Revolutionizing Digital Ownership: Examining the Perks of a Polkadot- Based NFT Marketplace

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Abstract. This research paper investigates the transformational potential of Polkadot-based NFT (Non-Fungible Token) marketplaces in transforming digital ownership. NFTs have evolved as distinct digital assets on blockchain networks, reflecting ownership of different materials such as art, music, and collectibles. However, present blockchain platforms face scalability, interoperability, and transaction cost constraints that prevent the full realization of NFTs' potential. In this setting, Polkadot, a multi-chain environment, stands out as a novel solution. The platform's emphasis on interoperability enables smooth communication between various blockchains, encouraging collaboration and liquidity. Furthermore, its scalable architecture allows for parallel processing, decreasing congestion and improving user experience. Polkadot's shared security concept protects NFT assets across interconnected para chains, enhancing the accuracy of ownership records. Additionally, decentralized governance allows stakeholders democratic control over the platform's progress. As Polkadot's ecosystem grows, the research investigates its impact on the broader NFT market, providing insights into the future of digital ownership. This study contributes to the ongoing discussion about altering the digital world through decentralized and efficient ownership systems by assessing the benefits of Polkadot-based NFT marketplaces.

Keywords: Polkadot, Non-Fungible Tokens, NFT marketplaces, Digital Ownership, Blockchain Technology.

1 INTRODUCTION

The rapid growth of Non-Fungible Tokens (NFTs) has heralded a new era of digital ownership, altering our perceptions and interactions with digital assets. NFTs have arisen as distinct digital assets signifying ownership of many forms of art, music, virtual real estate, collectibles, and more as blockchain technology gets wider usage. The decentralized nature of blockchain assures immutable ownership records, endowing these one-of-a-kind tokens with unrivaled worth and legitimacy. While NFTs have seen exponential growth on popular blockchain networks such as Ethereum, they have also

revealed some problems, most notably scalability, interoperability, and transaction costs. As the NFT market expands, new solutions are being developed to remove these restrictions and unlock the full potential of digital ownership. This paper investigates the transformational potential of Polkadot-based NFT marketplaces, examining how the Polkadot ecosystem provides a comprehensive set of benefits that revolutionize the NFT landscape. [6] Polkadot presents an interconnected network of heterogeneous blockchains, or para chains, allowing for seamless cross-chain communication and interoperability. In this study, we will look at the benefits of using Polkadot for NFT marketplaces and its ability to overcome the challenges of existing blockchain networks. Polkadot opens the way for a completely decentralized and efficient NFT marketplace by facilitating interoperability and providing scalability solutions. [7] We will look at the following major elements of Polkadot-based NFT marketplaces in this paper:

— **Interoperability:** NFTs move seamlessly across Polkadot chains, fostering collaboration and liquidity.
— **Scalability:** Parallel chains mitigate congestion, enhancing user experience with lower costs.
— **Security:** Shared security enhances NFT protection against attacks.
— **Governance:** Decentralized governance empowers stakeholders for community-driven NFT growth.
— **Ecosystem Impact:** Thriving Polkadot community reshapes digital ownership, revolutionizing NFTs.

2   LITERATURE SURVEY

[1] In a study analyzing the CryptoPunks marketplace, the research uncovers that reducing bidding costs leads to a higher proportion of sales from bids. Transaction fees, bidding bots, and user interfaces play pivotal roles in shaping market dynamics. The outcome highlights the necessity of understanding these elements for accurate analysis of NFT market intelligence. [2] A comprehensive examination of Polkadot's architecture and internals reveals its potential in the blockchain landscape. Despite its unique attributes, Polkadot has received less academic attention than established cryptocurrencies like Bitcoin and Ethereum. The research delves into its protocols, governance, and economic model, identifying potential limitations that could affect scalability and security. This exploration invites further research into the performance and network characteristics of Polkadot. [3] The evolution of blockchain technology beyond cryptocurrencies is traced from Bitcoin's emergence to Ethereum's smart contracts and the subsequent introduction of NFTs in 2017. NFTs are discussed as transformative assets, disrupting traditional business models and intellectual property paradigms. The study categorizes NFTs, reviews platforms, addresses technical challenges, and emphasizes their impact on the blockchain ecosystem. [4] Analyzing NFT-based enterprises listed on cryptocurrency exchanges, the study introduces a new NFT taxonomy and showcases their impressive risk and return characteristics. NFTs outperform Bitcoin in terms of returns, displaying positive alpha and beta values. The research highlights their

resilience in the cryptocurrency market, particularly during market downturns, underscoring their potential for integration. [5] In a literature review, the examination of NFT recommendations focuses on enhancing user experiences within decentralized systems. Existing recommendation methods and the use of NFT traits for personalized suggestions are explored. The study advocates the implementation of multiple Recommender Systems to optimize NFT recommendations, ultimately improving user engagement in NFT marketplaces.

