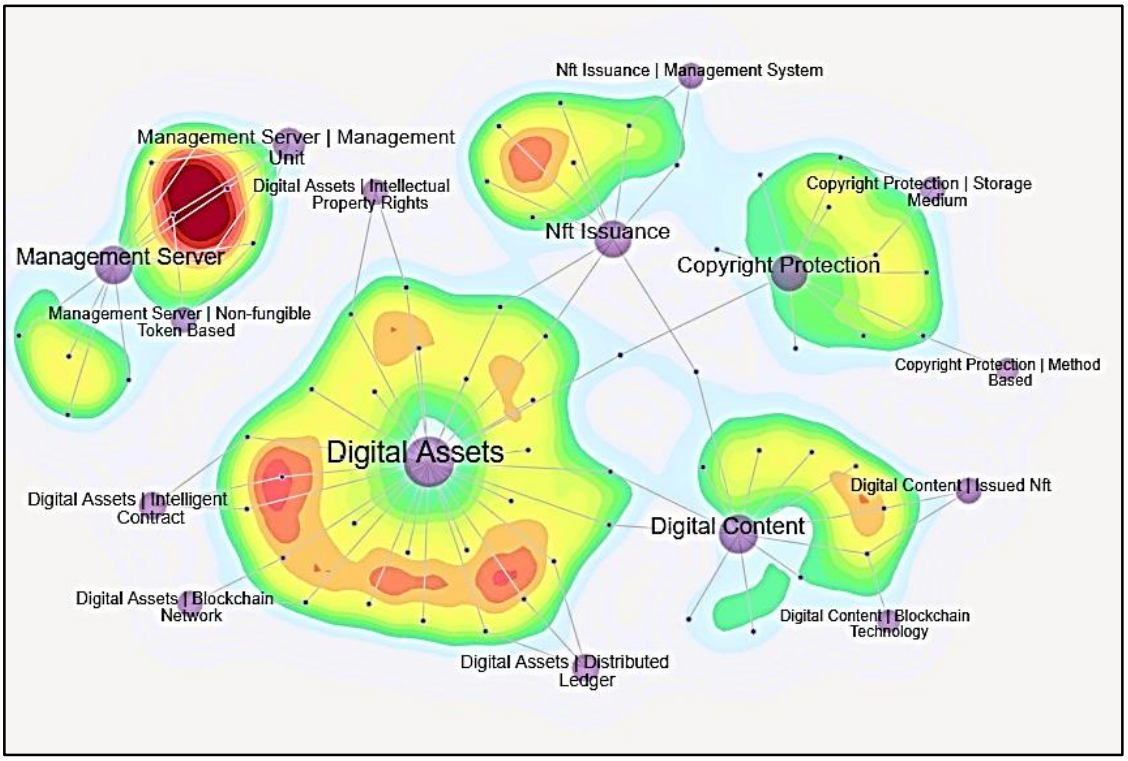

Figure 9: Hot spot analysis

The technology heat map analysis provides a bird's eye view of the patent portfolio developed by companies and research institutes to protect their patent with NFT. The analysis is based on text mining technology where the technical terms and keywords relating to NFT in IP and their frequency over the patents are used to derive the portfolios. The distance between the technical terms defines the correlation between the terms and their statistical analysis. The technology heat map represents the distribution density of the documents plotted on plane axes through certain predefined rules. The red regions are technology areas of high patent densities.

Figure 9 provides the network analysis between the clustered keywords. NFT has been created for the protection of IPR of digital assets and digital content through smart contracts that get registered in the distributed ledger. The patentability between this network of keywords is visible from the patent network as seen in Figure 9. Digital asset management systems hold patents in IP and methods for registering them. The other clustering of patents is based on the development of patents relating to the methods and system for NFT issuance. The clustered copyright-based patents are related to the methods by which the creative works are being stored in physical form. The digital assets

and digital content protected through NFT get registered in the blockchain network for further trading.

