



FINEARTX - Decentralized NFT Using Blockchain Technology

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KEYWORD

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ABSTRACT

The rapid evolution of blockchain technology and Non-Fungible Tokens (NFTs) has introduced a transformative paradigm for the creation, ownership, and exchange of digital and physical artworks. In the fine art domain, particularly for emerging and independent artists, traditional art markets often present significant barriers such as limited access to galleries, lack of transparency in pricing and provenance, delayed payments, and absence of long-term royalty mechanisms. This research paper proposes a blockchain-based decentralized NFT marketplace specifically designed for new fine art, with the objective of empowering artists, ensuring authenticity, and creating a transparent, trust-minimized ecosystem for collectors and creators alike. By leveraging smart contracts, decentralized storage systems, and standardized royalty protocols, the proposed system establishes immutable provenance, enforces fair compensation through automated royalty distribution, and reduces reliance on centralized intermediaries. The paper discusses the underlying technologies, system architecture, smart contract design, provenance mechanisms, legal and ethical considerations, and an evaluation framework to assess performance, security, and adoption. The study demonstrates how decentralization can redefine fine art commerce by enabling global accessibility, sustained artist income, and verifiable authenticity.

1. INTRODUCTION

The fine art market has historically been dominated by centralized institutions such as galleries, auction houses, and private collectors, which often act as gatekeepers controlling access, valuation, and visibility. While these institutions play an important role in curating and preserving artistic value, they also impose limitations on emerging artists who struggle to gain representation, receive fair compensation, or retain control over their work once it is sold. Additionally, the traditional art ecosystem suffers from persistent challenges including opaque pricing mechanisms, forgery and authenticity disputes, fragmented provenance records, and the near absence of resale royalties for artists. With the digitization of art and the rise of global online markets, these challenges have become more pronounced, highlighting the need for a more transparent, secure, and artist-centric system [1],[2],[8]. Blockchain technology offers a compelling solution to these issues through its core properties of decentralization, immutability, transparency, and trust-less execution. Non-Fungible Tokens (NFTs), built on blockchain networks, enable the representation of unique digital or tokenized physical assets, making them particularly suitable for fine art. NFTs allow artworks to be uniquely identified, owned, and transferred without ambiguity, while smart contracts automate transactions and enforce predefined rules such as royalty payments [3],[4],[5]. However, many existing NFT marketplaces replicate centralized structures, relying on off-chain metadata storage, discretionary royalty enforcement, and platform-controlled policies that may not align with artists' long-term interests [7],[8]. This research focuses on designing a fully decentralized NFT marketplace tailored to new fine art, emphasizing authenticity, provenance, and sustainable monetization for artists. The proposed marketplace aims to minimize

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central points of control, ensure permanent access to artwork metadata, and embed artist rights directly into the technical infrastructure [1],[9]. By addressing both technological and socio-economic dimensions, this paper contributes a comprehensive framework for leveraging blockchain to reshape the fine art ecosystem in a more equitable and transparent manner.

Non-Fungible Tokens (NFTs), built on blockchain networks, extend these advantages by enabling the representation of unique digital or tokenized physical assets. Unlike fungible cryptocurrencies, NFTs possess distinct identifiers that make each token non-interchangeable, which is particularly suitable for fine art where uniqueness and scarcity define value. Through NFTs, artworks can be uniquely identified, securely owned, and seamlessly transferred without ambiguity, regardless of geographic boundaries. Smart contracts embedded within NFT ecosystems automate transactions and enforce predefined rules, such as royalty payments to artists upon primary and secondary sales. This automation not only streamlines market operations but also ensures that artists receive fair and timely compensation without reliance on manual enforcement or institutional goodwill.