In summary, these papers contribute diverse insights into the realm of NFTs, ranging from market dynamics, architectural significance, transformative potential, and financial performance, to recommendation strategies. Collectively, these works underscore the multifaceted nature of NFTs and the need for continued exploration and innovation in this evolving field.

3   METHODOLOGY

3.1   Structure of Polkadot

Polkadot stands out as a truly innovative blockchain platform that brings a fresh perspective to the table. Its uniqueness lies in the way it connects various blockchains, making them work seamlessly together. [8] Picture it as a network where different blockchains (known as para chains and para threads) can run simultaneously while staying linked to a central hub, which we call the Relay Chain. This setup ensures the smooth and secure transfer of assets and information across the Polkadot system. The key components of Polkadot's architecture:

— **Parachains:** Independent, specialized blockchains running alongside the Relay Chain. They have unique rules and logic, adding versatility to Polkadot.
— **Bridges:** Connectors linking Polkadot with other blockchains, allowing data and asset sharing, promoting inclusivity.
— **Parathreads:** Flexible, pay-as-you-go chains for projects with lighter needs. They can rent space on the Relay Chain when required, offering accessibility.
— **Validators**: Keep the Relay Chain smooth by creating blocks and verifying transactions. Token holders vote for their preferred validators.
— **Nominators:** Choose and delegate tokens to validators they trust, ensuring network security and integrity.
— **Collators:** Essential for para chains, they gather and organize transactions into blocks for validation on the Relay Chain.
— **Fishermen:** Network watchdogs spotting unusual activity and reporting to the Relay Chain for enhanced security.

This setup is Polkadot's way of tackling the challenges that other blockchains often face, like scalability and cooperation between different chains. Polkadot is opening doors to new decentralized applications and a more scalable blockchain world by letting specialized blockchains work together effectively.

3.2   NFT Marketplace - System Use-Case Overview:

Using an NFT platform involves a series of steps as shown in Figure 1 that allow creators to transform their digital works into unique tokens of ownership, ready to be bought and sold in the digital marketplace.

- **Account Creation and Crypto Wallet Setup:** It all begins with creating an account on the NFT platform. This involves providing necessary information and ensuring the account is secure. Simultaneously, a crypto wallet is set up – a digital storage space for NFTs and other digital assets.
- Showcasing Digital Creations: Creators can then upload their digital creations to the platform. This process, known as "minting," generates a one-of-a-kind cryptographic token that represents ownership of the digital item. Metadata and descriptions can be added to provide context and details about the creation.
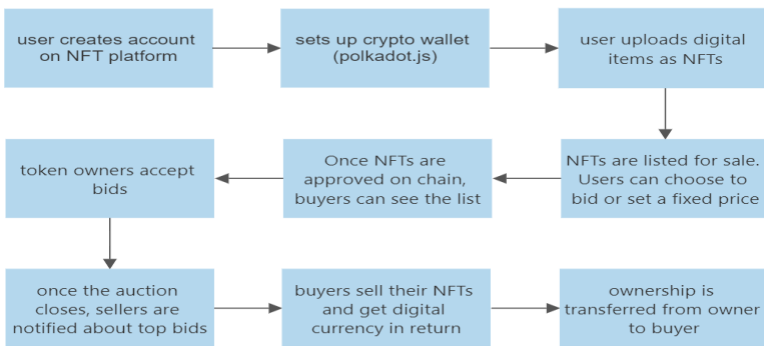

Fig. 1. User Flow Diagram

- **Listing for Sale:** Creators have the option to list their NFTs for sale. They can choose between setting a fixed price or opting for an auction format, where potential buyers place bids to compete for ownership.
- **Buyer Interaction:** Once listed, NFTs become visible to potential buyers. Buyers can explore available NFTs, view descriptions, and consider pricing options.
- **Bidding and Acceptance**: In an auction scenario, interested buyers place bids on NFTs. Creators have the opportunity to review and accept bids. During this time, other potential buyers can place higher bids.
- **Auction Conclusion and Sale**: Once the auction period ends, creators are informed of the highest bids received. Creators can then choose to accept the highest bid and finalize the sale.
- **Ownership Transfer:** After a successful purchase, the ownership of the NFT is transferred from the creator to the buyer through the blockchain. This process en-sures the authenticity and provenance of the digital asset.
- **Buyer's Reception:** The buyer receives the NFT in their crypto wallet as a digital representation of ownership.