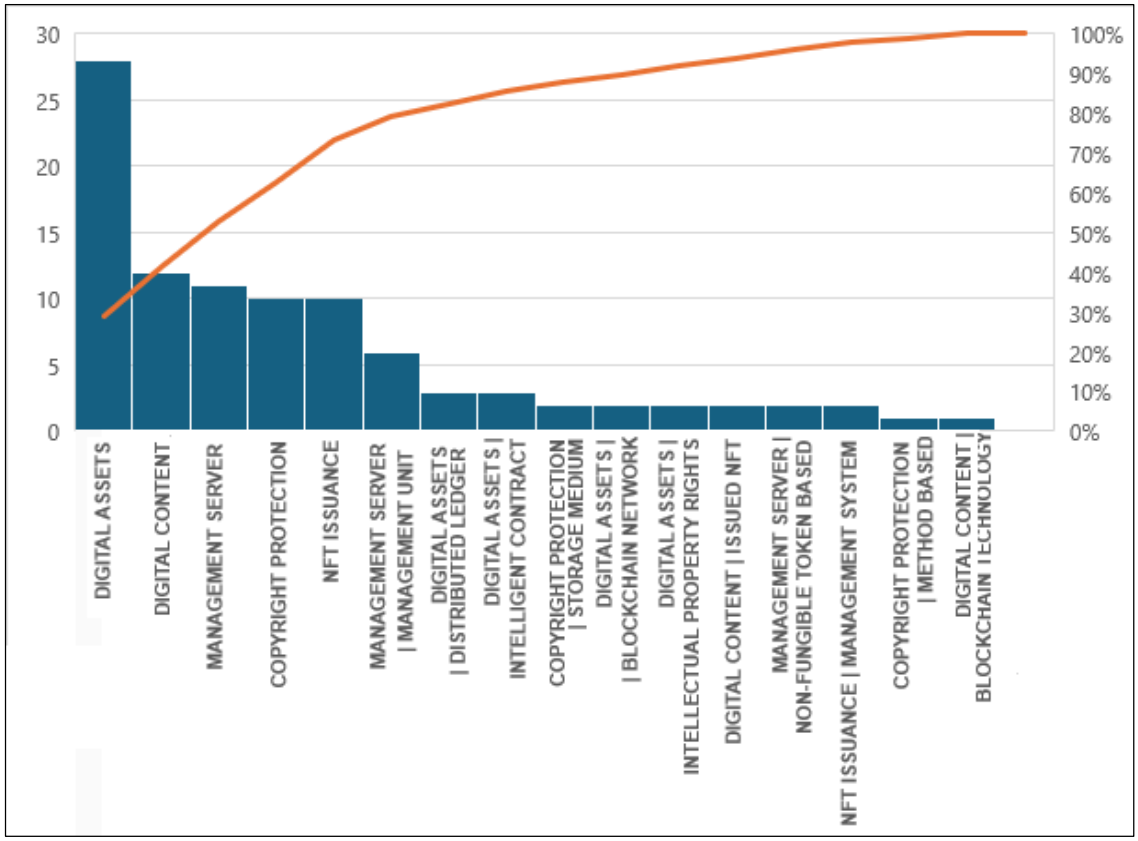

Figure 10: Portfolio chart

The clustering of patents under different portfolios and their frequency has been given using Pareto analysis in Figure 10. The left vertical axis indicates the number of patents in the technical field, while the right vertical axis provides the cumulative value of each field in percentage. It can be observed from the graph that 90% of the patents are related to protecting digital assets, 40% relate to asset management, and nearly 30% of the patents correspond to copyright management and NFT issuance. The patents in digital assets are related to the creation of smart contracts in blockchain networks for authorization, authorization methods, asset circulation methods, authentication protection methods, methods for setting up limitations on time for an asset to be owned by an authorized person, and IP management system using software as service interface layers. Digital asset management systems involve patents in creating marketplaces for transactions and tokenization controller methods. Copyright protection holds patents evolving on extended reality (XR) assets, bidding techniques for live IP work in progress,

and more particularly, in metaverse environment and copyright resource processing methods.

3.5. Highly competitive technology areas

Highly competitive technology areas are popular or busy fields where many inventors and companies are trying to patent similar ideas or technologies.

Based on a critical examination of the patents by grouping them under various categories, the high competition areas were identified to be credential processing, tokenization, digital multimodal data, revenue generation, NFT issuance, and trading services. The technical areas and some interesting topics covered by them are discussed as follows. Figure 11 provides the percentage distribution of patents in highly competitive areas.