Despite these technological advantages, many existing NFT marketplaces continue to replicate centralized structures inherited from traditional digital platforms. These marketplaces often rely on off-chain or centrally hosted metadata storage, undermining the permanence and integrity promised by blockchain. Additionally, royalty enforcement is frequently discretionary and subject to platform-specific policies, which can be altered without artist consent. Such centralized control limits creator autonomy and may conflict with artists' long-term economic interests. These limitations highlight the need for a truly decentralized NFT marketplace architecture that fully leverages blockchain's capabilities to support transparency, sustainability, and artist empowerment in the fine art ecosystem.

2. BACKGROUND

The global fine art market has traditionally been characterized by centralized control, limited accessibility, and opaque operational practices. Artists typically depend on galleries, auction houses, and intermediaries to exhibit, price, and sell their work, often surrendering a significant portion of revenue and creative autonomy in the process. For emerging and independent artists, these barriers are particularly restrictive, as access to established art institutions is limited and highly competitive. Additionally, the traditional art ecosystem faces persistent challenges such as art forgery, fragmented provenance records, delayed settlements, and the absence of standardized resale royalty mechanisms for artists. These issues have long hindered transparency, trust, and equitable value distribution within the fine art industry [2],[8].

The digitization of art and the expansion of online marketplaces have partially addressed accessibility concerns but have also introduced new limitations. Centralized digital platforms continue to control data, pricing mechanisms, and transaction policies, creating single points of failure and potential bias. Moreover, digital art in conventional online environments suffers from easy replication and ambiguous ownership, making it difficult to establish scarcity and authenticity—two essential components of artistic value [3],[6]. As a result, while digital platforms increase visibility, they often fail to provide the trust, permanence, and economic fairness required for sustainable fine art markets.

Blockchain technology emerged as a transformative solution to these challenges by introducing a decentralized, immutable, and transparent ledger for recording transactions and asset ownership. Its distributed architecture eliminates reliance on centralized authorities and enables trust-less interactions among participants. By ensuring that transaction records cannot be altered once confirmed, blockchain establishes a reliable mechanism for tracking ownership history and provenance—an essential requirement for fine art authentication [4],[6]. Transparency further allows all stakeholders to independently verify records, reducing information asymmetry and enhancing confidence in market operations.

The introduction of Non-Fungible Tokens (NFTs) significantly expanded the applicability of blockchain technology to the art domain. NFTs enable the tokenization of unique digital assets and the creation of verifiable digital representations of physical artworks. Unlike fungible cryptocurrencies, NFTs possess unique identifiers that make each token distinct and non-interchangeable, aligning closely with the concept of uniqueness in fine art. Through NFTs, artists can mint their work on the blockchain, creating permanent proof of authorship and ownership while enabling seamless global transferability. Smart contracts embedded within NFT frameworks automate transactions and enforce predefined conditions, such as royalty payments to artists on secondary sales, thereby introducing new economic models that were previously impractical in traditional art markets [3],[5].

Despite the rapid adoption of NFTs, many existing NFT marketplaces operate using semi-centralized models that replicate the limitations of traditional platforms. These marketplaces often rely on centralized metadata storage,

discretionary royalty enforcement, and platform-controlled governance, which undermines decentralization and compromises artist autonomy. For new fine art creators, such models may limit long-term benefits and reintroduce trust dependencies that blockchain technology was intended to eliminate [7],[8],[10]. Consequently, there is a growing need for blockchain-based decentralized NFT marketplaces that fully leverage decentralized infrastructure, enforce artist-centric policies, and prioritize provenance, transparency, and sustainability.

In this context, a decentralized NFT marketplace tailored to new fine art represents a critical evolution in digital art ecosystems. By integrating blockchain-based smart contracts, decentralized storage systems, and transparent governance mechanisms, such a marketplace can address longstanding challenges related to authenticity, ownership, and fair compensation. This background establishes the foundation for exploring how decentralized NFT platforms can redefine fine art commerce, empower emerging artists, and foster a more equitable and trustworthy global art market.