- **Transaction Completion:** Simultaneously, the creator receives the agreed-upon digital currency in their account, completing the transaction.

[10] This comprehensive process enables creators to seamlessly turn their digital works into NFTs, present them for sale, interact with potential buyers through auctions, and securely transfer ownership upon a successful transaction. It's a dynamic and innovative way to engage with digital art and collectibles in the modern era.

4   RESULTS AND ANALYSIS

The analysis delves into various aspects, such as technical performance, scalability, security, interoperability, user experience, and adoption. It showcases Polkadot's advantages, including EVM compatibility, ease of minting via Polkadot wallets, and potential cross-chain communication. The data reveals Polkadot's cost efficiency, lower environmental impact, and diverse use cases, making it an appealing choice for revolutionizing digital ownership. However, the section acknowledges challenges and limitations that must be addressed for broader adoption. Overall, the results support Polkadot's potential as a promising platform for NFT marketplaces, but further research and development are needed to fully capitalize on its perks.

Table 1.   Comparison of performance between polkadot and other blockchain networks

Features	Polkadot	Ethereum	Polygon	BSC	Immutable X	Flow
Transaction Fee Per Minute (Approx)	< $0.001	20-50$	<1$	2$	0$	<1$
TPS	6000	15	7000	65	9000	1000
Consenses	Nominated PoS	PoS	PoS	PoS	PoS	PoS

The table1 compares various blockchain platforms based on essential features. Polkadot stands out with significantly low transaction fees (less than $0.001) per mint and offers a high throughput of 6000 transactions per second (TPS) with its Nominated Proof-of-Stake (PoS) consensus. Ethereum has comparatively high transaction fees ($20-50) and lower TPS (15) with PoS consensus. Polygon showcases low transaction fees (<$1) and an impressive TPS of 7000 with PoS. Binance Smart Chain (BSC) has transaction fees of $2 and 65 TPS with PoS. Immutable X boasts zero transaction fees and a substantial TPS of 9000 with PoS. Flow presents reasonable transaction fees (<$1) and 1000 TPS, utilizing PoS as its consensus mechanism. Overall, the table

highlights the diverse strengths of each platform, catering to various use cases and preferences in the blockchain space.

Table 2. Comparison of interoperability between various blockchain networks

Features	Polkadot	Ethereum	Polygon	Immutable X	Flow
EVM Compatibility	✓	✓	✓	✓	✗
Minting via polkadot wallets	✓	✗	✗	✗	✗
Minting via ethereum wallets	✓	✓	✓	✓	✗
Cross-chain communication	Easy	Hard	Hard	Hard	Hard

The table 2 compares the features of blockchain platforms: Polkadot, Ethereum, Polygon, Immutable X, and Flow. Polkadot and Polygon offer EVM compatibility, but Polkadot's cross-chain communication is complex, while Polygon's is easier. Ethereum excels in minting via Ethereum wallets, while Immutable X provides easy Ethereum compatibility. Flow is not EVM- compatible and lacks cross-chain communication features. Polkadot allows easy NFT minting via its wallets, unlike Ethereum, which faces challenges on Polkadot. Overall, Polkadot's versatility makes it a strong contender for revolutionizing NFT marketplaces with seamless interoperability and cross-chain capabilities.