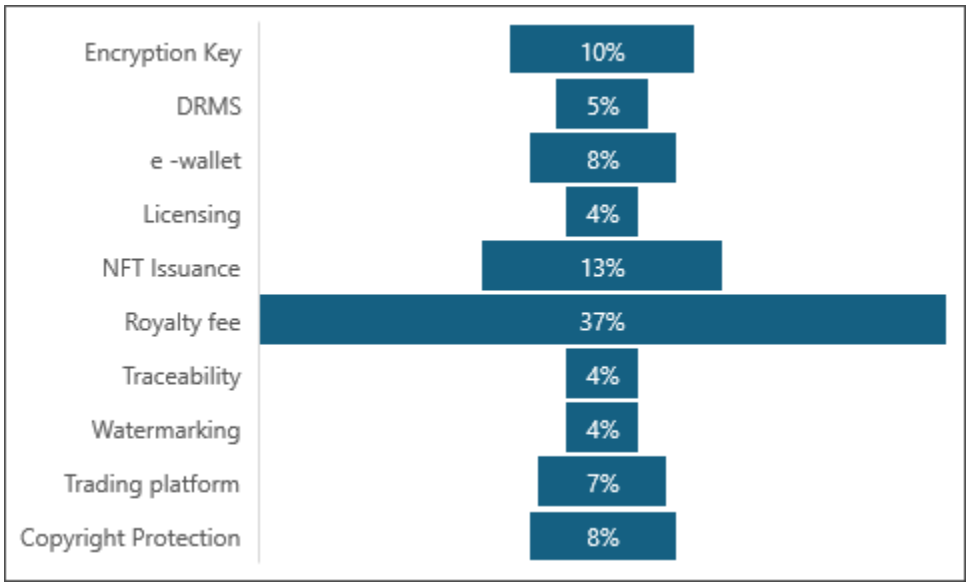

Figure 11: Key distribution of patents in a highly competitive area

3.5.1. Authentication by encryption keys

About 10% of patents are filed for protecting intellectual content through authentication using encryption keys and involves computerized agents. Some of the concepts of patents filed in this area involves enabling authentication of digital media ownership using genomic information for example: usage of DNA signature image and

DNA encryption keys for authentication,[24] authorized digital asset (e-book, audio, video) sharing by embedding audio code/file where the audio code acts as a unique identifier.[25]

3.5.2. Licensing, revenue generation, and royalty distribution of the asset

The vending or licensing of assets can be enabled using ash or digital wallet, NFT authentication, and NFT property management techniques through revenue-sharing methods and royalty distribution. For example, when a content creator, say an artist, uploads their work, they have a way to customize the royalty amounts for different uses or rights transfer and create digital wallets for each collaborator or partner. It resembles the establishment of a marketplace platform for intellectual properties, where all the information regarding the initial sale price, owners, and collaborators, how royalties are distributed and relevant licensing conditions or terms that trigger a royalty payment or fee are unveiled. These information are used to create a token to represent the content, smart contracts, digital crypto wallets, and so on.[26] An open asset trading platform for IP NFT artworks enables anyone to freely participate in trading and receive payment or profit generated from the IP rights, this also helps to split the ownership proof of art and intellectual property.[27] Method for calculating the value of creative rights based on the creation's revenue information.[28]

3.5.3. Rights management system

Digital rights management (DRM) allows tech domain use to manage and control access to copyrighted material. The development of intellectual rights management systems through license management and cryptographic services to protect data integrity is exemplary. Rights management is another highly explored area. The technical content of the patent applications relates to managing digital rights, licensing

[24] Park Jong-hwa, Server and Method for performing ownership authentication of digital media by digitally imaging genomic information, South Korea, KR102443040B1 (to Park Jong-hwa), dated September 14, 2022.

[25] Elmon Jacob, Elmon Brandon, A smart contract based blockchain application using non-fungible token for authorized asset sharing, United Kingdom, GB2607026A, (to Elmon Jacob, Elmon Brandon), dated May 23, 2021.

[26] Sutudu LLC, Systems and Methods for Forming and Operating NFT Marketplace, United states, US20230419283A1, (to Sutudu LLC), dated June 27, 2022.

[27] Junik Yang, Gilim park, Ip nft art assets transaction platform and reward system, South Korea, KR20230134878A, (to Junik Yang, Gilim park), dated March 15, 2022.