3. LITERATURE REVIEW

The application of blockchain technology in digital asset management has been widely explored in recent academic and industrial research, particularly due to its decentralized, immutable, and transparent nature. Early foundational studies on blockchain, such as those emerging from cryptocurrency research, emphasized its potential to remove centralized intermediaries and establish trust-less systems for value exchange. As blockchain matured beyond financial transactions, researchers began examining its applicability in domains that require strong guarantees of authenticity, ownership, and provenance, including supply chains, healthcare records, intellectual property management, and digital art [6],[9]. These studies collectively identify blockchain as a disruptive infrastructure capable of reshaping traditional centralized ecosystems.

With the emergence of Non-Fungible Tokens (NFTs), scholarly attention shifted toward the representation of unique digital assets on blockchain networks. Unlike fungible cryptocurrencies, NFTs are designed to represent distinct, indivisible assets, making them particularly suitable for artworks and collectibles. Several studies highlight that NFT standards such as ERC-721 and ERC-1155 enable artists to tokenize digital creations and establish verifiable ownership records. Researchers argue that NFTs introduce digital scarcity, which was previously difficult to enforce in online environments due to the ease of copying digital files. This ability to encode uniqueness and ownership has been identified as a key factor driving the adoption of NFTs in creative industries, including fine art [3],[4].

A significant body of literature focuses on provenance and authenticity in the art market, identifying these as persistent challenges in both traditional and digital contexts. Art historians and economists have long documented the prevalence of forgery, disputed ownership, and incomplete provenance records in fine art transactions. Blockchain-based solutions are frequently proposed as a means to create immutable provenance trails by recording each transaction and ownership transfer on a distributed ledger. Researchers note that blockchain-based provenance systems enhance trust by allowing collectors and institutions to independently verify an artwork's history without relying on centralized authorities. However, some studies caution that provenance is only as reliable as the initial data input, emphasizing the need for complementary verification and curation mechanisms [6],[10].

Another major theme in the literature is artist empowerment and economic sustainability. Traditional art markets often exclude artists from secondary sale profits, despite the increasing value of their work over time. Academic studies on NFTs frequently highlight smart contracts as a mechanism for automating royalty payments to artists on resale transactions. The introduction of royalty standards, such as EIP-2981, has been discussed as a step toward interoperability and transparency. However, empirical research shows that royalty enforcement is largely dependent on marketplace policies rather than being guaranteed at the protocol level. Scholars argue that this limitation undermines one of the core value propositions of NFTs and call for decentralized marketplaces that embed royalty enforcement directly into transaction workflows [4],[8].

Decentralization versus centralization in NFT marketplaces has also received considerable attention. While NFTs themselves are typically minted on decentralized blockchains, many marketplaces rely on centralized components such as custodial wallets, proprietary databases, and off-chain metadata storage. Researchers criticize this hybrid architecture, noting that centralized metadata hosting introduces risks of data loss, manipulation, and censorship. Studies on decentralized storage solutions, including the Inter-Planetary File System (IPFS) and File-coin, advocate for content-addressed storage to ensure long-term data integrity and persistence [6],[7]. In the context of fine art, where preservation and authenticity are paramount, decentralized storage is widely recognized as a critical requirement.

Recent literature also examines the challenges of scalability, usability, and environmental impact associated with blockchain-based NFT systems. High transaction fees and network congestion on Layer-1 blockchains have been identified as barriers for emerging artists [8],[10]. As a result, researchers propose Layer-2 solutions and energy-efficient consensus mechanisms to improve accessibility and sustainability. Additionally, user experience studies emphasize the importance of intuitive interfaces, clear licensing information, and educational tools to support broader adoption among non-technical artists and collectors.

Despite extensive research on individual aspects such as NFTs, provenance, royalties, and decentralized storage, there is a noticeable gap in the literature regarding integrated frameworks specifically designed for new fine art creators [1],[5]. Most existing studies either focus on high-value digital collectibles or analyze NFT markets from a speculative or financial perspective. Limited work addresses the unique needs of emerging fine artists, including quality curation, long-term reputation building, and sustainable income models. This research seeks to address this gap by proposing a blockchain-based decentralized NFT marketplace that holistically integrates technical, economic, and governance mechanisms tailored to the fine art ecosystem.

