Proceedings of the 3rd International Conference on Financial Technology and Business Analysis
DOI: 10.54254/2754-1169/137/2024.18809

Analysis of the Concepts and Applications of ETH: Finance, Online Payments and Transactions

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Abstract: With the rapid development of blockchain technology, encrypted assets have gradually become an important component of the global financial system. This study aims to analyze the concept of Ethereum (ETH) and its applications in finance, online payments, and transactions. This article first reviews the development history and research progress of blockchain, and then explores the current situation of the cryptocurrency market, with a focus on analyzing the basic characteristics and encryption algorithms of Ethereum. In the application section, this article discusses in detail the various applications of Ethereum in decentralized finance (DeFi) and non-fungible tokens (NFT), revealing its important role in promoting financial innovation and digital asset management. At the same time, the article also points out the limitations of Ethereum in terms of technical bottlenecks, compliance, and user education. Nevertheless, the future is still full of hope. Through this study, academia and industry practitioners can gain a deeper understanding of the potential and challenges of Ethereum, providing important references for its sustained development in the global financial ecosystem.

Keywords: Ethereum, DeFi, NFT, blockchain technology.

1. Introduction

Distributed ledgers and blockchain technology are drawing a lot of attention and triggering various projects across different industries [1-3]. Especially in the financial industry, blockchain technology can be well used for payments and transfers, securities and asset management, identity authentication, and anti-counterfeiting. This is not merely attributed to the widely recognized application of the technology, but also to the lack of the process efficiencies and the enormous cost issues [2]. As previously mentioned, blockchain is the technology that backs up the digital cryptocurrency system represented by Bitcoin. Recently, it has appeared an explosive growth direction in the research and application of blockchain technology due to the rapid development and popularization of Bitcoin. Blockchain technology's desirable traits include decentralization, integrity, immutability, verifiability, fault tolerance, anonymity, audibility, and transparency. One can find that many traditional problems can be well solved from the perspective of blockchain technology [4]. With the development of blockchain technology and the expansion of the exploration of its use, it has created significant opportunities together with other disruptive technologies such as big data, the Internet of Things,

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intelligent assistants and autonomous vehicle, and has produced potential unexpected social consequences [2, 5].

Bitcoin is the world's first completely Cryptocurrency, first proposed in the year of 2008 and officially initiated in 2009. Prior to the arrival of alternative blockchains like Ethereum, the future of decentralization was entirely in the hands of Bitcoin [6]. Bitcoin, as a cryptocurrency, has become a Notable financial software system. Such Systems rely on a secure decentralized ledger framework for mining, which is an important factor in them. Users can achieve secure and robust consensus for each transaction by adding records of past transactions to the distributed ledger known as Blockchain through mining. Wealth is also introduced through new units of currency [7]. The cryptocurrency market has faced significant instability and unheard-of changes within a short period of time [8]. Since Bitcoin was launched as the first anarchist cryptocurrency in January 2009, over 550 cryptocurrencies have been created, but most have only experienced limited successes. This research aims to delve into the applications and potential of Ethereum in fields such as finance, online payments, and transactions. In the financial field, Ethereum's decentralized financial applications provide efficient and low-cost financial services, challenging the operation mode of traditional financial systems. In terms of online payments, Ethereum's decentralized features simplify the cross-border payment process, improving transaction security and transparency. In the field of trading, Ethereum's decentralized exchange has promoted market fairness and openness. In addition, Ethereum's encryption algorithm ensures the security of transactions and data, protecting user privacy.

However, the current application of Ethereum also faces some challenges. Firstly, network scalability issues result in high transaction costs and slow processing speeds. Secondly, although blockchain has improved transaction transparency, user privacy protection still needs to be further strengthened. The application of Ethereum is uncertain due to the differences in regulatory policies for encrypted assets globally. There is still a wide assortment of growth prospects for Ethereum in the future. The gradual establishment of a global regulatory framework will provide support for the international development of Ethereum. The objective of this study is to furnish a comprehensive analysis of Ethereum's current application status, challenges, and future potential in the fields mentioned above, which will provide valuable references for further research and practice in related fields.