[28] Jang Myung-jun, Jang san, Jang Hani, Valuation server for performing valuation of rights to creative works, South Korea & PCT, WO2022211187A, (to Jang Myung-jun, Jang san, Jang Hani), dated June 23, 2021.

for software and other IP assets. Here, NFT and the blockchain offer a framework for confirming and authenticating licenses for digital material, software, and other IP assets. The license agreements are specified and enforced through smart contracts.[29] Likewise, there is a non-commutative Node-Centric Digital Rights Management System, that gives control over licensing, fair use of IP, and other information. Here, device-to-device connections can be encrypted and secured so that data passed from one device to another can only be viewed by end users or nodes.[30] Additionally, decentralized data streaming and delivery networks with digital rights management using non-fungible tokens have seen a lot of development. It provides a decentralized DRM solution that safeguards copyrighted materials when they are shared using decentralized networks.[31]

3.5.4. Protection using digital watermarking technology

Another technology area is the protection of multimodal intellectual content using digital watermarking technology. For example, a method for managing copyrighted work data by adding a watermark and uploading it to the blockchain. NFT storage and copyright protection are achieved by a combination of blockchain technologies and digital watermarking; a transaction support system that issues NFT to a user's wallet, embeds a digital watermark, and controls the copyright license of the material.[32]

3.5.5. Trading platform

Another highly patented area is the trading platform for NFTs such as the enablement of an NFT authentication system for digital artworks along with a sales platform, transaction management, and copyright trading system. A trading platform that allows IP creators to execute network sales and purchases during sales action. For instance, during main market sales, several customers can purchase the NFT of multiple intellectual property creators who upload electronic files such as text, image, audio and multimedia. Additionally, using the transaction interface, many customers can sell their

[29] Zelus Wallet LLC, Non Fungible Token (NFT) Based Licensing and Digital Rights Management (DRM) for Software and Other Digital Assets, United states, US20230245102A1, (to Zelus Wallet), dated February 02, 2023.

[30] Peepline LLC, Non-Commutative Node-Centric Digital Rights Management System, *United States,* US20230385386A1, (to Peepline LLC), dated May 25, 2023

[31] Jieyi Long, Mitchell C. Liu, Non-fungible token (NFT) based digital rights management in a decentralized data delivery network, US, US11075891B1 (to Theta Labs Inc), dated July 26, 2021.

[32] Wataru Shunsuke, Hoshino Mitsuhiro, Hoshi Maeda, Transaction support system, transaction support method and program, Japan, JP7158073B1 (to Wataru Shunsuke, Hoshino Mitsuhiro, Hoshi Maeda), dated October 21, 2021.

NFT to multiple customers when engaging in secondary market sales.[33] A logic model for Key Opinion Leader (KOL)/core opinion leader to operate the NFT IP trading platform, where the KOL operation is used to animate the NFT marked IP, encourages point-to-point transactions, initiates the creation of a value chain, and ensures the platform operates in an orderly and legal manner.[34] A copyright trading system that permits trustworthy digital work trade issued by the NFT DID management system.[35] Global music trading platforms that allow music owners to register and trade their music copyrights.[36] And a trading system that ensures cultural performances (exhibitions, plays, and films) are protected by copyright using tokens that are kept in an immutable state on blockchain technology. By distributing copyrights held by current production companies and guaranteeing regular performance operations, it uses blockchain technology to increase the value of cultural performances through several copyright distribution procedures and reliable performance operations.[37]

3.5.6. NFT issuance

These are techniques for monetizing NFT property, NFT-based registration, issuing techniques for intellect owners and generation of reward, methods for token dualization, and generation and issuance for the intellectual property. For example, issuing copyright for digital material (3D assets),[38] pet-related copyright works,[39] the

[33] Zhang Weien, non-fungible token trading system and method thereof capable of performing one-to-one/one-to-many/many-to-one/many-to-many sales/purchases of non-fungible token NFTs, Taiwan, TW202307763A (to Zhang Weien), dated August 03, 2021.

[34] Yang Baofu, Logic model for KOL operation NFT IP transaction platform, China, CN115829791A (to Yang Baofu), dated October 30, 2022.

[35] Oh Seong-heun, Kim Ui-jung, Lee Jeong-hoon, System for trading copyright using nft, South Korea, KR102534359B1 to (Oh Seong-heun, Kim Ui-jung, Lee Jeong-hoon), dated June 26, 2023.

[36] Michael Ahn, A method and system for registering the owner of music copyright and transacting some or all of the same, South Korea, KR20220161086A (to Michael Ahn), dated June 28, 2021.