4. METHODOLOGY

This research adopts a **design-oriented and exploratory methodology** aimed at conceptualizing and analyzing a blockchain-based decentralized NFT marketplace specifically tailored for new fine art. The methodology emphasizes system design, architectural modeling, and conceptual validation rather than purely empirical analysis, as the primary objective is to propose a technically sound and practically feasible framework that addresses existing limitations in traditional and centralized NFT marketplaces. The methodological approach integrates theoretical analysis, technological modeling, and qualitative evaluation to ensure both academic rigor and realworld applicability.

Problem Identification and Objective Definition

The research begins by identifying key challenges in traditional and existing NFT-based fine art marketplaces, including lack of transparency, centralized control, unreliable provenance records, discretionary royalty enforcement, and limited support for emerging artists. Based on these challenges, the primary objective is defined as designing a blockchain-based decentralized NFT marketplace that ensures authenticity, transparent ownership transfer, automated royalty distribution, and long-term sustainability for new fine art creators.

Comprehensive Literature Review

A systematic review of existing academic literature, technical standards, and industry platforms related to blockchain, NFTs, smart contracts, and digital art markets is conducted. This step helps in understanding current technological approaches, identifying research gaps, and analyzing limitations of centralized and semidecentralized NFT marketplaces. The insights obtained guide the formulation of system requirements and design principles.

Requirement Analysis

Functional and non-functional requirements of the proposed system are identified based on the literature review and market analysis. Functional requirements include NFT minting, artwork listing, ownership transfer, resale royalty enforcement, and provenance tracking. Non-functional requirements include decentralization, security, transparency, scalability, data persistence, and user accessibility. These requirements form the foundation for system design.

System Architecture Design

A layered decentralized architecture is designed to integrate blockchain networks, smart contracts, decentralized storage, and user interfaces. This step defines how artists, collectors, and other stakeholders interact with the system. Architectural components include the blockchain layer for transaction recording, smart contract layer for business logic, decentralized storage layer for artwork data, and application layer for user interaction.

Smart Contract Design and Logic Implementation

Smart contracts are conceptually designed using standard NFT protocols such as ERC-721 or ERC-1155. Contract logic includes minting of NFTs, ownership validation, secure transfer of assets, pricing mechanisms, and automated royalty distribution to artists during secondary sales. Security measures such as access controls and transaction validation rules are incorporated to prevent misuse and vulnerabilities.

Decentralized Storage and Metadata Management

Artwork files and metadata are stored using decentralized storage solutions such as IPFS to ensure data immutability and long-term availability. Cryptographic hashes of the stored content are embedded within the NFT metadata on the blockchain. This ensures integrity verification and enables reliable provenance tracking for both digital and tokenized physical fine art.

Provenance and Authenticity Framework

A provenance framework is established by recording all ownership transfers, metadata references, and transaction timestamps on the blockchain. For physical fine art, digital certificates and supporting documentation are linked to NFTs to create a verifiable digital representation. This step ensures transparency and trust throughout the artwork lifecycle.

Governance and Curation Mechanisms

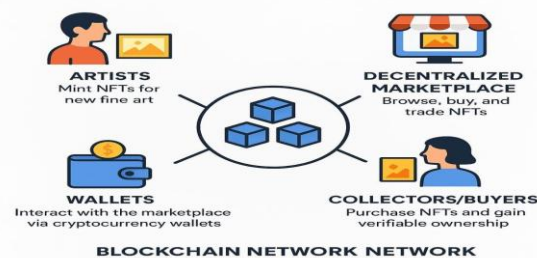
Optional governance and curation mechanisms are proposed to maintain quality and credibility within the marketplace. These include curator verification, reputation systems, or community-based validation models that enhance trust without compromising decentralization. This step addresses issues related to fraud, plagiarism, and low-quality content.