2. Basic Descriptions of ETH

Ethereum is an innovative decentralized platform centered around smart contract technology, which allows developers to create and run self-executing protocols on the blockchain. Ethereum's core is comprised of smart contracts, which are self-executing codes on the blockchain that enable automated execution of protocol terms. Smart contracts' design allows transactions to be conducted directly without intermediaries, which not only improves efficiency but also lowers transaction costs. Ethereum was made public in 2014 and commenced operations in 2015, with the goal of creating a fully functional application platform utilizing blockchain technology. It incorporates a Turing-complete programming language, which theoretically enables the execution of all applicable computations in smart contracts, i.e., codes that are permanently inscribed on the blockchain and can interact with user requests [9]. The core value of Ethereum lies in its fully functional programming language, which is well suited for implementing complex business logic and running in a decentralized manner [2]. Applications that do not rely on trusted third parties are particularly attractive in areas such as crowdfunding, financial services, identity management, and gambling. The Ethereum Virtual Machine (EVM) is the core component of the platform, providing a distributed computing environment that enables smart contracts to be securely executed globally. Currently, Ethereum is undergoing an upgrade to version 2.0, which introduces sharding technology to further enhance the network's transaction processing capabilities and reduce transaction costs.

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Ethereum's performance in Distributed finance and unique tokens has been exceptional at the moment. DeFi applications leverage smart contracts to offer financial services like lending and trading, which pose a challenge to the traditional financial system's operating model. Meanwhile, NFTs have introduced new business opportunities in the digital art and collectibles markets. However, the widespread use of these applications has also brought about problems of network congestion and high transaction costs [10, 11].

In terms of encryption security, Ethereum encrypts transaction data through hash functions to ensure that the data on the blockchain is tamper proof. In addition, the platform adopts a public-private key encryption mechanism to protect the security of user accounts. Signing transactions is done with the private key, while the public key is used to ensure the transactions are genuine. In terms of consensus mechanisms, PoW and PoS algorithms maintain network security through computing power and economic incentives, respectively. Overall, Ethereum provides solid support for the popularization and development of decentralized services with its strong technological foundation and continuously optimized network mechanisms.

3. Applications of ETH

The use of traditional blockchain technology in finance does not meet the expectations. The transaction throughput of many classic blockchains is embarrassingly low [9]. Decentralized finance (DeFi) and NFT markets have made a significant improvement to this problem, as they have completely altered what happens on the blockchain. In addition to the significant increase in transaction throughput, Ethereum still has many other huge positive applications. The decade long Studies and progress in blockchain technology. technology have led to an emergence concerning unique tokens. These digital assets are mirrored by tokens, which bear verification of ownership [10]. Each token's unique and distinctive novel features enhance the security of assets [11]. NFT has a wide range of applications in various fields such as education, fashion, sports, and digital arts [12].

Ante's research examined the growth and underlying dynamics of the non-fungible token (NFT) market since the start of 2021, utilizing data from the Ethereum blockchain starting from June 2017 and ending in May 2021, covering 14 major sub markets [13]. The success of the CryptoKitties project led to the Ethereum NFT market reaching its trading peak by the end of 2017, as the research shows. Although the number of transactions decreased by 2021, the value of transactions significantly increased. The research results show that there is a co integration relationship and multiple short-term causal relationships between NFT sub markets. The success of young projects is influenced by mature markets, while the performance of emerging markets also affects mature projects in turn. These findings provide an important perspective for understanding NFT as an emerging asset class and reveal the immaturity and inefficiency of the market. The summary of the transactions are illustrated in Fig. 1 [13].