[37] Bokkyun Moon, Transaction method through copyright sharing of cultural performance operation, South Korea, KR20230061754A, (to Bokkyun Moon), dated October 29, 2021.

[38] Park Sang-geun, Method and Device for providing NFT trading platform services based on metaverse, South Korea, KR102535807B1, (to Park Sang-geun), dated May 30, 2023.

[39] Junhyun Park, Pet creation NFT transaction management operation computer, pet creation NFT transaction management system and method therefor, South Korea, KR20230166320A, (to Junhyun Park) dated May 30, 2022.

servicing of e-book distribution and information protection based on NFT,[40] and the use of copyright NFT for the artist's copyright history management.[41]

3.6. Potential gaps in technology areas

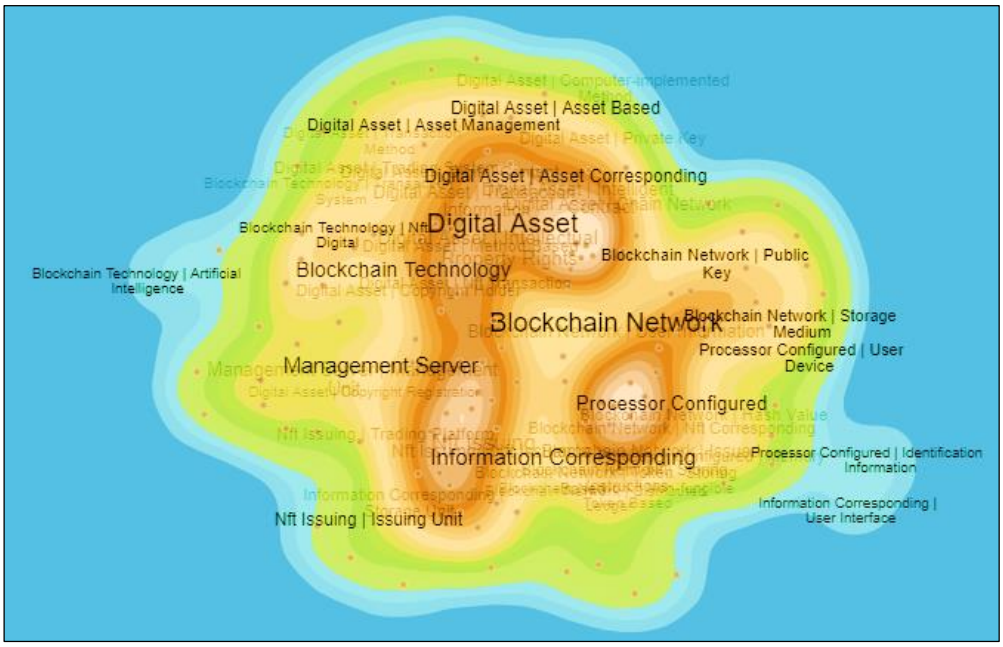

Figure 12: Whitespace analysis

Whitespace analysis or potential technical gaps provide insights into the areas where researchers can demonstrate proficiency and increase their chance of product-patent capabilities and the intensity of patent filing. All of these are represented using the color-coded image in Figure 12. The red areas indicate more patenting technical field and fading colors represent the decrease in patent numbers, with the blue area being the least. On critical examination of the patents by grouping them under various categories, the enablement areas were identified to be valuation management, authentication, on-chain program, choreography plagiarism, and NFT metadata. Particularly, patenting can be in the methods of valuation system that collects information on the revenue generation associated with the creation, system and methods for registering and creating an NFT asset, and recording the rights with the asset through smart contracts along with tracking the transfer of rights, algorithms for NFT asset's copyright authentication, generation of

[40] Kang Jong-do, system for servicing the distribution of e-books issued by NFT, South Korea, KR102458298B1 (to Kang Jong-do), dated October 25, 2022.

[41] Kim Min-jeong, Yoo Jin-ho, The creator's work history management system to which NFT issuance was applied, South Korea, KR20230089769A (to Kim Min-jeong, Yoo Jin-ho), dated December 14, 2021.

multidimensional media platforms for digitizing physical art and 3D objects, wide opportunities in media technology which include developing methods for plagiarism checker, virtual tutor with content protection, media composting techniques, digital story generation techniques, and blockchain-based media production platforms, further management of NFTs through methods for its restricted usage, predicting the NFT value, and NFT presentation systems. In view of IP management, the NFT-based methods for authorized usage of IP assets, IP commercialization and transactions systems, and IP account managing methods are the areas of patentability. Apart from these, methods for promoting and crafting NFT tokens and systems for creating NFT tokens remain optimistic.