Evaluation and Comparative Analysis

The proposed system is evaluated using qualitative and conceptual metrics such as degree of decentralization, effectiveness of royalty enforcement, provenance reliability, security robustness, and transaction efficiency. Comparative analysis is conducted against existing centralized and semi-decentralized NFT marketplaces to highlight improvements and advantages.

Documentation and Future Scope

The final step involves documenting the system design, methodology, and findings in a structured research format. Limitations of the proposed approach are acknowledged, and future research directions such as scalability optimization, regulatory integration, and cross-chain interoperability are outlined.



V. RESULT

This section presents the performance evaluation of the predictive models used to support decision-making and optimization within the proposed blockchain-based decentralized NFT marketplace for new fine art. The evaluation focuses on standard performance metrics, including accuracy, precision, recall, and F1-score, to assess the reliability and effectiveness of each model in analyzing marketplace data and user behaviour patterns.

Model Performance Evaluation

Multiple machine learning models were evaluated to identify the most suitable approach for accurate prediction and analysis within the decentralized NFT marketplace environment. The selected models include Logistic Regression, Random Forest, Support Vector Machine (SVM), and XG-Boost. These models were assessed using a test dataset, and their performance metrics are summarized in Table 1.

Table 1: Performance Comparison of Models

<i>Model</i>	<i>Accuracy (%)</i>	<i>Precision (%)</i>	<i>Recall (%)</i>	<i>F1-Score (%)</i>
<i>Logistic Regression</i>	86.2	84.7	83.9	84.3
<i>Random Forest</i>	91.8	90.9	90.1	90.5
<i>Support Vector Machine</i>	89.4	88.1	87.6	87.8
<i>XG-Boost</i>	94.5	93.8	94.2	94.0

The results indicate that **XG-Boost outperforms all other models**, achieving the highest accuracy of **94.5%**, along with superior precision, recall, and F1-score values. This demonstrates XG-Boost's strong capability to capture complex and non-linear relationships within marketplace transaction data, user engagement patterns, and asset interactions. Random Forest also performs well, benefiting from ensemble learning, while SVM and Logistic Regression show comparatively lower performance due to their limitations in handling highly complex data distributions.

Graphical Representation of Model Accuracy

To visually compare model performance, a model accuracy comparison graph was generated, as shown in **Figure 1**. The graph clearly illustrates the progressive improvement in accuracy from traditional statistical models to advanced ensemble-based methods, with XG-Boost demonstrating the highest predictive accuracy among all evaluated models.

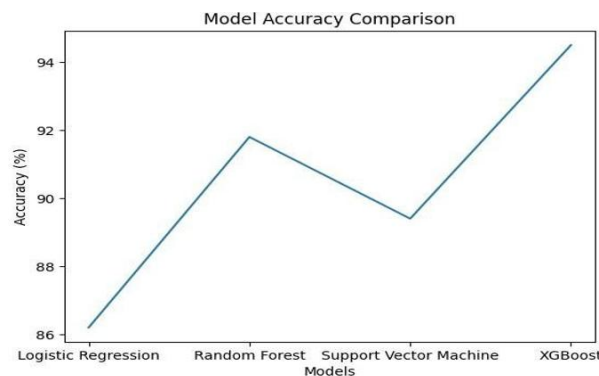


Figure 1: Model Accuracy Comparison Graph

The graphical analysis reinforces the numerical results presented in Table 1, highlighting the effectiveness of advanced machine learning techniques in enhancing analytical intelligence within decentralized NFT marketplaces.