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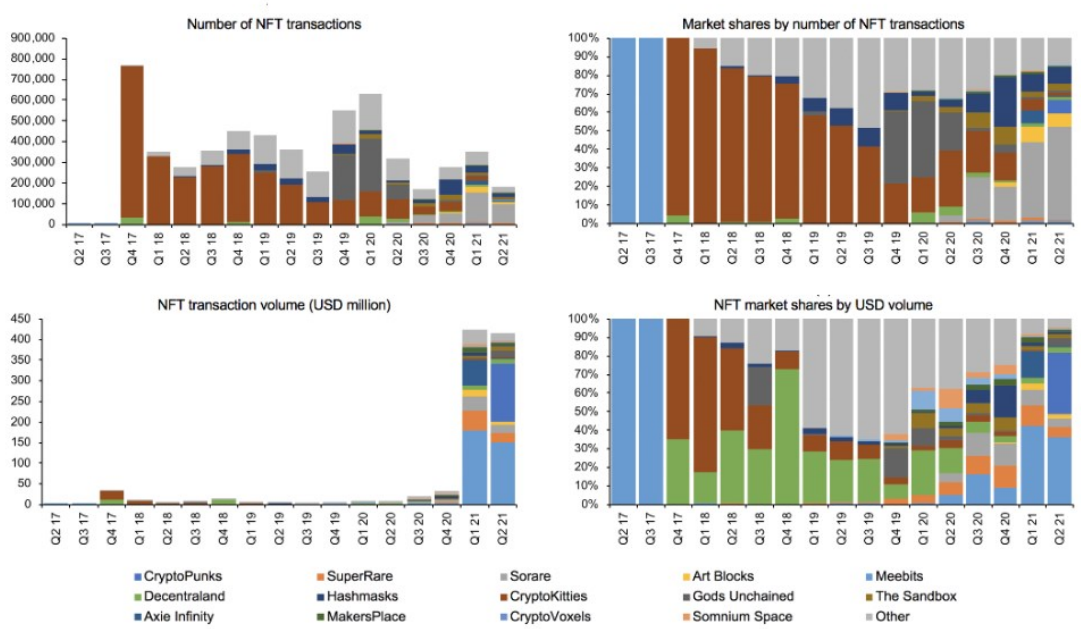

Figure 1: NFT transactions summary [13].

Kim et al. proposed a new type of reference called perpetual contract, which is a futures contract without an expiration date that can serve as collateral, and its corresponding NFT is the rights associated with the perpetual contract and its collateral [11]. This application is gradually addressing the issue of cryptocurrencies not being able to become a medium of payment and exchange. The main reason is the large price fluctuations, which have not brought enough credit confidence to people. Decentralized finance (DeFi) has been brought about by the introduction of smart contracts and standardized token interfaces on the Ethereum blockchain. Qiao et al. explored the time-frequency extreme risk spillover relationship between cryptocurrencies, decentralized finance (DeFi), and non-fungible tokens (NFT) using wavelet analysis [12]. Research has found that long-lived coins dominate the up and down risks of cryptocurrencies, while liquidity mining tokens exacerbate DeFi's depreciation has short-term risk, but manage it effectively in the medium term. NFTs related to Metaverse occupy a central position in the upstream risk network, but the trend is opposite in the long run. Traditional concepts have a negative impact on depreciation risk, while emerging concepts have a positive impact on market prosperity. Ultimately, these findings give investors advice on diversified strategies and risk management.

Ethereum, as a leading blockchain technology, has demonstrated significant advantages and disadvantages in its application in the financial sector. Recently, there has been notable rapid expansion in the decentralized finance (DeFi) and non-fungible token (NFT) markets, Ethereum has effectively increased transaction throughput and significantly improved the limitations of traditional blockchain in processing transaction efficiency. The NFTs supported by Ethereum not only represent digital assets, but also embed proof of ownership, making them widely used in various fields such as education, fashion, sports, and digital arts. These applications not only enrich the forms of digital assets, but also provide creators and users with more value and opportunities for participation. In addition, the introduction of new financial instruments such as perpetual contracts, combined with the use of NFTs, provides a solution for cryptocurrency payments and transactions, alleviating the trust crisis caused by price fluctuations. The use of smart contracts and standardized token interfaces further promotes the development of decentralized finance, greatly improving the efficiency and security of financial transactions.