3.7. Patent citation analysis

The chart shows the patent document records that have received maximum citations from other records in this subject matter.

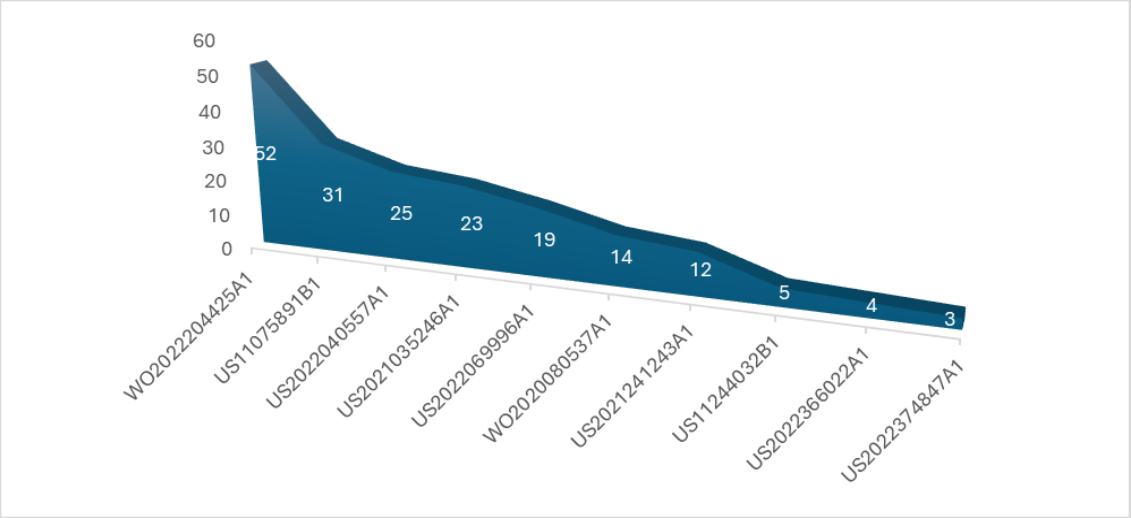

Figure 13: Most cited patents

In this section, we show how we use citation analysis to examine the connections among patents in the NFT technology field. The graph in Figure 13 highlights the most cited patents in the field of NFT technology. WO and US applications are most cited in NFT technology in IP. From the top five cited patent applications, the maximum cited patent applications are from WIPO with 66 counts and the US with 122 in total.

Citation network analysis as shown in Figure 14 offers two benefits to examining the evolution of NFT patents. First, we can trace the overall patterns of technological

relationships among NFT patents. Second, we can also specifically identify the influence of inventions or sets of inventions and map their diffusion through the economy. We describe the construction of citation networks included in our analysis as follows.