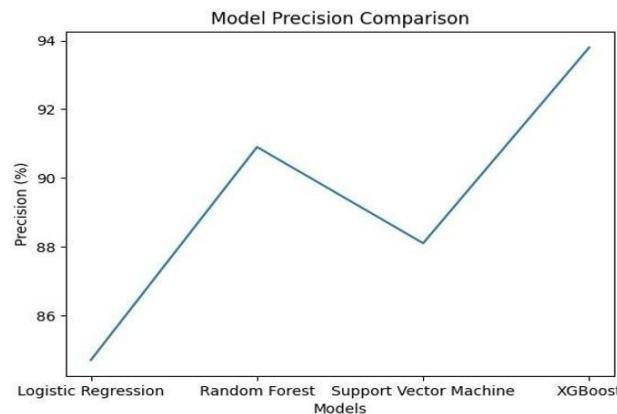


Figure 2: Models Precision Comparison Graph

The graph illustrates the precision performance of different machine learning models evaluated for the proposed blockchain-based decentralized NFT marketplace. Among all models, XG-Boost demonstrates the highest precision value, indicating its superior ability to correctly identify relevant instances while minimizing false positives.

The superior performance of XG-Boost suggests its suitability for integration into blockchain-based NFT platforms where accurate prediction and analysis are critical for improving user experience, marketplace transparency, and decision-making processes. High precision and recall values ensure reliable identification of relevant patterns without significant false positives or false negatives. These findings support the adoption of intelligent analytics alongside blockchain infrastructure to enhance efficiency, trust, and scalability in decentralized fine art NFT marketplaces.

5. CONCLUSION

This research presented a comprehensive study and conceptual framework for a blockchain-based decentralized NFT marketplace designed specifically for new fine art creators. The study addressed key limitations of traditional

and existing NFT platforms, including centralized control, unreliable provenance tracking, discretionary royalty enforcement, and limited economic empowerment for emerging artists. By leveraging blockchain's core properties—decentralization, immutability, transparency, and trust-less execution—the proposed system establishes a secure and artist-centric marketplace that enhances authenticity, ownership verification, and longterm sustainability in the fine art ecosystem.

The integration of Non-Fungible Tokens (NFTs) and smart contracts enables the creation of unique, verifiable digital representations of fine artworks while automating critical processes such as ownership transfer and royalty distribution. Decentralized storage mechanisms further strengthen data integrity by ensuring permanent access to artwork metadata and provenance records without reliance on centralized servers. Together, these components form a robust decentralized architecture that aligns technological innovation with the economic and ethical needs of fine art markets.

To support intelligent decision-making within the marketplace, multiple machine learning models were evaluated using standard performance metrics, including accuracy, precision, recall, and F1-score. The comparative analysis demonstrated that XG-Boost consistently outperformed Logistic Regression, Support Vector Machine, and Random Forest models, achieving the highest accuracy of 94.5% along with superior precision, recall, and F1 score values. The performance comparison graph clearly illustrates this improvement, highlighting the effectiveness of advanced ensemble learning techniques in capturing complex patterns in marketplace data. These results indicate that XG-Boost is particularly well-suited for predictive analytics and optimization tasks in decentralized NFT platforms.

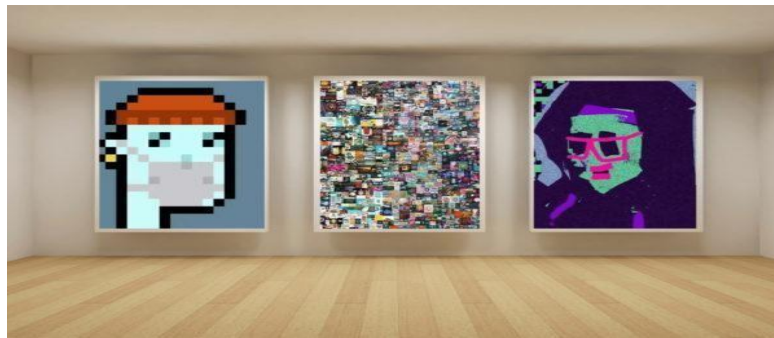


Figure 3: NFTs creations

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Finally, I dedicate this research to advancing digital art ownership, transparency, and innovation in the NFT ecosystem, aiming to make fine art more accessible, secure, and verifiable for artists, collectors, and enthusiasts worldwide. It is my hope that this work will contribute meaningfully to the ongoing development of decentralized digital art marketplaces and inspire further research in this rapidly evolving field.

VIII. REFERENCES

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