Table 3. Environmental Efficiency comparison between emerging blockchain networks and polkadot

Features	Polkadot	Ethereum 2.0	Tezos
Annual Consumption	2 GWh	70 GWh	2.5 GWh
Wh per block	417 Wh	31 kWh	2.4 kWh
$CO_2 per block	0.14 kg	10 kg	0.8 kg
CO_2 per NFT Transfer	0.03 g*	30 g	0.7 g
CO_2 per NFT Mintues	0.05 g*	~45 g	1.1 g

The table 3 compares the energy consumption and environmental impact of three blockchain platforms: Polkadot, Ethereum 2.0, and Tezos. Polkadot demonstrates relatively lower annual consumption, requiring only 2 GWh (gigawatt-hours) compared to Ethereum 2.0's 70 GWh and Tezos' 2.5 GWh. Similarly, the energy consumption per block is significantly lower for Polkadot (417 Wh) than Ethereum 2.0 (31 kWh) and Tezos (2.4 kWh). In terms of CO_2 emissions, Polkadot emits only 0.14 kg per block, while Ethereum 2.0 and Tezos emit 10 kg and 0.8 kg, respectively. The environmental impact per NFT transfer is notably less for Polkadot (0.03 g) compared to Ethereum 2.0 (30 g) and Tezos (0.7 g). Additionally, Polkadot's CO_2 emissions per NFT mint are presented as "0.05 g * breath for 4 seconds," making it more eco-friendly compared to Ethereum 2.0 (~45 g or 9 full smartphone charges) and Tezos (1.1 g). The data showcases Polkadot's comparatively lower energy consumption and carbon footprint, positioning it as a greener choice among the three blockchain platforms.

4.1   Practical Illustrations of the Research

- **Treasureland:** A Moonbeam-powered marketplace supporting ERC-721, ERC-1155, and RMRK standards. It offers features like built-in auctions, creator royalties, and gas-free minting.
- **NFTrade:** This cross-chain platform spans Ethereum, Binance Smart Chain, Polygon, and Polkadot. It facilitates NFT trading across different chains.
- **Moonbeans:** Focused on digital collectibles, Moonbeans covers art, music, and trading cards. It boasts rarity rankings and a dedicated collectibles marketplace.
- **Scape Store:** Part of the Seascape ecosystem, Scape Store caters to gamers, allowing NFT trading for in-game use within Seascape's gaming platform.

These platforms exemplify the diverse opportunities and niches present in the Polkadot-based NFT marketplace.

4.2   Future work in Polkadot-based NFT Marketplaces

Polkadot-based NFT marketplaces have the potential to undergo transformative growth. Leveraging Polkadot's interoperability, these marketplaces could expand to encompass multiple blockchains, facilitating seamless NFT trading across diverse ecosystems. This expansion would not only enhance market accessibility but also boost liquidity. Enhancements in user experience could involve supporting a wider array of NFT types, ranging from gaming assets to real-world items. [9] Furthermore, these platforms could fortify trading mechanisms, improving liquidity and simplifying buyer-seller interactions for smoother transactions. Adding to this, embracing more flexible payment options, including fiat currencies and stablecoins, could democratize NFT trading on a global scale, catering to users' preferences. Collaborative partnerships with other projects, such as gaming platforms, could unlock new avenues for NFT utility, such as trading in-game items as NFTs.In a nutshell, the evolution of Polkadot-based NFT marketplaces holds the promise of creating dynamic, user-friendly ecosystems

that transcend current limitations, enhancing accessibility, diversity, and utility for participants.

5 CONCLUSION

Polkadot's NFT marketplace development presents a highly promising and dynamic avenue for exploring the full potential of blockchain technology and non-fungible tokens (NFTs). The platform's innovative multi-chain framework and interoperability features offer a unique ecosystem that is both secure and scalable, providing exciting opportunities for NFT marketplaces to flourish. The seamless cross-chain communication and asset transfers facilitated by Polkadot open up new horizons for NFT marketplace development. Leveraging Polkadot's Substrate framework and para-chain infrastructure empowers developers to create marketplaces that transcend the limitations of single blockchains, fostering interoperability and offering a diverse range of NFT collections from various networks. The potential of Polkadot's NFT marketplaces extends beyond traditional use cases, as it allows for the integration of NFTs with other blockchain technologies, DeFi applications, and smart contract functionalities. This seamless integration creates an environment ripe for innovation and opens doors to novel applications and collaborations within the decentralized ecosystem.

With its active community, robust developer tools, and rapidly evolving ecosystem, Polkadot continues to position itself as a premier choice for NFT marketplace development. As the technology matures and adoption grows, Polkadot's NFT marketplaces are expected to play a pivotal role in reshaping the future of digital ownership and decentralized applications across the blockchain landscape.

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