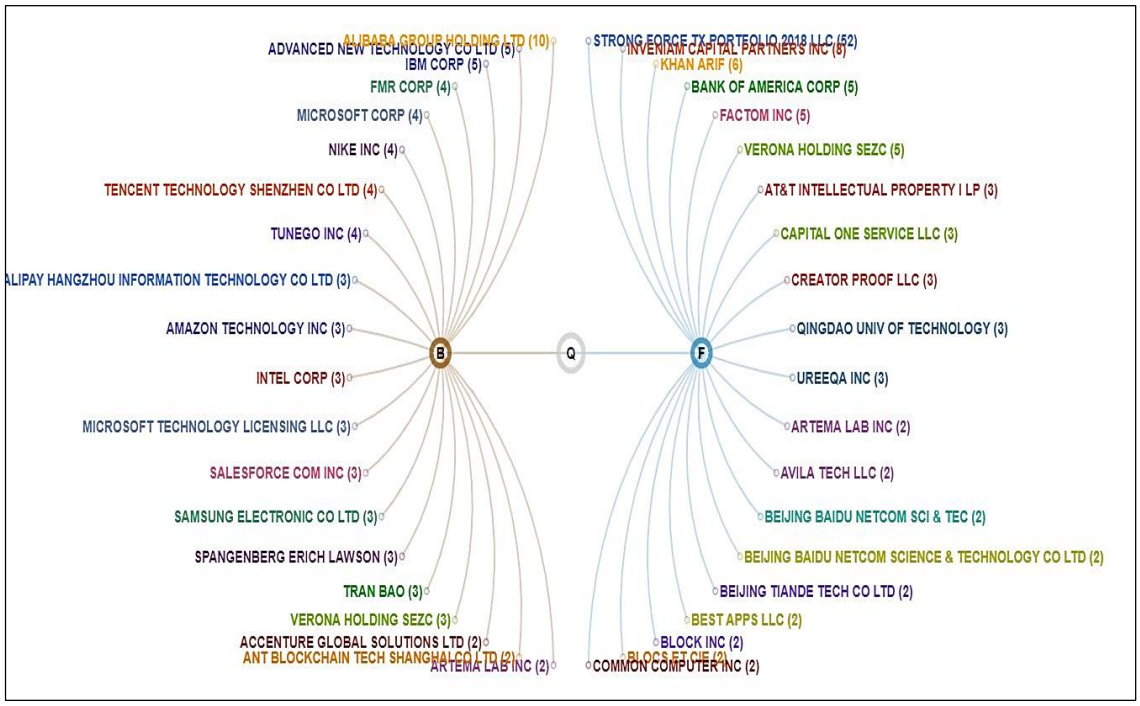

Figure 14: Patent citation inventor analysis

The inventor analysis was performed on 236 patent documents to identify the leading scientist. The studies were performed at two distinct levels, one including all the inventors and the other considering only the first inventor of each patent document. The assignee-citation analysis was performed on the 236 patent documents to identify the leading assignees. Figure 14 shows the patent trend citation information of top inventors/assignees who have filed more patents in NFT technology. The above analysis is divided into two, citation backward analysis and forward analysis. In the backward analysis, Alibaba group occupied the highest patent citation record of 10 patents, followed by advanced technology. IBMS occupied the second position reporting five patent documents. The other competitor assignees such as Microsoft, Shenzhen Co. Ltd., Intel, Amazon, Samsung, and Accenture have lesser patent citations in NFT technology.

In the forward analysis, Strong Force has the highest number of forward citations of 52 patents, followed by Iveniam reporting eight patent documents, and Khan Arif with six patent documents. Also, there are other competitors such as Bank of America, Factom,

AT&T Intellectual Property, and Capital One with a lesser number of forward citation patent records.

4. Conclusion

Even though the research on NFT has been increasing over the years, the use of NFT to protect IP is still in the exploratory phase. Over the years, about 236 unique patent applications have been filed in this field of study. There has been an upward trend since 2021; most of the patents were filed in 2022. The number of filings increased by 27% in 2022 compared to 2021, and patent grants increased from 16 in 2022 to 24 in 2023, which indicates that the research area is continuously growing.

From the analysis, it is evident that South Korea is the leading contributor with 39% of patents filed in NFT, with USA and China in second and third place respectively. All other countries are filing at a slower pace as compared to these countries. Even though South Korea is the leading contributor, the top assignee Ant Blockchain Tech (Shanghai) Co. Ltd., a subsidiary of Ant Group Co. Ltd., is from China, and the top individual assignee is Jang Moung Jun, a Korean inventor with six patents.

In terms of topics, the major areas covered or highly researched are trading platforms for IP, authentication using encryption keys, rights management system, digital watermarking, and so on. In addition the research topics where there is a potential to file patents are valuation management, chain program, choreography plagiarism, and NFT metadata.

NFTs are dynamic and evolving and will be a game changer. It holds immense promise for transforming digital ownership, licensing, and rights management. Using NFT to protect IP will enhance their value and ensure ownership rights, and provide creators with improved control, transparency, and avenues for monetizing their digital assets. The potential benefits of NFTs in IP protection are significant and continue to evolve as the technology matures and that has been promptly identified through this analysis.