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However, Ethereum also faces many challenges. Firstly, during network congestion, transaction fees will significantly increase, which puts high costs on users when conducting transactions, thereby affecting the willingness of ordinary users to participate. Secondly, the performance of the NFT market has shown issues of immaturity and inefficiency, with increased market volatility affecting investor confidence and market stability. Despite the introduction of new financial instruments, the price fluctuations of Ethereum and its derivative assets remain significant, failing to completely dispel people's doubts about its role as a payment medium. In addition, the transaction throughput of many classic blockchains is still very low, which makes Ethereum still face technical bottlenecks when processing large-scale transactions. Therefore, although Ethereum has performed well in improving transaction efficiency, introducing innovative financial tools, and expanding application scenarios, it still needs to actively seek solutions in terms of transaction costs, market maturity, and volatility risks to promote its sustained development and improvement.

4. Limitations and Prospects

Smart contracts and decentralized applications (DApps) are supported by Ethereum (ETH), an open-source blockchain platform that provides an infrastructure. In the fields of finance, online payments, and transactions, it has demonstrated enormous potential for application, but also faces some significant limitations. At present, there are several main limitations in the research on the application of Ethereum. Firstly, technological bottlenecks are a prominent issue. The transaction speed and network throughput of Ethereum are often limited during peak periods, resulting in transaction delays and high gas fees. For example, during network congestion, transaction fees may soar several times, seriously affecting user experience, especially for ordinary users. Secondly, although the DeFi (decentralized finance) and NFT (non fungible token) markets are growing rapidly, they are still in a relatively immature stage. These markets exhibit high volatility and liquidity risk, causing investors and users to face significant uncertainty when using these financial products. This instability not only affects the confidence of market participants, but may also have a negative impact on the overall health and sustainable development of the market. In addition, compliance and regulatory issues cannot be ignored. There are significant differences in regulatory policies for Ethereum and its applications in different countries and regions, which makes compliance issues complex. For example, some countries have strict regulations on cryptocurrency trading, while others may lack clear regulatory frameworks. The lack of unified standards also limits the interoperability between different applications, thereby affecting the widespread application of technology. Finally, the lack of user education is also a major challenge. Many potential users still have limited understanding of Ethereum and its applications, which to some extent hinders its widespread use. Existing research often fails to fully explore how to improve users' knowledge level and usage ability, which makes it challenging for average users to fully understand the potential and functionalities of Ethereum.

Despite these limitations, the outlook for future development remains optimistic. Some technological improvements will help alleviate current bottlenecks and promote the implementation and popularization of more applications. In the future, the scalability and processing capabilities of the network will be greatly improved to accommodate a greater number of users and applications. In addition, with the development of blockchain technology, future research can focus on the interoperability between Ethereum and other blockchain platforms. The maturity of cross chain technology will allow assets and information to flow freely between different blockchains, thereby expanding the application scenarios of Ethereum and enhancing its integration capabilities in the global blockchain ecosystem. With the gradual standardization and maturity of DeFi and NFT markets, investors will have a more reliable investment environment. Future research can explore how to improve market structure and develop new financial products to address market volatility and liquidity issues, thereby promoting the diversification and stable development of Ethereum

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applications. In order to promote the widespread application of Ethereum, future research should also focus on simplifying the user interface and operation process, making it easier for ordinary users to understand and use Ethereum's financial services. At the same time, strengthening user education and training will help users comprehensively grasp the functions and application scenarios of Ethereum, thereby enhancing its usage and popularity.

5. Conclusion

In summary, Ethereum (ETH) has demonstrated enormous potential in the fields of finance, online payments, and transactions, becoming an important representative of blockchain technology. This research begins by examining the historical development and research advancements of blockchain technology, followed by an analysis of the current state of the cryptocurrency market. It specifically emphasizes the fundamental characteristics of Ethereum, its consensus algorithms, and its encryption features. By thoroughly examining Ethereum's various applications in non-fungible tokens (NFTs) and decentralized finance (DeFi), one emphasize its important role in promoting financial innovation and managing digital assets. However, despite the broad application prospects of Ethereum, it also faces limitations such as technical bottlenecks, compliance challenges, and insufficient user education. Looking ahead, Ethereum will continue to have a significant impact on the global financial system, driving broader technological innovation and application development. These issues have to some extent constrained the popularity and application of Ethereum. Overall, this study not only provides a theoretical foundation for the academic community, but also offers important guidance for industry practice, helping practitioners understand the potential and challenges of Ethereum.

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