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Appendix

(containing 236 relevant unique patents used for analysis)

KR20230134878A, EP4280540A1, US2022374847A1, KR20230169769A, CN115017469A, CN116308325A, US2023298017A1, KR102457034B1, KR102564971B1, US2023230186A1, IN202221019661A, US2022318853A1, US2023118312A1, WO2023097084A2, KR102388581B1, KR20230109029A, KR102524323B1, KR20230087025A, WO2022211187A1, KR20230018629A, KR20230042884A, KR20220170723A, US2023230185A1, KR102488075B1, CN114707973A, US2023222187A1, US2022370778A1, CA3146075A1, US11481815B1, WO2023039180A2, US2023281705A1, KR102551004B1, US2023237408A1, WO2023220031A1, US11244032B1, KR20220136026A, CN116484330A, TWM622824U, US2023086191A1, KR20230038074A, US2022374503A1, US2022366022A1, KR102531437B1, KR102447320B1, KR102487467B1, US2021035246A1, KR102500458B1, CN115239525A, KR102526426B1, KR102482533B1, KR20230089769A, KR20230007988A, KR102579517B1, CN115587910A, KR102494106B1, WO2023102640A1, US2022040557A1, IN202321068065A, US2023093031A1, KR20220134490A, US2023274270A1, US2021241243A1, WO2022050739A1, KR20220030887A, KR20230161294A, CA3206364A1, CA3177552A1, US11075891B1, WO2023288282A1, US2023044901A1, US2023177480A1, US2023356091A1, IN202341014134A, JP2022091158A, US2023385386A1, KR20230142913A, US2022069996A1, RO135950A0, KR20230121464A, KR102553458B1, CN115829791A, KR102410669B1, CN116776300A, TW202307763A, KR20230115604A, CN115002130A, KR102443666B1, US2023281604A1, KR20230072644A, KR20230146814A, CN114429267A, US2023196353A1, WO2023144770A2, WO2023248028A1, KR102495580B1, CN115130139A, CN116342284A, US2023195855A1, US2022351186A1, WO2023183655A1, CN115170109A, US2023274268A1, CN114359590A, WO2023177211A1, US11863676B1, CN116629848A, CN116522293A, US2022309489A1, KR20230141057A, KR20220125195A, KR20230166320A, CN115099976A, WO2023043704A1, CN114091052A, CN113129176A, TWI814446B, CN113160001A, CN113128992A, CN113129177A, CN113112262A, CN116029868A, KR20230120331A, KR20220170651A, US2023342798A1, US2022368994A1, CA3177410A1, CN117114602A, KR20230110866A, KR20230098932A, KR102447797B1, WO2023128641A2, WO2022204425A1, KR20230098731A, KR20230132304A, KR20230016401A, US11481826B1, CN115759519A, JP2024005045A, CN115438316A, KR102541623B1, CN116644026A, JP7262033B1, CN115277724A, KR20230119547A, WO2022183070A1, JP2023077866A, JP2023184490A, KR20230155859A, KR102521383B1, KR20230115824A, US2023394480A1, KR20230017451A, US2023419283A1, US2022318938A1, KR20230137192A, WO2023177111A1, KR20230155858A, CN115272013A,

KR20230086501A, KR20230155860A, KR102534359B1, KR20230165027A, KR20230136460A, CN115952473A, KR20230136461A, IN202241037928A, WO2023090371A1, KR20220161086A, US2021365909A1, US2023325826A1, GB202113708D0, KR20230061754A, KR102443040B1, US2022398636A1, JP2023157807A, US2023044043A1, KR20230166420A, US2023038412A1, US2022269754A1, CN116150715A, NL2029246B1, CN115271962A, US2023306412A1, CN115730279A, KR20230147456A, CN117436042A, WO2023039267A1, KR20230011818A, KR20230123795A, EP4174706A1, EP4290873A1, KR102435789B1, KR20230103897A, KR102572638B1, US2023041807A1, KR20230106496A, JP2023102263A, IN202241047058A, US2023376922A1, WO2024003778A1, KR102540699B1, WO2023196612A1, JP7158073B1, KR20230097582A, KR102535807B1, US2023410094A1, KR20230132194A, US2023129900A1, US2023334382A1, CN115545751A, CN116723270A, CN115423561A, US2023056827A1, US2023245102A1, US2023368186A1, CN114155095A, KR20230115641A, CN116136730A, KR20230006719A, WO2020080537A1, KR102465842B1, WO2023084816A1, KR20230131690A, KR102598245B1, CN116155506A, US2023071913A1, US11836692B1, KR102502760B1, CN114218533A, SG11202105107WA, GB2607026A, KR20230060007A, KR102458298B1, KR20230163016A, CN114726554A, KR20230163015A.